How Universal School Vouchers Affect Educational and Labor Market Outcomes: Evidence from Chile

David Bravo Sankar Mukhopadhyay Petra E. Todd[1]

[1]David Bravo is Professor of Economics at the University of Chile and Director of the Microdata Center. Sankar Mukhodpadhyay is Assistant Professor of Economics at the University of Nevada. Petra Todd is Professor of Economics at the University of Pennsylvania. A preliminary version of this paper was presented at a conference in Amsterdam in May, 2008 and at the annual meeting of the Society of Chilean economists in September, 2008. We thank Jere R. Behrman, Sergio Urzua, and Kenneth I. Wolpin for helpful discussions. We are grateful for research support from a grant from the Spencer Foundation. We also acknowledge the support in the form of a pilot grant from the National Institutes of Health - National Institute on Aging, Grant number P30 AG12836, the Boettner Center for Pensions and Retirement Security at the University of Pennsylvania, and National Institutes of Health - National Institute of Child Health and Development Population Research Infrastructure Program R24 HD-044964, all at the University of Pennsylvania.

Abstract

This paper studies the effects of school vouchers in Chile, which adopted a nationwide school voucher program 28 years ago. Chile has a relatively unregulated, decentralized, competitive market in primary and secondary education and therefore provides a unique setting in which to study how voucher programs affect school choice as well as educational attainment and labor market outcomes. This paper develops and estimates a dynamic model of schooling and work decisions using data from the 2002 *Historia Laboral y Seguridad Social* and the 2004 *Enquesta Proteccion Social* (EPS) surveys. The dataset includes rich demographic information as well as contemporaneous and retrospective schooling and work information covering a thirty-five year time frame. Some individuals in the sample completed their schooling before the voucher program was introduced, while others had the option of using the vouchers over part or all of their schooling careers. The impacts of the voucher program are identified from the differences in the schooling and work choices made and wage returns received by individuals differentially exposed to the voucher reform. Simulations based on the estimated dynamic model indicate that the voucher reform induced individuals exposed to the voucher program to attend private subsidized schools at a higher rate. It also led to a compression of the educational attainment distribution, to an increase in wages of about 4% on average and to an increase in labor force participation. An examination of distributional effects shows that the voucher program benefitted individuals from both poor and non-poor backgrounds.

1 Introduction

School vouchers were first proposed by Milton Friedman (1962) as a way of improving quality of schooling. Friedman supported a role for government in the funding of schooling, but he argued that schooling might be more efficiently provided in the private sector. At first, his voucher proposal was considered a radical idea and was not seriously considered as a policy alternative, but school vouchers have since garnered support among policy-makers looking for ways to improve school quality. Recent advocates of voucher programs point to their value in fostering competition among schools, which is thought to generate quality improvements in both public and private school systems, and to their potential value in promoting equality of educational opportunity (Brighouse, 2000, Rouse, 1998, Hoxby, 2001, 2003). However, critics caution that voucher programs deplete already poorly funded public school systems of revenue, of their best students and possibly also of their best teachers and therefore may increase inequality (e.g., Ladd, 2002).

School voucher programs have been implemented in some U.S. cities, including Milwaukee, Dayton, New York City, the District of Columbia, Cleveland, and Denver and also in the state of Florida. Most of the existing programs are available only to children from low income families and/or from poor performing schools.[1] The evidence on the effectiveness of these programs in improving child test scores is mixed. (See, e.g., Krueger and Zhu, 2004, Yau, 2004, Peterson, Howell and Greene, 1999 and section two of this paper). The small-scale of most programs and their selective targeting makes it difficult to draw inference about the likely effects of vouchers were they to be adopted on a broader scale. Notably, the scale of existing programs has been too small to induce a supply response in the private schooling sector, which one would expect to occur with wider adoption. There are also no empirical studies for the U.S. or other countries of the potential long-term effects of voucher programs on educational attainment, earnings and employment outcomes.

This paper studies the effects of school vouchers in Chile, which adopted a nationwide

[1] The Cleveland program is an exception.

school voucher program in 1980. The voucher program was one of several market-oriented reforms initiated under Augusto Pinochet's military regime. At the time of the voucher program's adoption, Chilean economic and social policy was strongly influenced by the Chicago school of economics. (Valdez, 1995) At the same time as the vouchers were introduced, Chile transferred management of public schools from the national Ministry of Education to local municipalities. The design of Chile's voucher program is in many ways similar to Friedman's original proposal, with public financing of vouchers, voucher funds following the child to selected schools, coexistence of a government and private schooling sector with free entry in the private schooling sector, and some government monitoring of the quality of all schools. Since 1980, Chile has been a virtual laboratory for a relatively unregulated, decentralized, competitive market in primary and secondary education. It provides a unique setting in which to study how the voucher and decentralization reforms affect school choice and to examine their longer-term effects on educational attainment and labor market outcomes. This paper also explores how the reforms affect inequality by increasing the opportunities for children from poorer families to attend private schools and/or by changing the types of private schools attended by children from wealthier families.

Education in Chile is provided by three broad types of schools: municipal schools, private subsidized schools, and private non-subsidized (fee-paying) schools. Until 1994 (and over the time period covered by our data), private subsidized schools and municipal schools were financed primarily through the per capita government voucher given to every child.[2] Private non-subsidized schools, which include both religious (mainly Catholic) and lay schools, are financed from private tuition. Private subsidized schools can be for profit or not for profit, while private nonsubsidized schools are usually for profit. Parents are free to choose among both municipal and both types of private schools. Private schools can be selective in their admissions, while public schools are only allowed to be selective if there is excess demand. At all types of schools, students are required to take standardized tests in the 4th, 8th and

[2]Municipal schools may also receive some additional funding in the form of government transfers when the voucher amounts are not sufficient to cover operating expenses. In 1993, there was a change in rules to allow public and private schools to impose a small tuition charge on top of the voucher.

10th grades, called the SIMCE tests. The school's average test results are published annually and are used by parents as an indicator of educational performance.

Figure 1 shows the percentage of students attending different kinds of schools from 1981-2004.[3] In the first five years after the voucher program was introduced, the percentage of students enrolled in private subsidized schools increased rapidly, from 15% to over 30%, with a corresponding decline in enrollment in public schools. Subsequently, the share of private subsidized schools continued to increase at a more gradual pace and the corresponding market share of public schools to decrease. The market share of private nonsubsidized schools varied only a little over time, ranging from 5.5 to 9.5%.

There are a number of previous studies of the effects of voucher programs in Chile. All of the studies (e.g. Sapelli and Vial, 2002, Contreras, 2001, Hsieh and Urquiola, 2005, McEwan and Carnoy, 2001), analyze the relationship between standardized test scores (usually SIMCE test scores) and attendance at voucher schools using data collected at the schools. With data collected in school, one encounters multiple selection problems, namely, that the children/youth attending each type of school are self-selected and that test scores are only observed for those who attend school and not for drop-outs. Section two discusses some of the ways that literature has addressed selectivity problems in analyzing the effects of vouchers on tests scores. Some studies in the literature find little difference in test score performance between municipal and private subsized schools after controlling for family background (e.g., Mizala and Romaguera, 1997). The test score data were gathered many years after the voucher reforms, and as Mizala and Romaguera (1997) note the finding of no significant difference in test scores between municipal and private subsidized schools could be consistent with the voucher program having improved performance in both the private and public sectors. Other studies in the literature, such as McEwan and Carnoy (1999), Bravo, Contreras and Sanhueza (1999), and Sapelli and Vial (2002) find evidence of better performance in private schools. Some studies find evidence that public schools are better at serving disadvantaged students and private schools better at serving more advantaged

[3]The figure is based on data from the Ministry of Education.

students. The original goal of the voucher program, though was to improve performance at all types of schools through increased competition and not to create a superior private schooling sector.

Rather than study the determinants of test scores as does the existing literature, this paper uses household survey data to study the longer term effects of the school voucher reforms on educational attainment, employment, and earnings outcomes. In particular, we use the newly available, longitudinal survey in Chile called the *Enquesta Proteccion Social* (EPS) which elicited information from respondents on the types of primary and secondary schools they attended.[4] These data, collected in 2002 and 2004, contain rich labor market, demographic and pension-related information for a random sample of Chileans age 15 and older. Most relevant for our analysis is the information that was collected on the types of primary and secondary schools attended, the geographic location of the schools attended, family background, work history and earnings. The sample includes individuals who attended school prior to the introduction of vouchers, who were in the midst of their schooling careers at the time vouchers were introduced and who attended solely in the post-voucher regime. The thirty five year time frame covered by our data permits evaluation of the effects of the school voucher program on longer term educational and labor market outcomes, a question that has never been previously examined.

This paper develops and implements a behavioral model of decision-making about schooling and labor force participation over the life-cycle. The model builds on a well developed labor literature that analyzes labor market outcomes in the presence of self-selection into educational and/or occupational sectors. The seminal paper is that of Roy (1951), which explores the implications of occupational self-selection for earnings distributions within a static earnings optimization model.[5] Rosen and Willis (1979) extend the Roy model to an educational choice setting where individuals choose whether to attend college, basing their

[4] The first round of data were collected under the survey name *Historia Laboral y Seguridad Social* (HLLS). These data were collected by the Microdata Center at the University of Chile, under the leadership of David Bravo, with cofunding from an NIH grant to Petra Todd at the University of Pennsylvania.

[5] Heckman and Honore (1990) exposit the mathematical foundations for the Roy model and generalize it to nonnormal distributions.

decisions on expected lifetime earnings, on financing capacities that differ by family background and on nonpecuniary benefits of education. The model also builds on the Heckman and Sedlacek (1985) study of earnings distributions when individuals self-select into different economic sectors with the option of remaining out of the labor force. In our context, individuals select among different schooling sectors, representing the three schooling types, and make decisions about how long to attend school and whether to participate in the labor force. Our modeling framework explicitly controls for both observed and unobserved sources of heterogeneity that may affect selection into different types of schools as well as wage offers and preference parameters. Along the lines of Ben-Porath (1967), Keane and Wolpin (1997) and Heckman and Navarro (2005), our conceptualization of the schooling decision and of the wage offer equation assumes that individuals forgo earnings opportunities during periods of schooling investment, that they are motivated to undertake investments in part by anticipated future returns, and that wage offers represent a price paid to the human capital embodied in a person.[6] In the tradition of Behrman and Birdsall (1983) and Card and Krueger (1992a,b), we allow the returns to schooling depend on the quality of schooling provided. Specifically, the returns differ depending on the types of primary and secondary school attended and on whether attendance took place in the pre or post voucher regime. This allows the voucher system to have potentially altered the quality of schooling provided in both the private and public sectors.

The model we estimate allows components of future wage offers and of the payoffs to different types of schooling to be unknown at the time individuals make schooling and labor market decisions. It also incorporates permanent unobservable heterogeneity, in the form of discrete types that are assumed to be known to the agent but unknown to the econometrician (Heckman and Singer, 1984). Labor market experience accumulates endogeneously as a function of past labor supply choices. Identification of voucher effects comes from differences in the choices made and wage returns received by individuals differentially exposed to the

[6] Also see Heckman, Layne-Farrar and Todd (1996, 1997) for further discussion of the human capital pricing interpretation of the wage equation.

voucher program during their schooling careers. The model is estimated solely on males, mainly to avoid consideration of fertility choices.

The estimated behavioral model is used it to assess how the introduction of school vouchers affected sorting among different types of schools, educational attainment, earnings and labor market participation. By simulating schooling and labor supply choices over the life-cycle with and without vouchers, we can directly evaluate the cumulative effects of the voucher program as it operates through both schooling and labor market channels. The empirical findings show that school vouchers increase the likelihood of attending private subsidized schools and lower the probability of attending other types of schools (municipal and private nonsubsidized) at both the primary and secondary school levels. The wage parameter estimates indicate that at the primary school level, returns are highest in the private nonsubsidized schools and lowest in the private nonsubsidized schools. At the secondary school level, the returns are highest in the private nonsubsidized schools and lowest in the municipal schools.

As noted, our wage specification allows returns to schooling to differ in the pre and post voucher regimes. A comparison of the wage returns to schooling shows that the returns to all types of primary schooling increased substantially in the post-voucher period, with a large increase (about 1 percentage point) observed for primary municipal schooling. The increase is consistent with increased competition having improved the quality of all types of schools. Competition is particularly strong at the primary school level where there are more schools. At the secondary school level, we observe little change in the wage return to secondary schooling relative to pre-voucher levels. Competition among schools may be a less important factor at the secondary school level where there are relatively fewer, larger schools. Our estimated cost of attending schooling parameters indicate that the costs of attending school, particularly in rural areas, declined after the voucher program was introduced, which is most likely attributable to increased school availability due to the construction of many new schools and expansion of existing schools. The reduced cost of attending schools and the elimination of tuition for subsidized private schools led to an increase in attendance at

private subsidized relative to other types of schools.

We use the estimated schooling and labor force participation model to simulate the effect of the voucher program on educational attainment, wages and labor force participation. We find that on net the voucher program leads to a compression of the educational attainment distribution, with individuals at the lower end of the distribution completing more education and individuals at the higher end completing fewer years. The compression at the top of the distribution is due in part to the fact that the vouchers induce some people to switch from attending private nonsubsidized schools to private subsidized schools. Looking at wages, there are substantial effects of the voucher program. Individuals exposed to the vouchers at any point in their schooling career experienced about a 4 percent increase in realized wages and a 1-2 percentage point increase in labor force participation. The impacts are even larger for individuals who were exposed to the vouchers over their entire schooling careers. We do not find evidence that the voucher reforms increased inequality. There is a decrease in inequality in educational attainment and inequality in earnings remains approximatey the same. The voucher impacts are similar for people from poor and non-poor backgrounds, suggesting that the reforms did not disproportionately benefit those from well-to-do families.

The paper develops as follows. Second two discusses the existing literature and some of the results of previous studies of the Chilean voucher program. Section three describes the model and section four the estimation approach. Section five presents the empirical results and section six concludes.

2 Background and Related Literature

Although there has been much speculation and debate about the likely short-run and longer-term effects of large scale school voucher programs in the U.S. on students and teachers, (e.g. Neal, 2002, Hoxby, 2002, 2003, Ferreyra, 2002), the empirical evidence is still scarce. Much of what we know about school vouchers comes from small-scale studies examining the short-term effects of privately funded voucher programs on student test scores (e.g., Rouse,1998, Krueger and Zhu 2003, Yau 2004). For example, Howell and Peterson (2002) and Peterson,

Howell, Wolf and Campbell (2003) describe the results of evaluations of voucher programs in Dayton, OH, New York City, and Washington, D.C. Each of the programs was evaluated using a randomized design in which families who applied to participate in the program and met the eligibility criteria where randomized into treatment or control groups. The treatment group received a voucher that partly covered tuition at a private school. A baseline test score was collected along with three years of follow-up test scores. Howell and Peterson (2002) find that African-America children in the treatment group experienced statistically significant test score gains, but do not find significant gains for white or Hispanic children. There remains some controversy regarding their results, in part because of high attrition rates in the experimental control and treatment groups that may have compromised the comparability of the treatment and comparison groups.

A related U.S. literature studies the effects of attending private schools or Catholic schools on student test scores and graduation rates (e.g. Neal, 1997, Grogger and Neal, 2000, Evans and Schwab, 1995). That literature typically finds statistically significant positive effects of attending private schools, primarily for urban, African American and Hispanic children/youth. Voucher programs facilitate attendance at private schools, so the evidence on the effects of private schools could be viewed as broadly supportive of voucher programs, at least to the extent that urban, minority youth seem to benefit from private schooling.

There have been several studies of the Chilean voucher program's effects on student test scores. As noted in the introduction, all of the test score data were gathered long after the voucher reforms took place and are therefore not informative about the performance of public/private schools in the absence of vouchers. Nevertheless, these studies are informative on whether attendance at private schools in the post-voucher reform period is associated with higher test scores. With test score data, one also encounters multiple selection problems, primarily that the types of children attending each school are self-selected and, for older children, that test scores are usually unavailable for children not attending school. For example, if voucher programs induce people to stay in school longer, then not accounting for selectivity in school-going could bias the estimated effects on test scores. Sapelli and

Vial (2002) deal with the first selection problem within a static Roy model framework that explicitly models the choice between types of schools in a way that allows for both observed and unobservable sources of heterogeneity. They focus their analysis on second graders for whom the second selection problem (drop-outs) is not severe. Their study finds important gains associated with attendance at private subsidized schools that are largest for those attending those types of schools.[7] They also find that the relative performance of private and municipal schools depends on whether municipal schools receive additional government subsidies. In areas where the municipal schools do not receive extra subsidies, there is a significant test score gain from attending private subsidized schools.

Hsieh and Urquiola (2005) also consider the question of whether the Chilean voucher program resulted in better school performance. Their identification strategy compares communities that experienced a greater increase in private school enrollment to those that experienced less of an increase. Using community level data, they find that average standard test scores did not rise faster in communities where the private sector enrollment expanded more, and that average repetition and grade-for-age actually worsened in such areas relative to other communities.[8]

McEwan and Carnoy (2001) examine the relationship between average fourth grade SIMCE school test scores and the percentage of total enrollment in private schools at the community level (for the period 1988-1996), which they interpret as a measure of school competition. Their study finds that public schools that faced more competition had lower average test scores, mainly because of the mobility of the better students to private schools. They also find that non-religious voucher schools are no more effective than public schools, whereas Catholic voucher schools are more effective. They document that average per pupil expenditure is lower in private schools than in public schools, suggesting that these schools are more efficient even if they do not improve relative performance. August and Valenzuela

[7] They investigate both the effect of treatment on the treatment (TT) and the average treatment effect (ATE).

[8] A potential limitation of the analysis is that it examines differences in test scores over time, though the tests were not comparable over time prior to 1998, when test equating was introduced.

(2003) also analyze the relationship between test scores (in the year 2000) and school competition, using an instrumental variables approach where community population and distance to the closest city serve as instruments for competition. They find positive effects of competition on average test scores. Another study examining the relationship between test score performance and competition is that of Gallego (2002), which examines SIMCE scores between 1994 and 1997. The study finds that competition has a positive effect on educational achievement in general, but also that sorting results in higher scores in the voucher schools, which attract and accept only the better students.

McEwan (2001) examines the effects of attendance at a public or private voucher school on test score outcomes, using individual level data for eighth graders and using a control function approach to account for selectivity into type of school. He finds no important differences in achievement between public and non-religious voucher schools, but that Catholic voucher schools exhibit a small advantage in test scores over most public schools. Using fourth grade achievement test scores, averaged at the school level, Mizala and Romaguera (2000) and Bravo, Contreras and Sanhueza (1999) examine the gap in test score performance between municipal subsidized private schools and conclude that the test score gap is small or nonexistent after controlling for geographic and socioeconomic characteristics. Lastly, Tokman (2002) examines the relationship between primary school test scores and type of school, allowing the impact of attending private schools to differ by average socioeconomic status (using school-level data). Her results indicate that public schools are neither uniformly worse nor better than private schools. Rather, public schools appear to be relatively more effective for students from disadvantaged family backgrounds, which is a finding reminiscent of Neal (1997) for U.S. Catholic schools.

Tarry (1997) provides a good description of many details of the Chilean voucher system, including a discussion of changes in the supply of different types of schools. He notes that in 1979, there were 1846 private primary schools but by 1982 this number had increased to 1833 subsidized private schools and 452 nonsubsidized private schools. The supply further increased to 2234 subsidized private schools by 1988. Over the same time period, the number

of public schools declined from 7830 in 1979 to 5766 in 1988. Using SIMCE scores for fourth graders, Tarry provides evidence that public schools are more effective for disadvantaged students and private schools more effective for more advantaged students.

Although most of the studies on vouchers in Latin America have focused on Chile, there is a small literature on related programs elsewhere in Latin America. Angrist et al. (2002) evaluate the impact in selected Colombian cities of the *Programa de Ampliación de Cobertura de la Educación Secundaria* (PACES) voucher program. The vouchers were introduced in 1991, covered about one-half the cost of private secondary schools, and were renewable with satisfactory academic performance. Evaluation of the PACES program was facilitated by the fact that vouchers were initially awarded by lottery in some municipalities with excess demand for them. Angrist et. al. (2002) did not find any significant impact of vouchers on enrollment but do find significant positive impacts on grade progression rates, educational attainment after three years, and on standardized test scores.

The most prominent and most-studied recent related educational policies elsewhere in Latin American have been the conditional cash transfer programs that provide scholarships for primary and secondary school enrollment for children from poor families. The most well-known of these programs is the Mexican *Oportunidades* anti-poverty and human resource development program, formerly known as the PROGRESA program. The educational impacts are studied in Schultz (2000,2004), Behrman, Sengupta and Todd 2005, Behrman, Parker and Todd 2006, Todd and Wolpin 2007, and Attanasio, Meghir and Santiago (2001). These papers generally find positive impacts of school subsidy programs on school enrollment and educational attainment.

3 Model

We next describe the dynamic schooling and labor force participation model estimated in this paper. It assumes that the decision process starts at age 6, when parents are assumed to choose the type of primary schooling attended by their child to maximize the child's lifetime utility. The three choices are public municipal (M), private subsidized (S), or

private unsubsidized (NS). We assume that once a choice of primary school type is made there is no switching to a different type, in part because the data only record one type of primary and secondary school attended. All children are assumed to attend school through the 2nd grade, which is true in the data. In subsequent years, they decide whether to continue attending school or drop out. Children under the age of 16 are not allowed to work, so if they do not attend school they are assumed to be at home.

At age 14, there is a schooling decision about what type of secondary school to attend, with the same three options. Individuals can choose a secondary school type that is either the same or different from their primary school type. They incur a cost of transitioning from primary to secondary school that depends on the type of secondary school in relation to the type of primary school. This cost can be thought of as capturing costs of transferring from one school system to another, facing a new environment, having to make new friends, and possibly having to travel longer distances to get to a secondary school (since there are more primary schools than secondary schools). Individuals who complete 12 years of school make a choice of whether to attend college. If they choose to attend college, they make a choice each year about whether to keep attending for up to five years. We assume that once an individual leaves school, they do not return.[9]

Starting at age 16, individuals receive wage offers in every period that depend on their years of education completed so far, on the type and number of years of primary and secondary school attended, on the number of years attended before and after the voucher program was introduced, and on labor market experience, which accumulates endogeneously. Individuals can choose to accept the wage offer or be unemployed, in which case they receive a minimal unemployment consumption benefit. The model does not incorporate a savings decision, both for reasons of simplification and because few individuals in our sample report

[9]In the Ben-Porath (1967) model, where individuals choose when to invest in schooling, it is optimal to take schooling at the beginning of the lifetime to maximize the time period over which to reap the returns from schooling. We impose the simplifying assumption that individuals cannot return to school once they left in part because the data record the total years of education completed and not the precise school attendance history.

substantial voluntary savings.[10]

To allow for the possibility of unobservables affecting selection into types of schools and wages, we incorporate unobserved heterogeneity in the form of discrete unobserved types (e.g., Heckman and Singer, 1984). Let μ_k be an indicator variable that equals 1 if the individual is of type k, where $k \in \{1, 2, 3\}$.The probability of being a particular type depends on family background variables that include parents' education, family socioeconomic background when the individual was growing up (as reported in our survey), and the number of siblings. These variables are initial conditions in the model. The state space of the model consists of schooling history (type of primary education, type of secondary education, number of years of primary education pre/post voucher program, number of years of secondary education pre/post voucher program, number of years of college education and accumulated labor market experience.

During the ages (a) when the individual has the option of attending primary school, the current period alternative specific utility functions (U^i_{ak}) associated with the different schooling types for a persion of type k are:

$$U^S_{ak} = \Sigma^K_{k=1}\mu_k b^S_{1k} - T^S_1 1\left(v_a = 0\right) + \delta^S_1 1\left(R_1 = 1\right) + \delta^S_2 1\left(R_1 = 1\right) 1\left(v_a = 0\right) + \varepsilon^S_a \quad (1)$$

$$U^{NS}_{ak} = {}^{K}_{k=1}\mu_k b^{NS}_{1k} + \delta^{NS}_1 1\left(R_1 = 1\right) + \delta^{NS}_2 1\left(R_1 = 1\right) 1\left(v_a = 0\right) + \varepsilon^{NS}_a \quad (2)$$

$$U^M_{ak} = {}^{K}_{k=1}\mu_k b^M_{1k} + \delta^M_1 1\left(R_1 = 1\right) + \delta^M_2 1\left(R_1 = 1\right) 1\left(v_a = 0\right) + \varepsilon^M_a \quad (3)$$

b^i_{1k} $(i = S, NS, M, C)$ is a psychic cost (consumption value) of attending different types of primary school (or of attending college after secondary school) that may vary according to unobserved type, $T^S_1$is the tuition cost at a subsidized primary school (the cost is zero at other types of schools as they cannot be separately idenfied from the utility parameters. Note that this implies utlity parameters are net of tuition cost.). v_a is an indicator variable that equals 1 if the family is eligible for voucher at the child's age a, in which case the family

[10]Chile has a privatized pension system that requires individuals to save 10% in their pension account, which constitutes the primary form of savings for most people.

does not pay the tuition cost at a subsidized private school. δ_1^i $(i = S, NS, M, C)$ represents transportation cost of attending school for individuals living in the non-Santiago region. R_1 is an indicator for whether the individual lives in the capital city, Santiago, which is home to about half of Chile's population. This is included to reflect the fact that there is greater availability of private schools in Santiago along with good public transportation options. We allow transportation costs of attending different types of schools to vary pre and post voucher program, because many private subsidized schools were built shortly after the voucher program to accomodate the increased demand for them. There is a vector of preference shocks $(\varepsilon_a^S, \varepsilon_a^{NS}, \varepsilon_a^M)$ associated with different types of primary schooling. Let $d_1^S = 1$ if attended private subsidized primary, and $d_1^{NS} = 1$ if attended private nonsubsidized primary (else the indicator variable equal 0). Similarly, let $d_2^S = 1$ if attended private subsidized secondary, and $d_2^{NS} = 1$ if attended private nonsubsidized secondary school.

The utility associated with the different secondary school choices depends on preference parameters, tuition costs (T_2^S), costs of switching types of schools $(\rho^{prim,\text{sec}}$, $prim \in \{M, S, NS\}, \text{sec} \in \{M, S, NS\})$, and on region of residence (R_1). In the equations below, $1()$ denotes a function that equals one if the expression in parentheses is true.

$$
\begin{aligned}
U_{ak}^S &= \Sigma_{k=1}^K \mu_k b_{2k}^S - T_2^S 1\left(v_a = 0\right) + \rho^{M,S}(1 - d_1^S)(1 - d_1^{NS})1(E_a = 9) + \rho^{S,S} d_1^S 1(E_a = 9) \quad (4)\\
&\quad \rho^{NS,S} d_1^{NS} 1(E_a = 9) + \delta_1^S 1\left(R_1 = 1\right) + \delta_2^S 1\left(R_1 = 1\right) 1\left(v_a = 0\right) + \varepsilon_a^S \quad (5)\\
U_{ak}^{NS} &= [\Sigma_{k=1}^K \mu_k b_{2k}^{NS} - T_2^{NS}] + \rho^{M,NS}(1 - d_1^S)(1 - d_1^{NS})1(E_a = 9) + \rho^{S,NS} d_1^S 1(E_a = 9) + \quad (6)\\
&\quad \rho^{NS,NS} d_1^{NS} 1(E_a = 9) + \delta_1^{NS} 1\left(R_1 = 1\right) + \delta_2^{NS} 1\left(R_1 = 1\right) 1\left(v_a = 0\right) + \varepsilon_a^{NS} \quad (7)\\
U_{ak}^M &= \Sigma_{k=1}^K \mu_k b_{2k}^M + \rho^{M,M}(1 - d_1^S)(1 - d_1^{NS})1(E_a = 9) + \rho^{S,M} d_1^S 1(E_a = 9) + \quad (8)\\
&\quad \rho^{NS,M} d_1^{NS} 1(E_a = 9) + \delta_1^M 1\left(R_1 = 1\right) + \delta_2^M 1\left(R_1 = 1\right) 1\left(v_a = 0\right) + \varepsilon_a^M, \quad (9)
\end{aligned}
$$

with a corresponding vector of preference shocks.

After the individual completes at least two years of school, there is the option to drop out and stay home (leisure). After age 16, there is the option to work. To better capture the pattern of some periods of unemployment prior to the first job, the model also incorporates

a job search cost that is only incurred only with the first job (when experience x_a equals 0), and that depends on the level of educational attainment, E_a (<8 years, 8-11 years and 12 or more years). Denote the job search costs for the different education levels by ψ^{E_a}. The utility from working is the wage minus any job search cost:

$$U_{ak}^W = w_{ak} - 1(x_a = 0)\psi^{E_a}$$

The utility from leisure depends on preference parameters and a leisure preference shock:

$$U_{ak}^L = \Sigma_{k=1}^K \mu_k b_k^L + \varepsilon_a^L.$$

An individual who finishes high school can work, stay home or attend college. If he attends college, during those periods, he gets the utility:

$$U_{ak}^C = \Sigma_{k=1}^K \mu_k b_k^C + \delta_1^C 1\left(R_1 = 1\right) + \varepsilon_a^C,$$

where δ^C is a transportation cost for those living outside the Santiago region. After completing school, individuals choose between staying at home or working.

In the model, individuals may attend private instead of public schools because they get higher utility and/or because private schooling generates higher future wage returns. Let E_a^P denote the number of years of primary school attended and E_a^S the number of years of secondary education. Some individuals in the sample completed their schooling before the voucher program was introduced, while others had the option of using the vouchers over part or all of their schooling careers. To allow for changes in the returns to all types of education after the voucher program was introduced, we distinguish years of education pre and post voucher. Let $E_a^{P,v=0}$ and $E_a^{S,v=0}$ denote the number of years of primary and secondary education attended prior to the voucher program, and $E_a^{P,v=1}$ and $E_a^{S,v=1}$ the number of years attended after introduction of vouchers. Total years equals:

$$\begin{aligned} E_a^P &= E_a^{P,v=0} + E_a^{P,v=1} \\ E_a^S &= E_a^{S,v=0} + E_a^{S,v=1} \end{aligned}$$

G_a denotes the number of years of college education completed as of age a.

We assume that the amount of human capital embodied in a person depends on the educational attainment, the type of primary and seconday schools attended, how much schooling was obtained before or after the introduction of vouchers, and the amount of labor market experience, x:

$$H_{ak} = \varphi(E_a^{P,v=0}, E_a^{P,v=1}, E_a^{S,v=0}, E_a^{S,v=1}, G_a, x_a, d_1^S, d_1^{NS}, d_2^S, d_2^{NS}, \mu_k).$$

The wage offer equation is the product of the price paid per unit of human capital and the amount of human capital possessed by the person. We also introduce a stochastic term ε_a^W to reflect additional sources of heterogeneity in the amount of human capital and measurement error. The prices are allowed to vary depending on the regional labor market (here, whether the individual lives in the capital city).

$$w_a = p_H H_a \tilde{\varepsilon}_a^W$$

Taking logs and assuming that the log human capital production equation is linear in years of schooling and quadratic in work experience, we obtain the log wage equation:

$$\begin{aligned}
\ln w_a \;=\; & \alpha + \Sigma_{k=1}^K \mu_k \beta_{0k} + \Sigma_{k=1}^K \mu_k \pi_{0k} 1\left(R_1 = 1\right) + && (10)\\
& \beta_1 E_a^P + \gamma_1 E_a^{P,v=1} + && (11)\\
& \beta_1^S E_a^P d_1^S + \gamma_1^S E_a^{P,v=1} d_1^S + && (12)\\
& \beta_1^{NS} E_a^P d_1^{NS} + \gamma_1^{NS} E_a^{P,v=1} d_1^{NS} + && (13)\\
& \beta_2 E_a^S + \gamma_2 E_a^{S,v=1} + && (14)\\
& \beta_2^S E_a^S d_{2a}^S + \gamma_2^S E_a^{S,v=1} d_{2a}^S + && (15)\\
& \beta_2^{NS} E_a^S d_{2a}^{NS} + \gamma_2^{NS} E_a^{S,v=1} d_{2a}^{NS} + && (16)\\
& \beta_3^{M,S} G_a + \beta_3^{NS} G_a + \beta_4 x_a + \beta_5 x_a^2 + \varepsilon_a^W. && (17)
\end{aligned}$$

The intercept of the log wage equation, β_{0k}, which is allowed to depend on unobserved type to capture unobservable heterogeneity in human capital. π_{0k} captures the difference

in wage level between the Santiago and non-Santiago regions. This term is included to allow labor market conditions and the resulting price paid to human capital to differ in and outside of the capital city.[11] The coefficients β refer to the returns to different types of education prior to the introduction of the voucher program. The specification is more general than a standard Mincer-type specification, because it allows returns to primary, secondary and college years of schooling to differ. The γ coefficients represent the difference in the return after the introduction of the voucher (i.e. the return to schooling post voucher is given by $\beta+\gamma$). The γ coefficients are introduced to allow for the possibility that the voucher program potentially changed the quality of all types of schools. For example, increased competition may have improved the quality of both public and private schools. On the other hand, the voucher program could have drawn some of the better teachers out of the public school system, lowering public school quality. Thus, the coefficient γ could be either positive or negative. Below, we present evidence that individuals educated in the post-voucher period receive higher returns to their schooling.

Individuals differ in terms of the timing of the voucher program with respect to their schooling career. For example, an individual may have attended 5 years of primary school pre-voucher and 3 years primary and all of secondary post-voucher. β_1^{NS} and β_1^{S} (γ_1^{NS} and γ_1^{S}) capture the premium that individuals receive in the labor market for attending a private primary school, which is allowed to differ by type of school (non-subsidized verses subsidized). The coefficients β_2^{NS} and β_2^{S} (γ_1^{NS} and γ_1^{S}) capture the premium for having attended either a subsidized or non-subsidized private secondary school. If an individual attends secondary school, then there are nine different schooling type choices possible: public primary and secondary, public primary and private subsidized secondary, public primary and nonsubsidized private secondary, subsidized private primary and public secondary, subsidized private primary and private subsidized secondary, subsidized private primary and private nonsubsidized secondary, nonsubsidizied private primary and public seconday, nonsubsidizied private

[11] In logs, differences in the price paid to human capital across regions would be captured by an additive intercept term.

primary and subsidized secondary, subsidized secondary and nonsubsidizied secondary. The coefficients $\beta_3^{M,S}$ and β_3^{NS} is the earnings return for each year of college attended, which is allowed to differ depending on whether an individual attended a nonsubsidized private secondary school.[12] β_4 and β_5 represent the market return to actual labor market experience.

The maximized present discounted value of lifetime utility at t, the value function, is given by

$$V(\Omega(a), a) = \max_{d_j(a) \in K(a)} E\{\sum_{\tau=a}^{A} \beta^{\tau-t} U_a^j | \Omega(a)\},$$

where U_a^j is the maximum of the alternatives available to the individual at age t, denoted $K(a)$. A is the terminal age of the model, assumed to be age 62 (the standard retirement age in Chile for men). The expectation is taken over the distribution of preference and wage shocks.

4 Model Solution and Estimation

The solution to the optimization problem is a set of decision rules that relate the optimal choice at any age a, from among the feasible set of alternatives, to elements of the state space. Recasting the problem in a dynamic programming framework, the value function can be written as the maximum over alternative-specific value functions, $V^j(\Omega(a), a)$, i.e., the expected discounted value of alternative $j \in K(a)$ that satisfies the Bellman equation

$$\begin{aligned} V(\Omega(a), a) &= \max_{j \in K(a)} [V^j(\Omega(a), a)] \\ V^j(\Omega(a), a) &= U^j(a, \Omega(a)) + \beta E(V(\Omega(a+1), a+1 | d_j(a) = 1, \Omega(a)) \text{ for } a < A, \\ &= U^j(A, \Omega(A)) \quad \text{for } a = A. \end{aligned}$$

The solution of the optimization problem is not analytic, so the model is solved numerically. The solution consists of values of $E(V(\Omega_{t+1}, t+1 | d_j(a), \Omega(a))$ for all j and elements of $\Omega(a)$. We refer to this function as the Emax. The solution method is by backwards recursion,

[12] Individuals who attended nonsubsidized private secondary schools are more likely to be admitted to the most elite universities in Chile, which are University of Chile and Catholica University.

beginning with the last period, A. The multivariate integrations necessary to calculate the expected value of the maximum of the alternative-specific value functions at each state point are performed by Monte Carlo integration over the shocks. The state space is manageable, so that we evaluate the value of the Emax function at every possible state point without having to use interpolation methods.

The model is estimated by maximum likelihood. Let O_{it} represent the outcomes (education choices, work choices, observed wages) of individual i and age a. Also, let I_i denote the set of initial conditions for that individual (family background variables, type of primary school attended). The contribution to the likelihood of individual i is given by:

$$L_i = \sum_{k=1}^{K} \Pr(O_{ia}, O_{ia-1}, ..., O_{ia_0}; \mu_k = 1, I_i) \Pr(\mu_k = 1|I_i)$$

where $\Pr(\mu_k = 1|I_i)$ denotes the type probability which depends on initial conditions, which in our application represent family background socioeconomic status, parental education levels and numbers of siblings. The unobserved type is assumed to be known to the individual but not to the econometrician; the outside summation integrates over the type probabilities. The likelihood can be written as the product over the age-specific choice probabilities:

$$L_i = \sum_{k=1}^{K} \Pi_{a=a_0}^{A} \Pr(O_{ia}|O_{ia-1}, ..., O_{ia_0}; \mu_k = 1, I_i) \Pr(\mu_k = 1|I_i).$$

To illustate the calculation of the likelihood, suppose that the jth alternative chosen by individual i is to work, so that we observe a wage at age a. The probability of observing that choice and wage outcome conditional on the state space (which includes $O_{ia-1}, ..., O_{ia_0}$, I and *type*) is:

$$\Pr(d^j(a) = 1, w_a|\Omega(a), I, \mu_k = 1) = \Pr(d^j(a)|w_a, \Omega(a), I) f(w_a|\Omega(a), I, \mu_k = 1),$$

where $f(w_a|\Omega(a), I, \mu_k = 1)$ is the wage density.

The overall likelihood for $i = 1..N$ individuals is the product over the individual likelihoods:

$$L = \Pi_{i=1}^{N} L_i.$$

To complete the description of the model, we need to specify the functional form for the type probabilities. They are assumed that type depends on parents' education, number of siblings, and family socioeconomic status (the initial conditions, denoted I_i) in the following way.

$$P\left(type = k|I_i\right) = \frac{\exp(I_i'\tau)}{1+\exp(I_i'\tau)}$$

To estimate the probilities, $\Pr(O_{it}|O_{it-1},...,O_{it_0};\mu_k = 1)$ in a way that improves the empirical performance of the estimator, we use the kernel smoothed frequency simulator proposed by McFadden (1989). For each set of error term draws, the kernel of the integral is

$$\frac{\exp\{\frac{V^i(a)-\max(V^j(a))}{\tau}\}}{\Pi_{l=1}^{J}\exp\{\frac{V^l(a)-\max(V^j(a))}{\tau}\}},$$

times the density of the observed wages. Here, $V^i(a)$ is the value function associated with the choice that person i made at age a, $\max(V^j(a))$ is the value function associated with the maximal choice, and τ is a smoothing parameter.

The model parameters enter the likelihood through the choice probabilities that are computed from the solution of the dynamic programming problem. Subsets of parameters also enter through the wage offer function. The maximization of the likelihood function iterates between solving the dynamic program and calculating the likelihood.

5 Empirical Results

6 Data

In 2002, the Microdata Center of the Department of Economics of the Universidad de Chile, conducted a new household survey called *Historia Laboral y Seguridad Social (HLLS)*. In 2004, it administered a follow-up survey, the *Enquesta Proteccion Sociale (EPS)*. The data from the 2002 survey contain demographic and labor market information on 17,246 individuals age 15 or older, including information on household characteristics, education, training and work history, pension plan participation, savings, as well as more limited information on

health, assets, disability status and utilization of medical services. Of particular relevance to this project are the questions on labor force and participation in training/education, which include retrospective information back to 1981, as well as questions on educational attainment, family background (number of siblings, parent's education, poverty status during adolescence), type of primary and secondary school attended, and location (geographic region) of schools attended. Appendix A contains a detailed description of the sampling frame for the 2002 and 2004 surveys.

Our analysis sample consists of 3910 male individuals who were at most 21 years old in 1981 and for whom we observe the educational attainment and a labor force participation history. We have a total of 107394 person-year observations on these individuals. Each individual was asked the type of primary and secondary school they attended. We assume that they started attending school at age 6 (the standard age) and attended continuously until the end of their schooling career.[13]

6.1 Descriptive Statistics

Table 1 shows the means of variables used in our analysis, for the complete sample and by type of primary school attended. The average age is 30.6 years and the average education level 11.0 years. A comparison of the last three columns shows that individuals who attended municipal primary attain on average 10.5 years of schooling. Those who attend private primary schools complete substantially more education, with an average of 12.8 years for those attending private subsidized primary and 14.1 years for those attending private nonsubsidized primary. Roughly a third of our sample resided in Santiago (the capital city) at the time of attending school. School attendance patterns are different in Santiago, in part because of the wider availability of all types of schools as well as good public transportation options. More than half of people who report attending private primary schools (subsidized or nonsubsidized) did so in Santiago. The annual earnings of our sample is $3835, in 2002 US Dollar-equivalents.

[13] The assumption of continuous schooling was made in part because we do not have information on the exact schooling progression pattern, only on the final schooling attainment.

Average earnings are roughly comparable for those attending municipal or subsidized primary school, but are nearly double for those attending nonsubsidized private school ($6691 on average).

Table 1 also provides information on the family background of the individuals in our sample. The men in our sample attain much higher average education levels than did their parents; on average, the mothers' have 7.1 years of education and the fathers' 7.8 years. The parental education levels are higher by 0.3-0.5 years for individuals who attended private subsidized primary school than for municipal school attendees, and almost 2 years higher for private unsubsidized primary school attendees. Respondents were also asked about the poverty status of their family while growing up, which was reported in four categories: indigent, poor, good and very good. Only a small proportion (2.5%) report their family background as indigent. The majority report their family's socioeconomic status as being poor (34.8%) or good (59.2%), and a small proportion (3.4%) report very good. As seen in the table, individuals who attend private schools are less likely to report their background as indigent or poor. On average, the individuals in our sample have 3.7 siblings, with slightly fewer (3.3 on average) for private school attendees. In the model we estimate, family background and numbers of siblings are determinants of the unobserved type probability.

As seen in Figure 1, following the introduction of vouchers in 1980, the percentage of individuals attending municipal schools decreased dramatically. The decrease was most pronounced in the first five years, but continued thereafter. Correspondingly, the percentage of individuals attending private subsidized primary schools increased. The percentage attending private nonsubsidized schools exhibits an increase over the 1990-2000 period followed by a slight decline. The percentage choosing private nonsubsidized schools is overall much smaller, ranging from a low of 5.1 in 1981 to a high of 9.5 in 1996.

Tables 2a and 2b examine how the choice of primary school type relates to the choice of secondary school type, for subsamples who were (Table 2a) and were not (Table 2b) exposed to school vouchers prior to age 15 (when individuals typically start secondary school). Each cell shows both unconditional and conditional (on primary school type) probabilities of

choosing certain secondary schooling types. Among those not exposed to vouchers by age 15, 34.9% of those who attended municipal primary school did not attend secondary school. Among those exposed to vouchers, the percentage not attending secondary goes down to 19.7%. Those who attend a municipal primary school and continue on in secondary are most likely to transition to a municipal secondary school. A comparison of the transition patterns for those not exposed and exposed to vouchers shows that the fraction attending subsidized school more than doubles after the voucher program and the fraction attending municipal schools declines slightly. Conditional on having attended a private subsidized primary school, the probability of attending a private subsidized secondary school also is higher for those exposed to the vouchers. In summary, the sample exposed to vouchers is much more likely to continue on to secondary school and more likely to attend private subsidized primary and secondary schools.

Figure 2 examines how school attendance patterns differ by types of schools attended. It shows the percentage of individuals still in school at a given age, by type of primary and secondary schools attended. The top panel shows the school-going patterns for individuals that attended municipal primary school, by type of secondary attended. The notation "M,." refers to municipal primary and no secondary; "MM" to municipal primary, municipal secondary; "M,S" to municipal primary, subsidized private secondary"; "M,N" to municipal primary, nonsubsidized secondary. Regardless of primary school attended, individuals who attend nonsubsidized secondary schools show the highest attendance rates by age and are also most likly to attend college. Individuals who attend nonsubsidized primary and secondary schools have the highest attendance rates during college-age years, with about two-thirds still in school at age 20. Among those who do not attend secondary schools (not shown in the figure), individuals enrolled in subsidized primary school have higher primary school attendance rates.

Figure 3 shows the educational attainment distribution, overall and by type of primary school attended. Individuals who attended municipal schools are much more likely to be in the lowest education categories or to have dropped out of primary school. 31% complete

exactly 12th grade and 25% go beyond. Individuals who attend private subsidized primary schools are more likely to finish 12th grade (34%) or go beyond (46%), but their educational attainment is not nearly as high as that of individuals attending nonsubdizied primary schools, 68% of whom go to some college.

Figure 4 graphs the percentage working by age and by type of primary school attended, where the sample is restricted to individuals who have completed their schooling and are legally permitted to work (age 15 and older). The differences in working rates are most pronounced in the 20's, when those who attended municipal schools exhibit the highest rates of working. For example, at age 24, 86% of municipal school attendees are working in comparison to 73% of private subsidized primary attendees and only 54% of private nonsubsidized. Starting at around the mid 30's, though, the working rates of individuals who attend nonsubsidized private schools surpass those of the other groups and reach close to 100%, while those who attended either municipal or private subsidized primary schools have lower rates of around 93%. There is a decline in working rates in the late 40's among those who attended municipal or subsidized private primary schools.

Figure 5 graphs the age-earnings relationship by educational attainment categories and type of primary school attended. The age-earnings curves are smoothed using local regression.[14] Among those completing less than 8 years of education, municipal school attendees have a flatter age-earnings relationship than private school attendees. For individuals completing 8 to 11 years of school or who complete high school only (12 years), the age-earnings relationship is comparable across the three different schooling types, with no clear evidence of an earnings premium for having attended a private primary school. For those who complete more than 12 years of schooling, earnings are comparable for those who attended municipal or subsidized private schools but are much higher for those who attended nonsubsidized private schools. This difference is most likely attributable to differences in the types of colleges attended, with a higher proportion of private nonsubsidized secondary schools attending the premiere universities (Catholica University and Universidad de Chile). Earnings also increase

[14] A bandwidth of 5 years was used for the plots.

with age with a rate of increase that is higher for those with higher schooling completion levels.

6.1.1 Reduced form estimated decision rule models

In Tables 3, 4 and 5, we present estimates of choice models that relate the decision variables in our model (school attendance, type of school attended, educational attainment and work) to the state variables. These estimates are reduced form in that they do not impose the structure of the model and also do not account for unobservable heterogeneity. Table 3 shows the estimation results where the outcome measure is educational attainment. In the first column, the specification includes two indicator variables for whether the voucher program was available during primary and secondary school ages (ages 6-14 and ages 15-18). The second column of estimates includes a variable that indicates the total number of years the individual was exposed to the voucher program at any point over ages 6-18. For example, if the individual was in second grade when the program was introduced, the exposure is 10 years. Individuals who attended school during a period when vouchers were available, ceteris paribus, have substantially higher educational attainment. The first specification shows that exposure starting in primary school, prior to making secondary school type choices, is most important. Conditional on primary exposure, exposure to vouchers during secondary school is not associated with significantly higher years of education. Individuals whose parents (mothers and/or fathers) have more education also achieve higher educational attainment levels, with the estimated coefficient on mother's education being about fifty percent larger that on father's education. Also, individuals from less poor families have significantly higher educational attainment levels than individuals from indigent families (the omitted category). The number of siblings is not a significant predictor of educational attainment, conditional on the other included variables. Residing in the city of Santiago at the time of attending school is associated with 1.33 years higher attainment.

Table 4 presents estimates from a multinomial logit model for the choice of primary school type, where the estimates refer to the probability of choosing a subsidized or nonsubsidized

private primary school relative to a municipal school. Having the voucher available during primary or secondary school years is associated with a statistically significant increase in the probability of choosing the subsidized primary private school type (the private school type that accepts the voucher), without any significant change in the probability of choosing the nonsubsidized primary school type. Mothers' and father's education are statistically significant determinants of the probability of choosing a private unsubsidized school. Individuals with more siblings are less likely to attend private schools. The family background variables are not significant determinants of the choice of primary school type, conditional on the other included regressors. Residing in Santiago makes it much more likely that an individual attends private primary school.

Table 5 presents estimates from a probit model of the probability of working, where the subsample includes all person-year observations for those 15 or older who are not in school. More years of education increases the probability of working in a given year. Being exposed to the voucher program during primary school years decreases the probability of working; being exposed only in secondary school years has no significant effect. Having more siblings is associated with increased probabilities of working (statistically significant at 5% level), while being from a less poor family is associated with a lower probability of working. Not surprisingly, more previous labor market experience increases the probability of working in the current period. The probability of working also increases with age at a decreasing rate. Residing in Santiago substantially increases the probability of working.

6.2 Empirical Results

6.3 Parameter Estimates and Model fit

As described above, the wage specification allows the wage returns from schooling to depend on type of school attended (primary and secondary) and on whether attending prior to or after the voucher program came into place. Wages are measured only in 2002 and 2004, so differences in the returns from different types of schooling are identified solely from differences in the labor market performance of individuals educated in the pre and post voucher regimes.

Table 6 shows the estimated wage returns to primary, secondary and college education, where the primary school returns correspond to two-year returns, and the secondary and college returns to one-year returns. The wage return to secondary school is substantially higher (more than twice as high) as the return to primary school. As seen in the table, the wage returns to primary schooling increased in all types of schools after the voucher program, particularly in municipal schools where it increased from 0.045 to 0.056. This increase is consistent with an increase in the quality of schooling, perhaps due to more competition among schools. The parameter estimates indicate that at the primary school level, returns are highest in the private nonsubsidized schools and lowest in the private nonsubsidized schools. At the secondary school level, the returns are highest in the private nonsubsidized schools and lowest in the municipal schools. These rankings are preserved pre and post voucher.

Table 7a and 7b report the fit of the estimated model to the actual schooling choice conditional distributions for the subsamples who were and were not exposed to vouchers by age 15. To generate these fits, we use the estimated model to simulate choices for all the individuals in our sample, starting from their initial conditions, and we compare simulated and actual choices. In the tables, the simulated cell percentage appears in parentheses under the actual percentage. The percentage corresponds to the percentage choosing a particular secondary school type conditional on a primary school type. The model predicts a large difference in the school choice distribution for the two groups that differ in their voucher exposure, as seen in the data. The model underpredicts somewhat the percentage of individuals attending municipal primary school who do not go on to secondary school for the subgroup not exposed to vouchers (prior to age 15). The model is fairly accurate in predicting the distribution of school choices for those who attend private subsidized primary school. The predictions are less accurate for attending private unsubsidized primary school who were exposed to vouchers, but these individuals constitute only about 5% of the individuals exposed. Aggregating across all secondary school types, the model predicts fairly well the proportions attending different kinds of primary schools, for both subsamples (the last

column of the tables).

Table 8 presents the goodness-of-fit for the educational attainment distribution for the subsample that was and was not exposed to the voucher program. The simulation captures the much higher relative educational attainments for the sample that was exposed to the voucher program, however, the actual difference is usually more pronounced that that predicted by the simulation. The predicted percentage completing 12th grade is fairly accurate for the sample that was not exposed to vouchers. For both subsamples, the simulation underpredicts the percentages dropping out of college after one year and has a larger fraction going for two years. In general, though, the simulation does capture the large differences in the schooling distributions for the subsamples that were and were not exposed to the voucher program.

Table 9 reports evidence on how the model fits the labor force participation patterns, disaggregated by type of primary and secondary schools attended and by age caterogies. The numbers in parentheses indicate the number of person-year observations in that cell, in part because the predictions are usually more accurate for larger size cells. The predictions captures the general pattern of rising labor force participation rates with age (over the age ranges indicated), although the age increase is a little steeper in the data than in the simulation. The predicted patterns also capture the fact that individuals who attend private schools have lower participation rates over younger ages (age 16-25). The average predicted labor force participation rates over all educational categories (shown in the last row of the table) are fairly accurate.

Table 10 shows the model fit to mean wages within cells defined by type of education categories. The mean overall annual wages predicted by the model is \$4524, which is lower than the actual mean of \$4736. Disaggregating by school types, we see that the simulated model reproduces the pattern of lower wages for people who attended only municipal schools or for people who did not attend secondary schools. It also generates the pattern of higher wages for those who attended nonsubsidized primary and secondary schools, although the simulated wages in this category understate the actual wages.

6.4 Counterfactual policy evaluation

We next use the estimated model to explore how the school tuition vouchers affect school attendance and labor market decisions and whether vouchers contributed to declining inequality in educational attainment and earnings outcomes. To perform this policy simulation, we simulate school and labor force choices and wage outcomes with and without the voucher program for the group of individuals exposed to the voucher program at any point in their schooling career. The simulation without the program modifies the budget constraint to reflect the additional tuition cost that would have to be paid for private schooling and adjusts the return to years of schooling for all school types to pre-voucher levels. Recall that returns to primary schooling are estimated to be larger post-voucher for all types of schooling, whereas there is little difference between estimated pre and post voucher returns to secondary schooling. The effects of the voucher program on the returns to schooling are identified from differences in the wages paid to those who received education in the pre and post voucher periods, controlling for actual labor market experience.[15]

One potential concern in performing these simulations is that there may have been other improvements in the quality of schools in the post-voucher period that also influence the wage returns to schooling. Table 11 summarizes the major schooling reforms that took place in Chile since 1980. As seen in the table, a number of reforms were instituted in 1990, most notably an expansion in the value of the voucher, an increase in school resources (in part implemented through the increase in the value of the voucher), and an almost doubling of the public school teacher wage that was negotiated by the teacher's union. The change in the teacher's wage is unlikely to dramatically affect the quality of the schooling over the short term, because it takes some time to become a licensed teacher and to replace existing teachers. Over the longer-term, however, the higher wage would be expected to attract more qualified entrants into the teaching profession and improve school quality.[16] Some

[15] Recall that the wage data pertain to years 2002 and 2004, so the wage data are measured at the same time for everyone.

[16] There is a college entrance exam given in Chile analogous to the SAT in the US. These reforms corresponded with a reversal in a long-term declining trend in the average test scores of new teachers, suggesting

additional schooling reforms were instituted in later years, including a competitive school funding program called SNED (implemented in 1996), an increase in the length of the school day along with a school expansion program (implemented in year 2000), and the introduction of a new teacher evaluation and certification program in 2002 and 2003.

Most of these reforms come after the individuals in our sample have already completed their schooling. In fact, only 5% of our sample was potentially exposed to the 1996 reform while in primary school, and none were exposed to the year 2000 or subsequent reforms. Roughly 15% of our sample was attending primary and secondary school in 1990, so these individuals might have been affected by the 1990 schooling reform that expanded the value of the voucher and increased the teacher wage. For reasons of parsimony, our model specification does not allow for changes in the return to education for individuals attending in the post 1990 time period for part of their schooling career, although such an extension would potentially be feasible.

6.4.1 Effects of voucher program on educational outcomes

Table 12 reports the effect of vouchers on educational outcomes for the subsample that was exposed to vouchers at any point during their primary education years. To explore distributional effects of the program, results are reported for the whole sample and by whether the individual reports being from a poor family or not, where poor family corresponds to having reported either being indigent or poor when growing up.[17] As seen in the first row of table 11, the voucher program increases attendance at private subsidized primary schools by 5.6 percentage points. There is similarly a substantial increase in attendance at subsidized secondary private schools of 5.3 percentage points, which is somewhat greater for the non-poor subsample than the poor subsample. The voucher program reduces the attendance rate at nonsubsidized primary private schools by around -1.3 percentage points and at non-subsidized secondary private schools (-0.6 percentage points), indicating that some of the

that the higher pay did increase the quality of new entrants into the teaching profession.

[17] Family background socioeconomic status was reported in four categories and we take the first two categories as poor.

students attending the premiere nonsubsidized private schools are induced by the voucher tuition incentive to attend subsidized private schools.

Table 13 shows how the voucher program affects the entire education distribution for the same three subsamples. The voucher program increased the probability of completing lower grades (up through grade 12) but then decreased the probability of attending college. The table shows a compression of the education distribution, with individuals at the lower end completing more grades and those at the higher end completing fewer grades. A comparison of the results for the poor and non-poor subsamples reveals similar impacts across the two groups. The last four rows of Table 12 show the effects of the voucher program on the college completion rate and on median education levels. There is a 1% reduction in college going with no change in medians. Thus, the voucher program decreases inequality in educational attainment levels without much effect on median levels.

6.4.2 Effect of voucher program on labor market outcomes

In Table 14, we simulate the effect of the voucher program on earnings and labor force participation. Looking at wages, we find substantial effects of the program. As seen in Table 14, mean earnings are higher with the voucher program by about $200 for both the poor and nonpoor subsamples, over age ranges 16-45, which represents about a 4% increase in earnings. As expected, higher wage offers leads to an increase in the labor force participation rate, with the largest impact on labor force participation rates of about three percentage points occuring over the age 16-25 range.

7 Conclusions

This paper uses a newly available dataset from Chile to study the longer term effects of school vouchers on educational and labor force outcomes over the life-cycle. The previous literature on vouchers in the Chilean context has focused on test score impacts using school test score data collected many years after the voucher reform was introduced. Our study uses household survey data on individuals who obtained their education before, during and

after the voucher reforms and therefore has the potential to capture reform related changes in both public and private sector schools.

After estimating a dynamic model of schooling and work decisions, we use the model to evaluate how the introduction of school vouchers affected school choice, educational attainment, earnings and labor market participation of the subgroup of people exposed to the vouchers. Simulating schooling and labor supply choices over the life-cycle with and without vouchers permits a direct assessment of the full effects of the voucher program as it operates through both education and labor market channels.

We find that the wage returns to all types of primary schooling increased substantially in the post-voucher period, which is indicative of improvements in the quality of primary schooling. At the secondary school level, there is almost no change in the wage return to secondary schooling relative to pre-voucher levels. The lack of observed improvement in the quality of secondary schools may be due, in part, to the construction of new private subsidized schools after the introduction of the voucher program that are generally thought to be inferior (in the sense of producing standardized test scores) than the stock of older private schools (See, for example, the discussion in Parry, 1997). The costs of attending school, particularly in rural areas, declined substantially after the voucher program was introduced. The decreased costs of attending school, the tuition voucher and changes in the returns to schooling combine to induce a larger fraction of individuals to attend private subsidized schools in the post-voucher time period and a lower fraction to attend municipal or private nonsubsidized schools.

Simulations based on the model indicate that individuals who attended school in the post voucher regime receive on average a higher return for their primary schooling, which increased in all types of schools. At the secondary school level, some individuals who switched from attending municipal to attending private subsidized schools also receive a higher return, but other individuals who switch from attending private nonsubsidized to attending private subsidized receive a lower return. Our simulations indicate that the voucher reforms had the effect of compressing the educational attainment distribution without changing its median.

We also find substantial effects of the voucher program on wages and labor force participation, with a 4 percent increase in realized wages and a 1-2 percentage point increase in labor force participation.

Appendix A

The sampling frame of the 2002 HLSS survey consists of individuals enrolled in the social security system for at least one month during the 1981-2001 time period, which included individuals who in 2002 were working, unemployed, out of the labor force, receiving pensions, or deceased (in which case the information was collected from surviving relatives). The sample was drawn from a sampling frame of approximately 8.1 million current and former affiliates compiled from official databases (which covers approximately 75% of the population). The sampling frame for the EPS in 2004 was augmented to include individuals not affiliated with the social security system, so that the sample is representative of the entire Chilean population over the age of 15. Individuals who were interviewed in 2004 but were not interviewed in 2002 were asked questions pertaining both to the 2002 and 2004 time period. In our analysis, we use the longitudinal data collected by both the 2002 and 2004 surveys.

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Table 1
Descriptive Statistics
(Std. Deviation in Parentheses)

	Overall	Municipal Primary	Private subsidized primary	Private unsubsidized primary
Age	30.6	31.3	27.1	29.2
	(7.2)	(7.1)	(7.0)	(7.6)
Years of education	11.0	10.5	12.8	14.1
	(3.4)	(3.3)	(2.6)	(2.8)
Attended primary in Santiago	35.3	30.3	57.0	55.6
	(0.48)	(46.0)	(49.6)	(49.8)
Attended secondary in Santiago	31.1	25.6	54.1	56.1
	(46.3)	(43.7)	(49.9)	(49.8)
Annual earnings (in 2002 dollars)	3835	3706	3630	6691
	(4412)	(3945)	(4149)	(9351)
Mother's education	7.1	6.9	7.3	8.7
	(3.77)	(3.60)	(4.1)	(4.9)
Father's education	7.8	7.7	8.2	9.7
	(4.1)	(3.9)	(4.3)	(5.1)
Family				
Indigent	2.5	2.6	2.4	2.6
	(15.7)	(15.8)	(15.2)	(16.1)
Poor	34.8	35.7	30.7	31.2
	(47.6)	(47.9)	(46.2)	(46.4)
Good	59.2	58.5	63.0	60.3
	(49.2)	(49.3)	(48.3)	(49.1)
Very good	3.4	3.2	4.0	5.8
	(18.3)	(17.7)	(19.6)	(23.5)
Number of siblings	3.7	3.8	3.2	3.3
	(2.7)	(2.7)	(2.6)	(2.8)
Number of observations	3910	3168	553	189

Table 2a
Choice of Primary and Secondary School Types
Sample not exposed to vouchers before age 15 (1211 individuals)
(conditional probabilities in parentheses)

		Secondary School Type				
		None	Municipal	Subsidized	Nonsubsidized	All Secondary types
Primary Type	Municipal	34.9 (39.7)	47.2 (53.6)	5.2 (5.9)	0.7 (0.8)	87.9
	Subsidized	1.2 (15.8)	2.2 (28.4)	4.3 (54.7)	0.08 (1.1)	7.8
	Nonsubsidized	0.3 (7.8)	1.5 (35.3)	0.6 (13.7)	1.8 (43.1)	4.2
		36.5	50.8	10.1	2.6	

Table 2b
Choice of Primary and Secondary School Types
Subsample exposed to vouchers before age 15 (2699 individuals)
(conditional probabilities in parentheses)

		Secondary School Type				
		None	Municipal	Subsidized	Nonsubsidized	All secondary types
Primary Type	Municipal	19.7 (25.3)	45.94 (64.0)	10.78 (9.2)	1.48 (1.5)	77.9
	Subsidized	1.04 (6.1)	5.19 (30.6)	9.78 (57.6)	0.96 (5.7)	17.0
	Nonsubsidized	0.15 (2.9)	0.93 (18.1)	0.89 (17.4)	3.15 (61.6)	5.1
		20.9	52.1	21.5	5.59	

Table 3
Decision Rule Model for Years of Education
(standard errors in parentheses)

Variable†	(1) Estimated Coefficient	(2) Estimated Coefficient
Intercept	7.87	7.78
	(0.39)	(0.37)
Voucher available during primary school years	1.13	…
	(0.15)	
Voucher available during secondary school years	-0.03	…
	(0.20)	
Years exposed to voucher††	…	0.09
		(0.01)
Mother's education	0.06	0.06
	(0.02)	(0.02)
Father's education	0.04	0.04
	(0.02)	(0.02)
Number of Siblings	-0.05	-0.04
	(0.02)	(0.02)
Family background poor	0.96	0.94
	(0.34)	(0.33)
Family background good	1.38	1.34
	(0.33)	(0.33)
Family background very good	1.06	1.04
	(0.43)	(0.43)
Resided in Santiago during primary or secondary school years	1.36	1.30
	(0.11)	(0.11)
Number of observations	3910	3910
R-squared	0.10	0.10

† In addition, the specification includes indicator variables for whether information on mother's education, father's education, region of residence is missing.

†† Total number of years exposed to voucher prior between ages 6 and 18.

Table 4
Multinomial Logit Model for the Probability of Choosing Subsidized or Non-subsidized Primary Relative to Municipal Primary Choice
(standard errors in parentheses)

	Estimated Coefficients	
Variable†	Subsidized Primary Choice	Non-subsidized Primary Choice
Intercept	-2.95	-4.22
	(0.39)	(0.58)
Voucher available during primary school years	1.04	0.02
	(0.19)	(0.22)
Voucher available during secondary school years	0.42	-0.24
	(0.24)	(0.31)
Mother's education	0.009	0.09
	(0.02)	(0.03)
Father's education	0.01	0.06
	(0.02)	(0.03)
Number of Siblings	-0.06	-0.04
	(0.02)	(0.03)
Family background poor	-0.11	-0.11
	(0.32)	(0.49)
Family background good	-0.02	-0.25
	(0.32)	(0.48)
Family background very good	0.05	0.13
	(0.39)	(0.58)
Resided in Santiago during primary or secondary school years	1.05	1.11
	(0.09)	(0.15)
Number of observations	3910	

† In addition, the specification includes indicator variables for whether information on mother's education, father's education, region of residence is missing.

Table 5
Decision Rule Model for Working
Probit Model
(standard errors in parentheses)

Variable†	Estimated Coefficient
Intercept	-5.36
	(0.12)
Years of education	0.08
	(0.003)
Attended subsidized primary	-0.12
	(0.02)
Attended nonsubsidized primary	-0.11
	(0.04)
Voucher available during	-0.49
primary school years	(0.08)
Voucher available during	0.19
secondary school years	(0.12)
Labor force experience (in years)	0.31
	(0.003)
Age	0.49
	(0.008)
Age squared	-0.01
	(0.0002)
Mother's education	-0.007
	(0.003)
Father's education	0.005
	(0.003)
Number of Siblings	0.009
	(0.003)
Family background poor	-0.04
	(0.04)
Family background good	-0.07
	(0.02)
Family background very good	-0.06
	(0.06)
Resided in Santiago during primary or secondary	0.07
school years	(0.02)
Number of observations	64302

† In addition, the specification includes indicator variables for whether information on mother's education, father's education, family background poverty status, region of residence or number of siblings is missing.

Table 6

Estimated Wage Returns to Schooling by Type of School, Pre and Post Voucher

	Pre-voucher	Post-voucher
Municipal primary (two-year return)	0.045	0.056
Subsidized primary (two-year return)	0.043	0.045
Nonsubsidized primary (two-year return)	0.050	0.058
Municipal secondary	0.050	0.050
Subsidized secondary	0.067	0.064
Nonsubsidized secondary	0.069	0.069
College education	0.033	0.033
College premium for those who attended nonsubsidized secondary	0.008	0.008

Table 7a
Actual and simulated schooling choice distribution
subsample not exposed to vouchers before age 15 (1213 individuals)
(simulated choices in parentheses)

		Secondary School Type				
		None	Municipal	Subsidized	Nonsubsidized	Total across all secondary Types
Primary Type	Municipal	34.8	47.1	5.2	0.7	88.0
		(30.2)	(50.1)	(3.5)	(0.8)	(84.5)
	Subsidized	1.2	2.2	4.3	0.1	7.8
		(2.5)	(3.9)	(3.1)	(0.6)	(10.1)
	Nonsubsidized	(0.3)	1.5	0.6	1.8	4.2
		(0.5)	(1.8)	(0.7)	(2.3)	(5.3)

Table 7b
Actual and simulated schooling choice distribution
subsample exposed to vouchers before age 15 (2699 individuals)
(simulated choices in parentheses)

		Secondary School Type				
		None	Municipal	Subsidized	Nonsubsidized	Total across all secondary Types
Primary Type	Municipal	19.7	46.0	10.7	1.5	77.9
		(18.4)	(48.9)	(5.7)	(1.3)	(73.5)
	Subsidized	1.0	5.2	9.8	1.0	17.0
		(2.3)	(7.7)	(8.6)	(1.1)	(19.7)
	Nonsubsidized	(0.2)	0.9	0.9	3.1	5.1
		(0.4)	(2.2)	(1.3)	(2.9)	(6.8)

Actual and Simulated Schooling Attainment
by whether exposed to voucher program before secondary school

	Subsample not exposed to vouchers		Subsample exposed to vouchers	
Years of schooling	Actual	Simulated	Actual	Simulated
5 or more	93.1	94.3	96.9	96.7
6 or more	93.1	94.3	96.9	96.7
7 or more	83.9	88.8	92.8	93.6
8 or more	83.9	88.8	92.8	93.6
9 or more	63.6	66.8	79.1	79.7
10 or more	58.2	63.6	74.9	77.5
11 or more	44.4	56.9	67.8	72.9
12 or more	42.7	47.9	63.5	64.4
13 or more	16.6	26.8	29.7	39.6
14 or more	14.0	15.6	24.5	23.9
15 or more	9.9	9.7	16.9	14.5
16 or more	6.1	5.8	11.4	7.7
17	3.1	2.8	5.6	3.7

Table 9
Actual and Simulated Labor Force Participation Rates
by Primary-Secondary Schooling Choice and Age
(Number of person-year observations in parentheses)

	Age 16-25		Age 26-35		Age 36-45	
Primary-secondary schooling type	Actual	Simulated	Actual	Simulated	Actual	Simulated
M-M	60.2 (19669)	59.1	93.9 (13801)	88.8	94.6 (6268)	90.4
S-M	45.6 (1648)	50.3	93.4 (775)	86.2	95.6 (325)	87.0
NS-M	40.6 (529)	40.3	90.5 (412)	78.5	97.5 (246)	81.3
M-S	52.9 (3413)	59.1	94.1 (1926)	91.1	93.2 (536)	90.7
S-S	42.9 (2943)	53.6	93.2 (1405)	90.6	96.5 (439)	91.1
NS-S	41.9 (286)	51.1	91.6 (155)	87.9	100* (65)	88.1
M-NS	48.1 (480)	51.0	90.2 (298)	86.4	95.3 (108)	87.4
S-NS	30.3 (241)	52.9	85.5* (69)	89.4	69.2* (26)	89.3
NS-NS	25.2 (1118)	47.6	92.6 (607)	89.4	97.7 (268)	88.6
M primary only	86.9 (11266)	89.2	91.3 (9246)	95.4	89.6 (4905)	95.2
S primary only	80.8 (449)	78.1	88.8 (297)	89.7	82.5 (160)	92.6
NS primary only	85.9* (78)	61.0	84.4* (58)	85.9	80.6* (31)	85.3
All Educational categories	63.6 (42120)	64.6	92.8 (29049)	90.2	92.8 (13377)	91.1

M: municipal, S: subsidized private, NS: nonsubsidized private.
*Less than 100 observations.

Table 10
Actual and Simulated Mean Wages of Workers (in 2002 US Dollars)
By Primary-Secondary Schooling Type and Age

Primary-Secondary Schooling Type	Age 16-45	
	Actual	Simulated
Municipal-Municipal	4949	5185
Subsidized-Municipal	5407	6568
Nonsubsidized-Municipal	7206	7205
Municipal-Subsidized	5945	6465
Subsidized-Subsidized	5671	7081
Nonsubsidized-Subsidized	3703*	7418
Municipal-Nonsubsidized	6206	7363
Subsidized-Nonsubsidized	5921*	7488
Nonsubsidized-Nonsubsidized	13605	8005
Municipal only	3022	2632
Subsidized only	3231*	2908
Nonsubsidized only	4287*	3676
All Educational categories	4736	4524

*These cells have relatively small numbers of observations (less than 100).

Table 11

Summary of Major educational reforms in Chile since 1980

	Reform	Detailed Description
1981	Introduction of nationwide school voucher program	Private subsidized schools have to accept amount of voucher as full payment of tuition. Voucher amount changes somewhat over the years. It decreased in real terms until 1990, when it increased.
1990	Union negotiated increase (almost doubling) of mandatory minimum wage for teachers, applicable for 1990-2004.	Both public and private teachers are members of the Teacher's Union, which negotiates over min teacher wage applicable to both public and private sector. Teachers in private schools can also form a school level union that negotiate wages over a min. level, but teachers in public schools cannot. At the end of the 1990's, there was an increase in the entrance exam scores (like SAT) of new teachers, which reversed a previous long-term downward trend in scores.
1990-2004	Increase in school resources	Achieved through increasing voucher amount and through special programs for schools.
1994	Change in rules to allow public and private schools to impose a small tuition charge on top of the voucher	This was allowed for private subsidized schools and, with some restrictions, for municipal schools. They cannot impose the charge on poor families.
1996	Introduction of SNED program – National System of Student Performance Evaluation	Within groups of comparable schools (in terms of student family background), identifies best 25% of schools according to the student results. These schools gain extra funds which are divided equally between the teachers of the school. Schools are designated "excellence" schools for two years.
2000	Increase of 20% in the length of the school day (about 6-7 hours per week) with no change in the number of days per year.	This reform required an expansion of many schools, because students had previously attended either morning or afternoon classes, which was no longer possible with the extended school day. Both public and private schools could apply for public school expansion funds and the program was gradually implemented. Information is available on which schools obtained these funds.
2002	Introduction of a new federal teacher certification program.	Teachers in public and private subsidized schools voluntarily submit a teaching portfolio (that includes video of classroom time) and take an exam. Teachers who receive the certification get an extra month of pay per year for ten years, paid for by the government. Currently, about 5% of all teachers receive this certification.
2003	New teacher evaluation program	Mandatory evaluation of all public school teachers every four years that be used for teacher dismissal. Public school teachers hired at the municipality level.

Table 12
Simulated effect of voucher program on education outcomes
by family background status

	Complete sample†			Poor Subsample††			NonPoor Subsample‡		
	With Program	Without Program	Diff	With Program	Without Program	Diff	With Program	Without Program	Diff
% Attending private subsidized primary	19.7	14.1	5.6	18.2	13.2	6.0	20.6	14.6	6.0
% Attending private nonsubsidized primary	6.8	8.1	-1.3	6.3	7.4	-1.1	7.1	8.5	-1.4
% Attending private subsidized secondary	15.4	10.1	5.3	14.1	9.4	4.7	16.5	10.6	5.9
% Attending private nonsubsidized secondary	5.1	5.7	-0.6	4.7	5.0	-0.3	5.5	5.8	-0.3
% Attending college	39.6	40.6	-1.0	36.6	37.6	-1.0	41.3	42.5	-1.2
25% quantile years of education	10	10	0	9	9	0	10	10	0
Median years of education	12	12	0	12	12	0	12	12	0
75% years of education	14	14	0	14	14	0	14	14	0

†Refers to sample of individuals exposed to voucher program at any point in their schooling careers.
†† Refers to subsample that reported family background as indigent or poor.
‡Refers to subsample that reported family background as good or very good.

Table 13
Voucher Impact on Education Distribution
Percent Completing at least x years of schooling

	Complete sample†			Poor Subsample††			NonPoor Subsample‡		
Years of schooling	With Program	Without Program	Diff	With Program	Without Program	Diff	With Program	Without Program	Diff
5	96.7	96.5	0.2	96.3	96.1	0.2	97.0	96.9	0.1
6	96.7	96.5	0.2	96.3	96.1	0.2	97.0	96.9	0.1
7	93.6	93.4	0.2	92.7	92.4	0.3	94.1	93.9	0.2
8	93.6	93.4	0.2	92.7	92.4	0.3	94.1	93.9	0.2
9	79.7	79.3	0.4	76.9	76.4	0.5	81.4	80.9	0.5
10	77.5	76.9	0.6	74.4	73.8	0.6	79.3	78.7	0.6
11	72.9	72.3	0.6	69.4	68.9	0.5	74.9	74.2	0.7
12	64.4	64.3	0.1	60.7	60.7	0.0	66.5	66.4	0.1
13	39.6	40.6	-1.0	36.6	37.6	-1.0	41.3	42.5	-1.2
14	23.9	25.2	-1.3	21.9	23.0	-1.1	25.0	26.5	-1.5
15	14.5	15.7	-1.2	13.2	14.2	-1.0	15.2	16.5	-1.0
16	7.7	8.6	-0.9	7.1	7.9	-0.6	8.1	9.1	-1.0
17	3.7	4.0	-0.3	3.4	3.7	-0.3	3.8	4.2	-0.4

†Refers to sample of individuals exposed to voucher program at any point in their schooling careers, over ages 15-45.
†† Refers to subsample that reported family background as indigent or poor
‡Refers to subsample that reported family background as good or very good.

Table 14
Voucher Program Impact on Labor Market Outcomes
(Earnings and Labor Force Participation)

	Complete sample†		Poor Subsample††		NonPoor Subsample‡	
	With Program	Without Program	With Program	Without Program	With Program	Without Program
Mean earnings						
ages 16-25	2695	2594	2526	2437	2800	2692
ages 26-35	5604	5402	5308	5129	5775	5560
ages 36-45	7447	7260	7032	6866	7688	7488
ages 16-45	5249	5085	4955	4811	5421	5247
Percent of time participate in the labor force						
ages 16-25	62.0	60.0	63.9	62.1	60.9	58.7
ages 26-35	90.3	89.1	90.6	89.6	90.0	88.9
ages 36-45	91.1	90.5	91.4	90.9	90.9	90.3
ages 16-45	81.1	79.9	82.0	80.9	80.6	79.3

†Refers to sample of individuals exposed to voucher program at any point in their schooling careers, over Ages 16-45.
†† Refers to subsample that reported family background as indigent or poor.
‡Refers to subsample that reported family background as good or very good.

Table A.1
Estimated coefficients from OLS Wage Regression

	OLS		
Variable	Coef.	Robust Std. Err.	T
Experience	.065	.005	12.50
Experience squared	-.002	.0002	-9.33
College	.171	.010	17.70
Municipal primary before reform	.112	.025	4.54
Subsidized primary before reform	.121	.030	4.09
Nonsubsidized primary before reform	.170	.034	5.04
Municipal primary after reform	.138	.025	5.56
Subsidized primary after reform	.139	.026	5.32
Nonsubsidized primary after reform	.116	.032	3.66
Municipal secondary before reform	.124	.014	8.90
Subsidized secondary before reform	.106	.030	3.59
Nonsubsidized secondary before reform	.197	.038	5.14
Municipal primary secondary reform	.091	.008	11.78
Subsidized primary secondary reform	.111	.010	10.84
Nonsubsidized secondary after reform	.155	.020	7.86
Constant term	6.874	.102	67.62

Table A.2 (a)
Estimated Parameter Values

Parameter	Estimate		Estimate
Ln Wage constant Type 1 Type 2 Type 3	6.56 7.43 6.68	Rental rate on municipal secondary post-voucher $(\beta_2 + \gamma_2)$	0.0500
Rental rate on municipal primary pre-voucher (β_1)	0.0450	Rental rate on private subsidized secondary pre-voucher $(\beta^S{}_2)$	0.0670
Rental rate on municipal primary post-voucher $(\beta_1 + \gamma_1)$	0.0558	Rental rate on private subsized secondary post-voucher $(\beta^S{}_2 + \gamma^S{}_2)$	0.0643
Rental rate on private subsidized primary pre-voucher $(\beta^S{}_1)$	0.0427	Rental rate on private nonsubsidized secondary pre-voucher $(\beta^{NS}{}_2)$	0.0691
Rental rate on private subsized primary post-voucher $(\beta^S{}_1 + \gamma^S{}_1)$	0.0452	Rental rate on private nonsubsized secondary post-voucher $(\beta^{NS}{}_2 + \gamma^{NS}{}_2)$	0.0694
Rental rate on private nonsubsidized primary pre-voucher $(\beta^{NS}{}_1)$	0.0501	Experience (β_3)	0.131
Rental rate on private nonsubsized primary post-voucher $(\beta^{NS}{}_1 + \gamma^{NS}{}_1)$	0.0576	Experience squared (β_4)	-0.0034
Rental rate on municipal secondary pre-voucher (β_2)	0.0500	Rental rate on years of college education (β_5)	0.033
Ln Wage constant penalty for non-Santiago region Type 1 Type 2 Type 3	 -0.09 -0.01 -0.03	Extra Rental rate on years of college education for non-subsidized school (β_5)	0.008

Table A.2(b)
Parameter Estimates

Parameter	Estimate		Estimate
Utility public primary school		Net cost of primary subsidized school	-139.1
Type 1	669.5		
Type 2	5044.1		
Type 3	2329.0		
Utility subsidized primary school		Net cost of secondary nonsubsidized school	-99.0
Type 1	259.0		
Type 2	4981.3		
Type 3	2283.5		
Utility nonsubsidized primary school (net of tuition costs)		Utility from college	
		Type 1	-170
Type 1	-70.7	Type 2	3392.5
Type 2	4783.7	Type 3	1498.8
Type 3	2201.9		
Utility public secondary school		Utility from Staying Home	
Type 1	539.0	Type 1	-190.0
Type 2	4123.6	Type 2	3647.4
Type 3	2216.5	Type 3	1418.5
Utility subsidized secondary school			
Type 1	430.6		
Type 2	3872.3		
Type 3	2240.2		
Utility nonsubsidized secondary school (net of tuition cost)			
Type 1	-30.7		
Type 2	3644.8		
Type 3	2102.5		

Table A.2(c)
Parameter Estimates Related to Schooling and Job Finding Costs

Parameter	Estimate	Parameter	Estimate
Cost of attending municipal school from outside of Santiago	-129.5	Cost of changing from subsidized primary to non-subsidized secondary	-508.6
Cost of attending subsidized school from outside of Santiago	-231.8	Cost of changing from non-subsidized primary to municipal secondary	-792.5
Cost of attending non-subsidized school from outside of Santiago	-233.7	Cost of changing from non-subsidized primary to subsidized secondary	-300.0
Cost of attending college from outside of Santiago	-101.2	Cost of changing from non-subsidized primary to non-subsidized secondary	-91.0
Cost of changing from municipal primary to municipal secondary	-164.2	Cost of finding first job if less than 9 years in school	-5662.9
Cost of changing from municipal primary to subsidized secondary	-609.2	Cost of finding first job if 9-12 years of school	-8425.5
Cost of changing from municipal primary to private secondary	-700.0	Cost of finding first job if more than 12 years of school	-8176.6
Cost of changing from subsidized primary to municipal secondary	-825.2	Extra Cost of attending municipal school from outside of Santiago (pre voucher)	-5.0
Cost of changing from subsidized primary to subsidized secondary	-91.1	Extra Cost of attending subsidized school from outside of Santiago(pre voucher)	-50.0
		Extra Cost of attending non-sub school from outside of Santiago(pre voucher)	-50.0

Table A.2(d)
Parameter Estimates Related to
Variances of Shocks

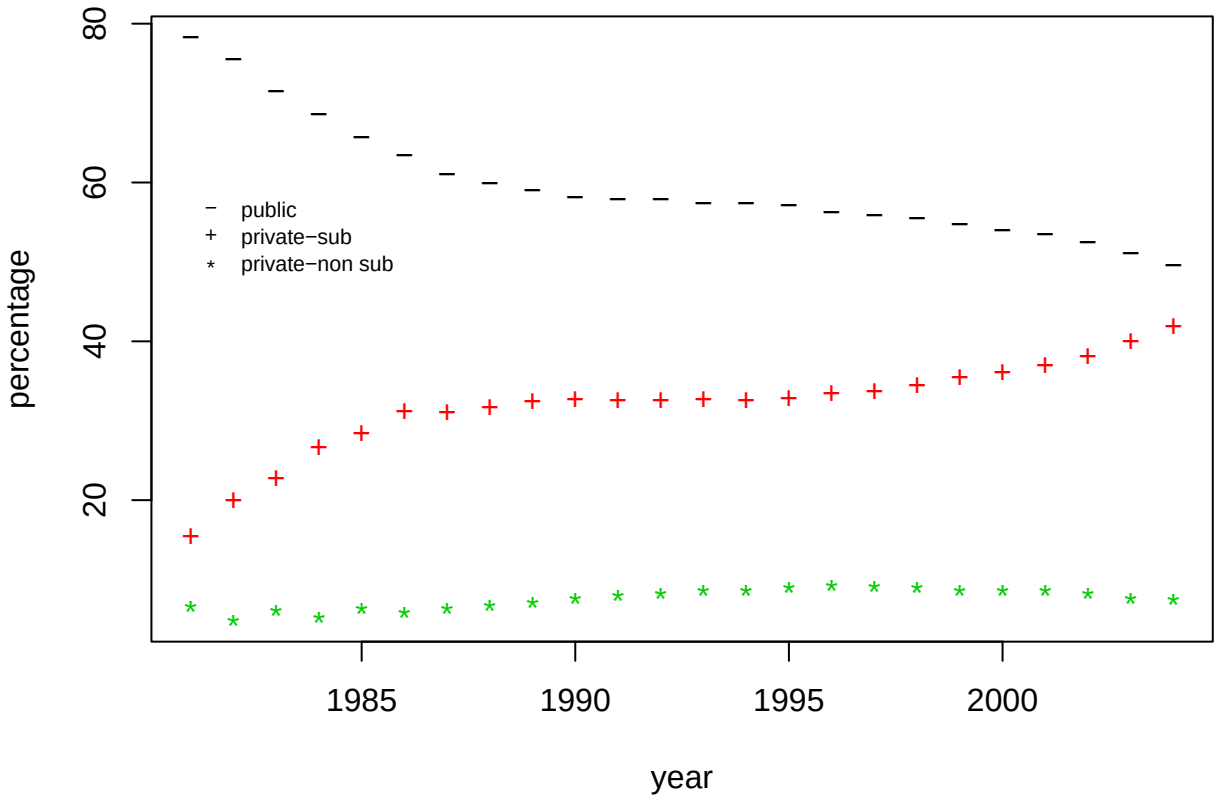
Parameter	Estimate
Std. error of ln wage error term	0.526
Std. error of preference shock for public school	785.2
Std. error of preference shock for private subsidized school	540.5
Std. error of preference shock for private nonsubsidized school	253.3
Std. error of preference shock for home utility	1484.0

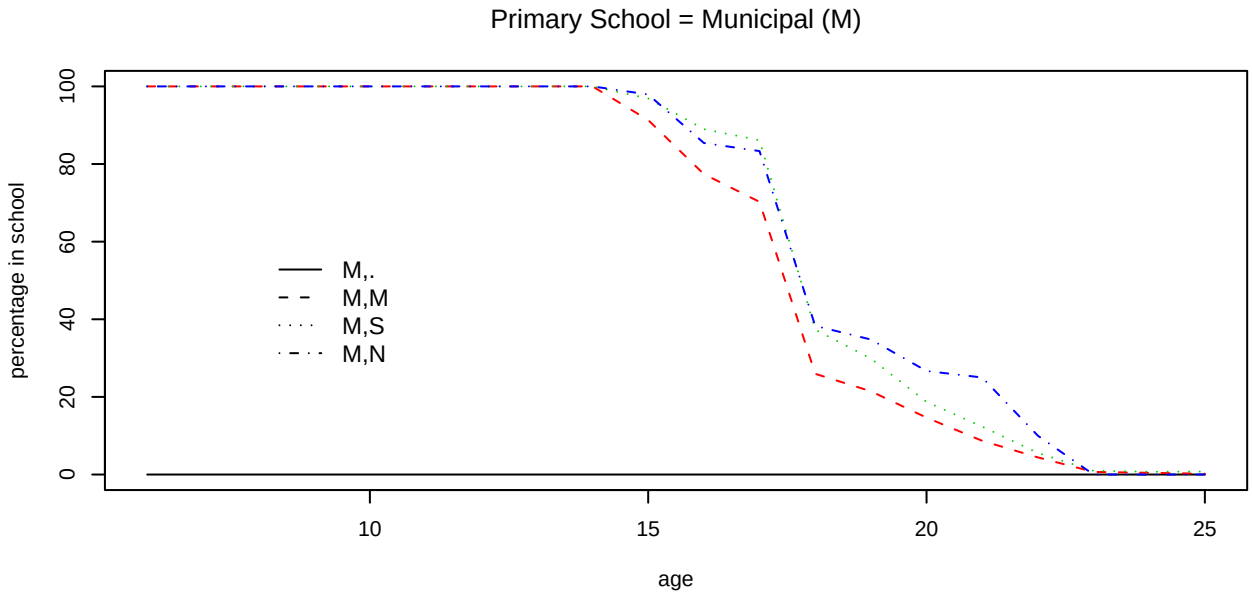
Table A.3

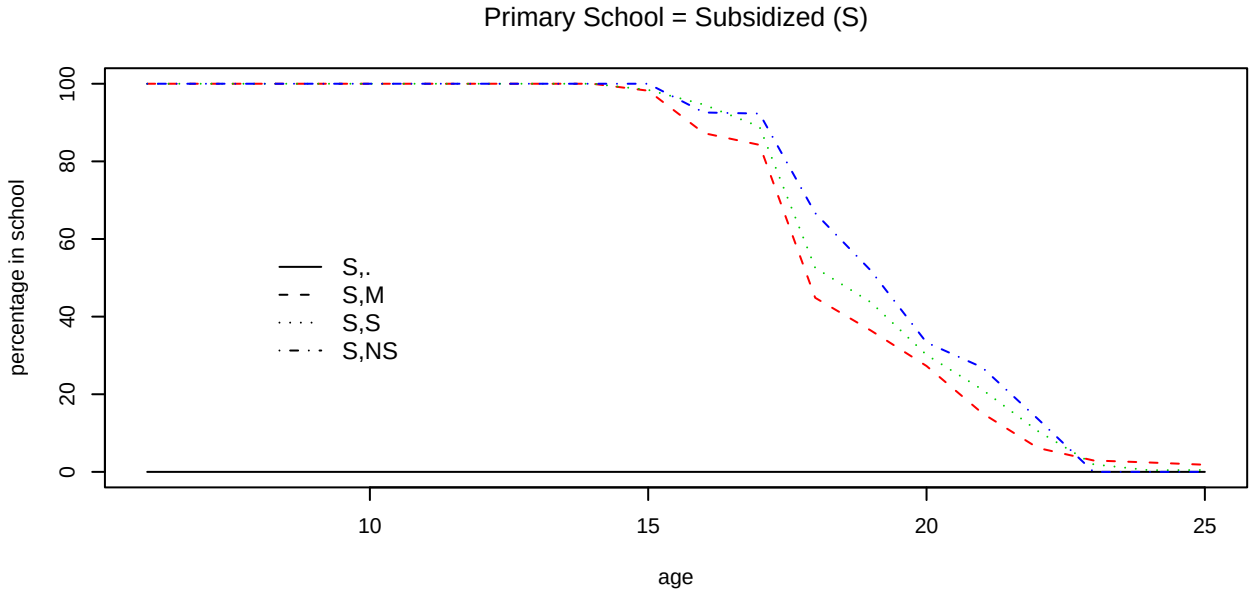
Simulation of Effects of Voucher reforms on earnings distribution

Percentile	No voucher	Voucher
1	1188	1204
5	1637	1683
10	2112	2178
25	3295	3389
50	5064	5206
75	6900	7110
90	8143	8433
95	8857	9106
99	9737	9806
Mean (Std dev)	5123 (2236)	5280 (2301)
CV	0.437	0.437
Skewness	0.13	0.10
Kurtosis	2.07	2.02

Figure 1: Percentage Attending Different Types of Schools by Year




Primary School = Municipal (M)
percentage in school
0
20
40
60
80
100
10
15
20
25
age
M,.
M,M
M,S
M,N


Primary School = Subsidized (S)
percentage in school
0
20
40
60
80
100
10
15
20
25
age
S,.
S,M
S,S
S,NS

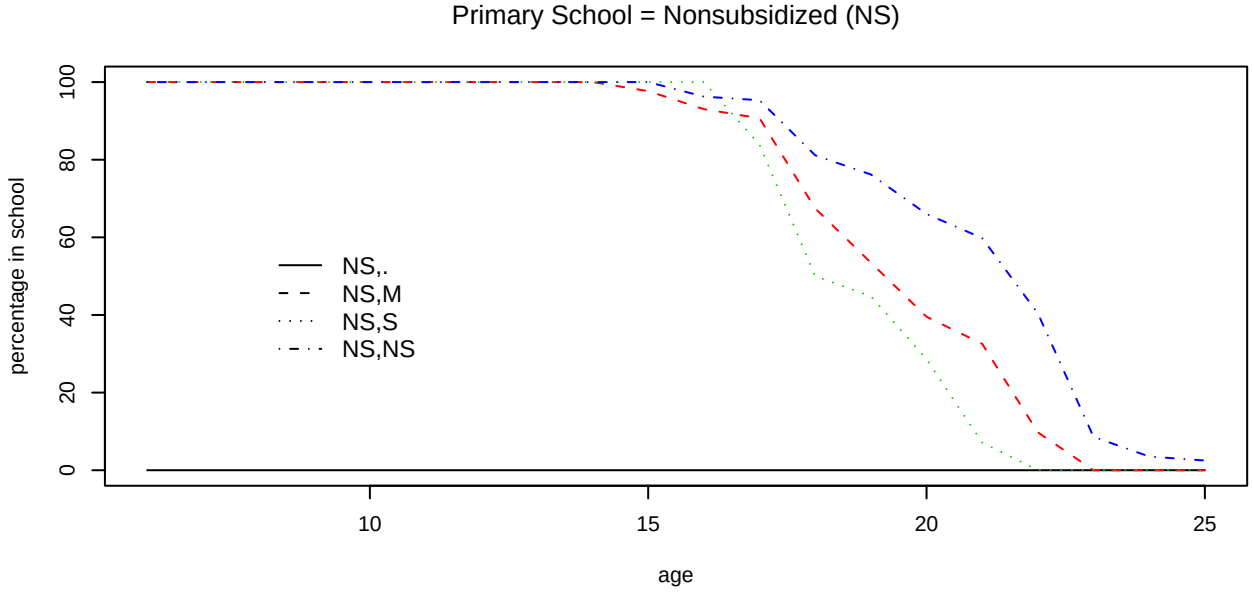

Primary School = Nonsubsidized (NS)
percentage in school
0
20
40
60
80
100
10
15
20
25
age
NS,.
NS,M
NS,S
NS,NS

Figure 3: Education Distribution, Overall and By Type of Primary Attended

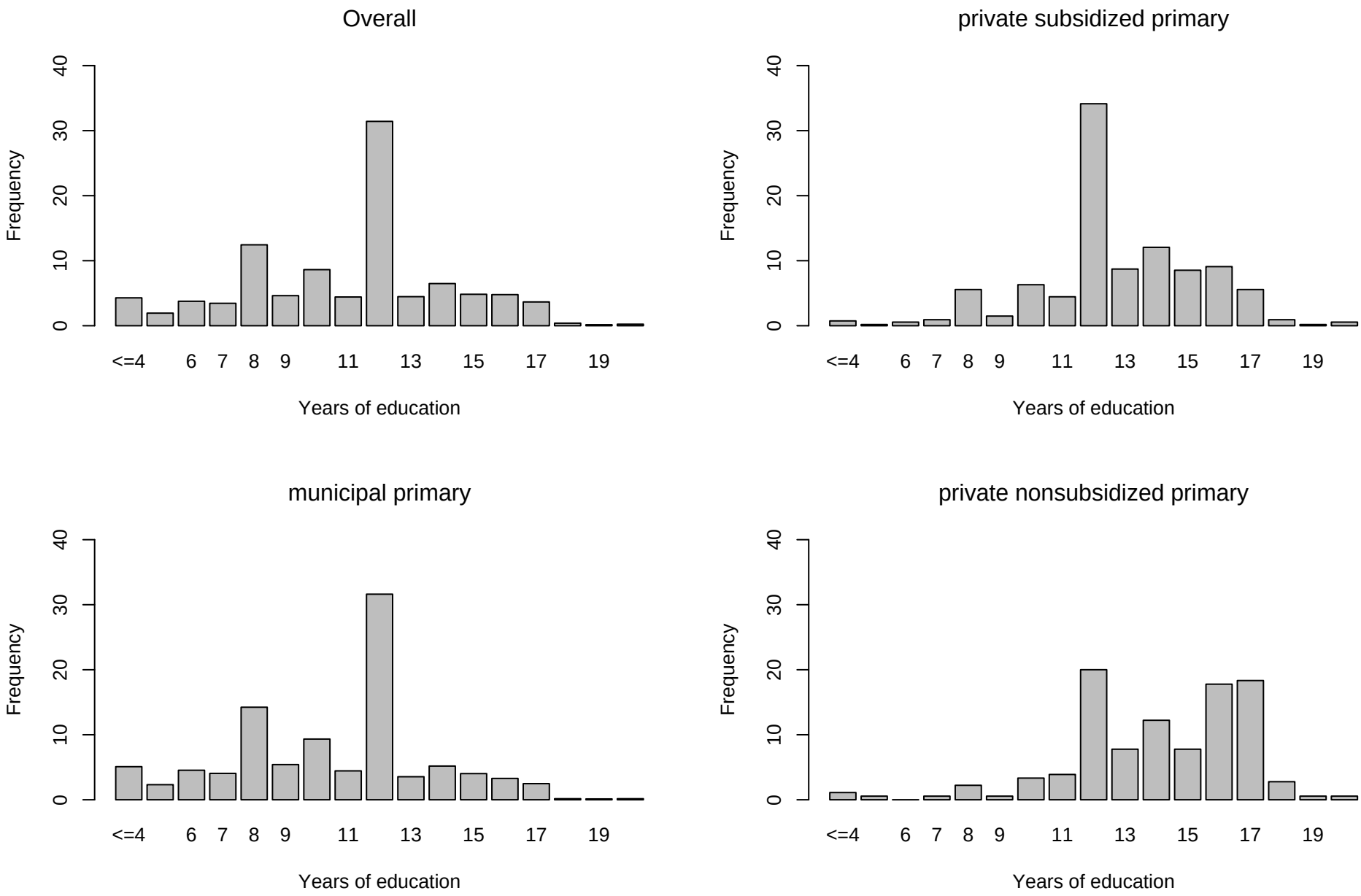


Figure 4: Perc. Working by Age and Type of Primary School

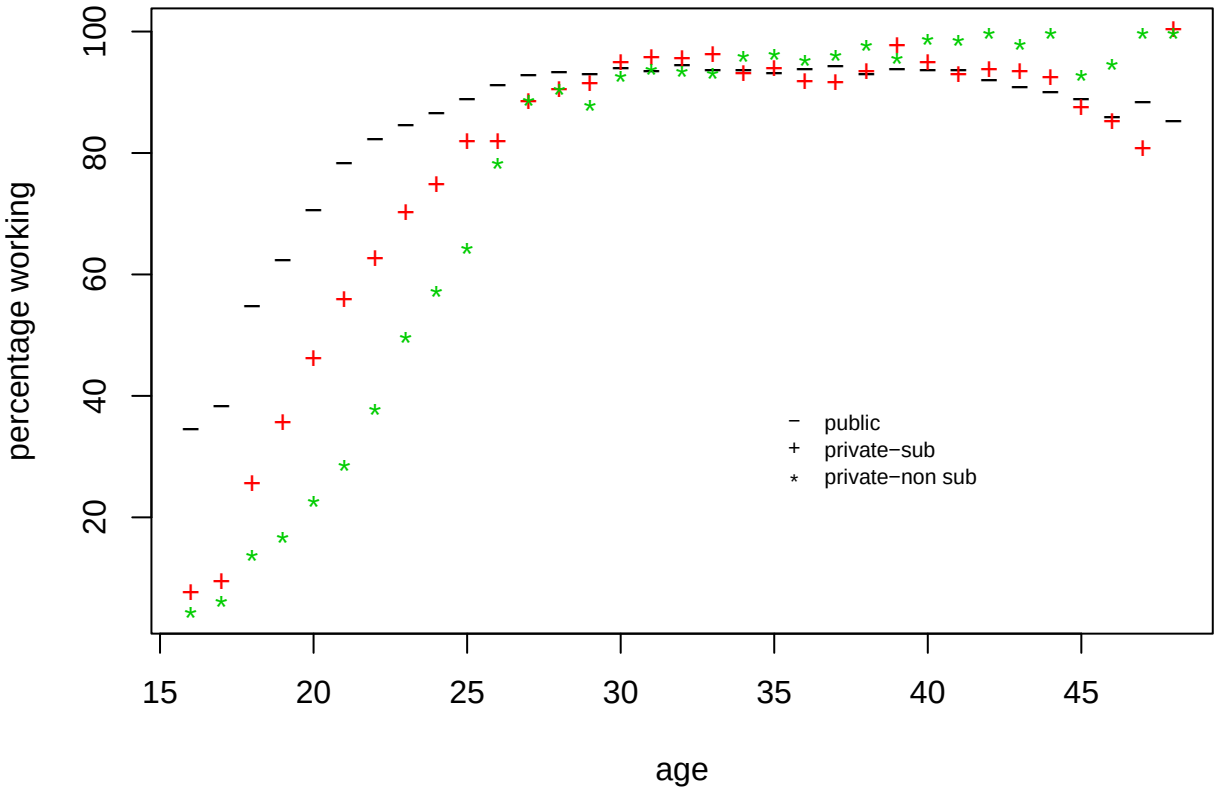


Figure 5: Smoothed Earnings−Age Relationship by Education Class and Schooling Type