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Self-Selection in the Market of Teachers

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Abstract

Public school teachers usually have centralized earning schedules, where their income depends mainly on experience. On the contrary, in private schools, there is high wage dispersion, and salaries respond mainly to teacher's performance. That dichotomous labor regulation encourages teachers with better unobservable skills to self-select in private schools because the likelihood of earning higher wages is higher than in public schools. The other side of the coin is the existence of "bad" teachers self-selecting in public schools. Using a representative sample of Chilean teachers, we estimate a two-sector Roy model to test self-selection. We find evidence of negative self-selection of teachers in public schools.

Keywords: education, human capital, self-selection
JEL Classification: I21; I28; J24

I. Introduction

Public school teachers commonly have centralized earning schedules with high seniority returns and strong limitations on firing poor-quality teachers. On the contrary, wages in private schools are set decentralized and are more directly related to the performance of teachers in the classroom. This dichotomous labor regulation is linked with how the influence of teachers' unions affects the earning schedule in the public sector.[1] Those distinct regulatory schemes for public and private schools produce different wage structures

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[1]Ballou and Podgurskyl (2002) find that returns to seniority are relatively higher for public school teachers in the United States. They posit that this phenomenon cannot be explained by teachers' human capital or the imperfect monitoring of their performance. They find that unions seek to reward senior teachers with "backloaded increases in pay" and junior teachers with fewer steps in their salary schedules "to reach high levels of pay more quickly." Heutel (2009) shows that higher teacher salaries in unionized districts in the United States can be explained by a tournament model. He states that large administrator-to-teacher salary ratios lure teachers to compete to be promoted as administrators. Like Ballou and Podgurskyl (2002), Heutel (2009) also rejects the imperfect monitoring hypothesis as a cause of high seniority returns. He argues that "teachers are among the most difficult of all employees to fire." The

in the private and public education sector. Private schools present high wages dispersion whereas public schools exhibit a very rigid wage structure with a low variance of wages.

If highly qualified teachers perform well in both markets, a traditional two-sector Roy model would predict that teachers with higher unobserved abilities should be concentrated in the market with a higher wage dispersion (i.e., private schools), and negative selection should be observed in the sector with highly compressed wages (i.e., public schools). Therefore, an over(bad) regulations governing the teaching career in public schools could result in important differences in the quality of teachers in public and private schools.

Chile presents a case where two different regulation for public and private schools coexist. On the one hand, public schools have been regulated since 1991 by the Teaching Statute (Estatuto Docente), which limits the grounds for dismissal and produces a very rigid wage structure that is heavily based on teachers' years of experience. On the other hand, private schools are regulated by the Labor Code (Código del Trabajo), with very general and flexible rules for setting salaries, in the same way that the Code regulates interactions between employers and employees are regulated in the remaining private markets of the economy.

We take advantage of the existence of this dichotomous labor regulation in Chile to test the existence of self-selection of teachers in public schools. Our empirical strategy considers a two-sector Roy model with no cost for teachers from moving among public and private schools. After controlling for teacher's and school's observable characteristics, we find evidence consistent with the existence of negative self-selection of teachers in public schools.

Our results are important for two reasons. First, empirical evidence supports the idea that unobservable characteristics (e.g., persistence, reliability and self-discipline) are as important as, or even more important than, observable characteristics (e.g., education, training courses) for the effectiveness of teachers in the classroom. Therefore, the rigid wage structure for teachers in public schools, which promotes negative self-selection, may partially explain poor academic results of students attending these schools. Second, our results suggest that an improved regulation that increase the variance of wages in public schools might be an effective way of attracting teachers with unobservable skills to the public sector.

Empirical evidence supports the key role of teachers in the cognitive and noncognitive development of students. Aaronson, Barrow, and Sander (2007) find that replacing a teacher with another one who is rated two standard deviations superior in quality can add 0.35 to 0.45 grade equivalents, or 30% to 40% of an average school year, to a student's math score performance. Kane, Rockoff, and Staiger (2008) use six years of data on student test performance to evaluate the effectiveness of teachers in New York City public schools. They find that, among those with the same certification status, there are large

findings of Ballou and Podgurskyl (2002) and Heutel (2009) present different explanations consistent with the idea that tenure protections challenge public schools to use alternative models to fire shirking teachers, rather than traditional models of imperfect monitoring.

and persistent differences in teacher effectiveness. They show that raising the effectiveness of novice teachers in New York by one standard deviation would have an impact on student achievement similar to the expected improvement of novices who spend eight years teaching in the district. Rivkin, Hanushek, and Kain (2005) show that teacher quality has powerful effects on reading and mathematics achievement. Their results suggest that the effects of a costly ten-student reduction in class size are smaller than the benefit of moving one standard deviation up the teacher quality distribution, highlighting the importance of teacher effectiveness in the determination of school quality. Rockoff (2004) finds that a one standard deviation increase in teacher quality raises test scores by approximately 0.1 standard deviations in reading and math on nationally standardized distributions of achievement.

Additionally, effectiveness or teacher quality depends not only on observable characteristics (education, family background, etc.) but also on unobservable ones. Aaronson et al. (2007) relate the measured teacher effects to observable characteristics of the instructors and show that the vast majority are unexplained by standard observable characteristics of teachers, including those that are typically used for compensation purposes. Lazear (2003) suggests that "there is no strong evidence that observable characteristics of the teacher are good predictors of the ability to affect student performance."

Those pieces of evidence suggest that the existence of negative self-selection of teachers in public schools may partially explain why several studies using Chilean student-level data find that, even after properly controlling for students' socioeconomic backgrounds, students attending voucher private schools have higher educational outcomes than those from public schools.[2]

The existence of negative self-selection based on unobserved abilities in the public sector and the importance of these abilities on the effectiveness of teachers in the classroom also have direct policy implications. An efficient way of attracting teachers with better unobservable skills to public schools is by increasing the flexibility of the legal framework regulating teachers' salaries in public schools to produce higher wage dispersion, similar

[2]McEwan (2001) finds that there is no consistent difference between student achievement in public and nonreligious private voucher schools, although fee-paying private schools and Catholic private voucher schools have higher achievement levels than public schools. Mizala and Romaguera (2001) and Sapelli and Vial (2002, 2005) find that students attending private voucher schools have higher educational outcomes than those from public schools. More recently, Anand, Mizala, and Repetto (2009) find that students in fee-charging private voucher schools score higher than students in public schools. However, they find no difference in the academic achievement of students in fee-charging private voucher schools relative to their counterparts in free private voucher schools. Their results suggest that low-income students who typically attend public schools can benefit from attending private voucher schools. Bravo, Mukhopadhyay, and Todd (2010) use the 2002 and 2004 Social Protection Surveys (Encuesta de Protección Social) to estimate a dynamic model of schooling and working decisions. They conclude that the school voucher program induced individuals affected by the program to attend private voucher schools at a higher rate, to achieve higher educational attainment, to participate more in the labor force, and to earn higher wages. Finally, Lara, Mizala, and Repetto (2011) use a number of propensity-score-based econometric techniques and changes-in-changes estimation methods and find that private voucher education leads to small differences in academic performance.

to that in the private sector. This policy may encourage teachers with higher unobserved abilities to migrate from private to public schools and, in the end, improve the academic results of children attending those schools.

The rest of the paper is organized as follows. Section II. analyzes the Chilean education system, focusing on the regulation that governs the wage structure in public and private schools. Section III. develops the theoretical model. Section IV. describes the data set used. Section V. discusses the empirical strategy to identify the model. Section VI. presents the empirical results. Section VII. concludes.

II. The Structure of Teachers' Salaries in Chile

The Chilean primary and secondary education system is composed of three types of schools: (i) public schools financed by government subsidies based on students' attendance and by additional funds from local governments (municipalities); (ii) private schools that are also financed by the government and, since 1992, by co-payments made by parents (semiprivate schools[3]); and (iii) private schools financed exclusively by parents (private schools).[4] The current labor legislation of public schools differs from that of private and semiprivate schools. Since 1991, the hiring, firing, and salaries of teachers working in municipal schools have been regulated by the Teaching Statute. The statute set a basic remuneration called Basic National Minimum Salary (BNMS), which is supplemented by several bonuses, many of them indexed to the BNMS.

Table 1 summarizes the main bonuses that a typical public school teacher earns during her working life. As this table shows, the wage structure in public schools is very rigid and heavily based on experience and training courses taken by teachers, with almost no compensation linked to teachers' performance in the classroom. For instance, in addition to their BNMS, teachers receive a bonus based on their teaching experience, which is equivalent to 6.76% of the BNMS for the first two years in the labor market and 6.66% of the BNMS for every two additional years.[5] Additionally, depending on their participation in training courses, teachers can receive an additional compensation equivalent to 40% of their BNMS (as maximum). The wage structure in the public sector also establishes special bonuses related to the type of degree obtained by teachers (professional degrees and majors), their celebration of national holidays, and the number of their children between 4 and 24 years attending school.

On the other hand, semiprivate and private schools are regulated by the Labor Code, with very general and flexible rules for hiring, firing, and setting salaries, in the same way that the Code regulates interactions between employers and employees are regulated in the remaining private markets of the economy. The flexible regulation of this sector produces

[3]Among those schools, there exist free semiprivate schools that do not charge copayments to parents and fee-charging semiprivate schools that charge positive copayments.

[4]Public, semiprivate, and private schools represented 40.71%, 50.73%, and 8.56%, respectively, of the total enrollment in primary and secondary education in 2010.

[5]The maximum is set at 100% of the BNMS for a teacher with more than 30 years of experience.

a higher wage dispersion than that found in the public sector.

Table 2 presents summary statistics of teachers' earnings by school type. On average, semiprivate and private school teachers receive a higher monthly wage than public school teachers. In relation to wage dispersion by school type, Table 2 shows that, on average, wages in semiprivate and private schools have a higher dispersion than those in public schools.

III. The Model

The basic model for our analysis is the Roy model of self-selection for workers with heterogeneous skills, in the spirit of Heckman and Sedlacek (1985). We assume that there are two market sectors in which income-maximizing teachers can work. The first market is composed of public schools, and the second of private and semiprivate schools. Teachers can choose the sector in which they work. However, they can work in only one type of school. We assume that there are no costs of moving among schools.

In our model, the production of primary and secondary education is carried out by performing a sector-specific task t_i. Each teacher is endowed with a vector of skills s that enables her to perform the sector-specific tasks. Therefore, different teachers endowed with different skills will tend to specialize in different sectors. Denote by $t_i(s)$ the sector-i-specific task that a teacher with skills s can perform. We assume that the human capital that the average student receives in sector i depends on the specific task t_i performed by the average teacher working in that sector.

We denote by p_i the exogenously determined fixed price of the task produced in sector i. Then, the wage that a teacher with a level of skills s obtains in sector i is the amount of sector-i-specific task that the teacher produces multiplied by the market price of that task. Therefore, the log wages in sector i for a teacher with s skills are given by the following expression:

$$\ln w_i = \ln p_i + \ln t_i(s) \quad \forall i \in \{1, 2\} \tag{1}$$

A teacher endowed with s skills will choose sector i if the following condition is satisfied:

$$\ln w_i \geq \ln w_j, \tag{2}$$

where equation (2) is the selection equation of the model.

We assume a simple functional form relating tasks to skills:

$$\ln t_i = b_i s \tag{3}$$

Additionally, following the results of Aaronson et al. (2007) and Lazear (2003), we assume that the vector of skills has measured and unmeasured components, s_m and s_u, with coefficients b_{im} and b_{iu}. That is,

$$b_i s = b_{im} s_m + b_{iu} s_u \tag{4}$$

Equation (4) highlights the fact that not only the observed characteristics of teachers are important in the production function of education, but so are the unobserved ones. Assume that s_m is distributed independent of s_u and $E(b_{iu}s_u) = 0$. Then, the log wages in sector i can be written as:

$$\ln w_i = \beta_i X + U_i, \tag{5}$$

where $\beta_i = [1\, b_{im}]$, $X = [\ln p_i\, s_m]'$, and $U_i = b_{iu}s_u$. We assume that (U_1, U_2) is a mean zero normal vector with covariance matrix Σ. We define σ_{ij} as the component located in row i and column j of matrix Σ.

We define sector 1 as the market that includes public schools managed by local government. Therefore, sector 2 includes semiprivate and completely private schools. The mean of log wages observed in the markets of public and private schools is given by:

$$E(\ln w_1 | \ln w_1 > \ln w_2, X) = \beta_1 X + \left(\frac{\sigma_{11} - \sigma_{12}}{\widetilde{\sigma}}\right) \lambda(c) \tag{6}$$

$$E(\ln w_2 | \ln w_2 > \ln w_1, X) = \beta_2 X + \left(\frac{\sigma_{22} - \sigma_{12}}{\widetilde{\sigma}}\right) \lambda(-c), \tag{7}$$

where $\widetilde{\sigma}^2 = \mathrm{Var}(U_1 - U_2)$, $c = \frac{-(\beta_1 - \beta_2)X}{\widetilde{\sigma}}$, $\lambda(c) = \frac{\phi(c)}{\Phi(-c)}$ and $\lambda(c) \geq 0$.

λ is the so-called inverse Mills ratio, which depends negatively on the propensity score-that is, the probability of choosing the public sector. The goal of this paper is to present evidence of self-selection based on teachers' unobserved skills in the market of Chilean schools. This paper aims at empirically identifying the coefficient that accompanies the inverse Mills ratio in equation (6). Different from other studies in the literature that use this type of methodology, in this paper the variable of interest is the inverse Mills ratio itself. To gain further insight, let's analyze equations (6) and (7).

Teachers' abilities should ensure an equal performance in both markets. That is, an agent with high unobserved abilities to teach in the private sector should also be an agent with high unobserved abilities to teach in the public sector. Therefore, we expect a high value of σ_{12}. Second, as discussed in Section II., different labor regulation in the private and public sectors generates two different markets. Sector 1 (the market of public schools) should be characterized by highly compressed wages, whereas sector 2 should have a higher wage dispersion. That means that σ_{11} should be small, and σ_{22} large. Therefore, according to equations (6) and (7), we expect negative selection in sector 1 but positive selection in sector 2. That is, the average teacher working in sector 1 earns a lower wage than the wage that the average teacher of population would earn in that sector, conditional on their observable characteristics. As suggested by the model developed in this section, this result reflects the fact that teachers with lower unobservable skills self-select into the public sector because the distinct wage structure existing in sectors 1 and 2.

The previous result is very intuitive. If σ_{12} is high, then a teacher with high unobserved abilities in sector 2 will also be a teacher with high unobserved abilities in sector 1. Additionally, teachers with unobserved skills have a higher probability of earning a

high wage in the sector where the wage variance is higher. Therefore, higher unobserved abilities' teachers will choose to work in the private sector, and lower unobserved abilities' teachers will choose the public sector. This phenomenon is what we called "negative self-selection", which is the natural consequence of the dichotomous labor regulation. In addition, λ is the so-called inverse Mills ratio. It depends negatively on the propensity score-that is, the probability of choosing the public sector. Specifically, as the propensity score tends to one, λ tends to zero, and thus the wage of the average teacher working in the public sector is not so different from the wage that the average teacher in the population would earn in that sector. That is because a propensity score close to one means that almost all teachers choose to work in the public sector. The opposite interpretation works in the case when the propensity score is close to zero.

Our main goal is to provide formal empirical evidence on the previous intuition. The next section describes the data used in our estimations, Section V. discusses the empirical strategy to identify the key parameters of our model, and Section VI. presents empirical results.

IV. Data

We use data from the Chilean Teaching Longitudinal Survey 2009. This database contains information for a representative sample of teachers working in public and private schools (which includes semiprivate and private establishments) in Chile. Also, this database contains information about teachers' socioeconomic backgrounds, academic careers, and earnings and the schools where teachers worked, the training programs in which they participated, and whether they received bonuses from the Ministry of Education associated with their participation in programs designed to evaluate their performance.

Since an important percentage of teachers of secondary level works in both private and public schools, and the survey does not allow to identify the funding type of the school where teachers work most of the time, we restrict our sample to primary education teachers who worked in schools of the same funding.

We use information on teachers' observable characteristics (such as gender and family background information, including the education level of their parents), teachers' postsecondary studies (such as the score they obtained on a standardized admissions test to enter postsecondary education), teachers' years of work experience, variables related to their participation in training programs, and teachers' hourly wages. Table 3 presents summary statistics of our sample.

V. Parameter Identification

In this section, we discuss the empirical strategy to identify the key parameters of our model. Before doing so, we describe the econometric specification for the outcome equations. Our baseline specification uses the natural logarithm of the hourly wage earned by

a teacher in sector i in 2009 as the outcome variable. As we previously explained, sector i takes the value of 1 for public schools and 2 for private schools (including semiprivate and private schools). The covariates include a vector of a teacher's observable characteristics: gender and parents' education. Additionally, we include a variable that characterizes the teacher's postsecondary studies which contains the score that the teacher obtained on a standardized admissions test to enter postsecondary education (PSU score). We also include a vector of variables that describes the teacher's work experience (such as years of work experience and its square, and hours that a teacher spent in training courses). Finally, we include two set of variables that intend to control for the characteristic of the places where schools are located. First, a vector of dummy variables at the province level. Second, the unemployment rate in the county where schools are located. These variables intend to control for some set of non-pecunary benefits paid to teachers that could explain differences in wages across sectors (section 6.1 further discusses this issue).

To avoid a cumbersome notation, we summarize all covariates of the model with X. We first run a probit regression to compute the probability that a teacher with observable characteristics X chooses the public school sector:

$$\text{Prob}\left(\ln w_1 > \ln w_2 | X\right) = \Phi\left(\frac{\left(\beta_1 - \beta_2\right) X}{\widetilde{\sigma}}\right) \tag{8}$$

Notice that with the previous probit we can identify $\widehat{c}$ and build the inverse Mills ratio $\lambda\left(\widehat{c}\right)$. After that, we use the estimated inverse Mills ratio as regressor in the following regression:

$$\ln w_1 = \beta_1 X + \left(\frac{\sigma_{11} - \sigma_{12}}{\widetilde{\sigma}}\right) \lambda\left(\widehat{c}\right) + \varepsilon_1 \tag{9}$$

The coefficient of $\lambda\left(c\right)$ will tell us whether positive, negative, or no selection exists in the public school sector. Notice that even though positive selection could potentially be observed in both sectors, negative selection can exist just in one market. We know that $0 \leq \text{correlation}^2(\ln w_1, \ln w_2) = \sigma_{12}^2/\sigma_{11}\sigma_{22} \leq 1$, and thus $0 \leq (\sigma_{12}/\sigma_{11})(\sigma_{12}/\sigma_{22}) \leq 1$. Negative self-selection in sector 1 implies that $\sigma_{12} > \sigma_{11}$, and thus $\sigma_{12}/\sigma_{11} > 1$, which in turn implies that $\sigma_{12}/\sigma_{22} < 1$. Therefore, if $\sigma_{11} - \sigma_{12} \leq 0$, then $\sigma_{22} - \sigma_{12} > 0$. That is, negative self-selection in sector 1 automatically implies positive self-selection in sector 2.

Additionally, even though two-step models with no exclusion restrictions are identifiable whenever $\lambda\left(\widehat{c}\right)$ is a non-linear function and there is no cost for teachers from moving across sectors, a problem of collinearity may appear when $\lambda\left(\widehat{c}\right)$ has little variation with respect to X, and thus, $\lambda\left(\widehat{c}\right)$ might have significant degrees of linearity. Therefore, we also estimate our baseline empirical model including as a exclusion restriction the type of school attended by teachers during their secondary education. That variable is included in the selection regression and excluded from the wage equation.

VI. Results

In this section we analyze the results of the empirical implementation of our model. As we previously explained, we first estimate the probability that a teacher, conditional on her observed characteristics, chooses to work in a public school. Table 4 (second column) presents the estimated coefficients of equation (8). In general, the estimated coefficients have the expected signs. Our results indicate that teachers who have participated in more training courses have a higher and statistically significant probability of working in public schools. Additonally, more experienced teachers have also a higher probability of choosing to work in public schools. The latter results are consistent with the regulatory framework of public schools. As we previously explained, the Chilean market of public schools is regulated by the Teaching Statute, which gives special monetary benefits to teachers based on their years of experience and participation in training courses (see Table 1). Therefore, it is likely that more experienced teachers with more hours in training courses have a higher probability of choosing to work in public schools.

After estimating the probability of working in public schools, we estimate the effect of self-selection on wages using the approach of two-step estimation developed by Heckman (1979). The third column of Table (4) presents the results of equation (9) for the sample of teachers who worked in public schools in 2009. Our findings indicate that teacher experience is one of the most important variables that determine earnings in the public sector. This result is consistent with the importance that the Teaching Statute gives to the years of experience to set teacher's wages in public schools.

Regarding the main coefficient of interest, the mills ratio coefficient, our empirical results suggest the existence of negative self-selection of teachers in public schools. As shown in the third column of Table (4), the coefficient that measures the presence of self-selection in the market of public teachers (i.e., the coefficient of the inverse Mills ratio), is negative and statistically significant at 1%.

Next, we perform some robustness analysis for our main empirical result. As we explained in section II., we consider three types of schools, classified by their funding sources: public schools, semiprivate schools, and private schools. These differences also determine the legal framework that regulates schools. Specifically, even though semiprivate schools are regulated by the Labor Code, they share with public schools some minor elements of their wage structures[6], although the main elements that rigidize the wage structure in public schools are basically absent in semiprivate schools. In this context, we redefine sector 2 to consider only semiprivate schools. We seek to analyze if the results of Table 4 are only driven by the sample of private schools. Table 5 presents these results. We observe that our results remain consistent with our initial estimations: the estimated coefficient of the parameter that identifies the type of selection in public schools is negative and statistically significant (at 5%).

[6]For instance, teachers who work in public and semiprivate schools can receive special monetary benefits according to their performance in government programs designed to measure teachers' achievement (such as *Asignación por Excelencia Docente* and *Asignación por Excelencia Pedagógica)*

Additionally, as discussed in section 5, two-step models' identification relies upon non-linearity of $\lambda(\widehat{c})$, hence two-step models with no exclusion restrictions may have problems of collinearity. Therefore, we present additional results using the type of school attended by teachers during their secondary education as exclusion restriction. That variable is included in the selection regression and excluded from the wage equation. Tables 6 and 7 present the results using the definition of sector 2 of Table 4 and 5, respectively. First, observe that the sign of the coefficient of the variable used for the exclusion restriction is the expected one. Teachers that attended public schools during their secondary education are more likely to work in the public education sector. Additional, tables 6 and 7 shows again evidence of negative self-selection of teachers in public schools as the Mills ratio coefficient is negative and statistically significant at conventional levels.

A. Discussion

The evidence found in this paper documenting a negative coefficient of the inverse Mills ratio shows that (1) the estimated first-stage propensity to teach in public schools is associated with lower wages, and (2) that the unobservables determining a public school teaching position are negatively correlated with the unobservables determining wages. Those unobservables may include ability and underlying teacher quality, as suggested by the model developed in section 3, but also tastes for compensating differentials that depress wages like job security, non-pecuniary benefits, and so forth.

For instance, assume that all teachers are identical regarding their observable characteristics Xs. However, there are unobervable tastes for some non-pecunary benefits, for instance, the security levels of the neighborhoods where schools are located. Assume that there are agents that value those non-pecunary benefits whereas other agents do not value them. Additionally, assume that public schools are located in more safety neighborhods. In that case we could have that individuals that value to work in more safety neighborhoods self-select in public schools and earn a lower wage than the wage that the average teacher (for whom security is less valuable) of the population would earn in that sector, because of compensating differentials. Evidence shows that even though this case is possible, it is very unlikely.

First, in order that the latter explains the negative sign of the coefficient of the inverse Mills ratio, it must be true that working in public schools embodies higher non-pecunary benefits than working in private schools. However, as documented in Chumacero et al. (2011) private schools are more concentrated in areas where students have a higher household income, which would imply that the working conditions and environment in private schools as well as the characteristics of the neighborhoods where they are located are better-quality than those ones where public schools are located. Therefore, if any, non-pecunary benefits might be more relevant in private than in public schools. In that case, we are underestimating the importance of the negative self-selection in public schools.

Additionally, the empirical model includes two types of variables that control for, at least, some set of non pecuniary benefits paid in different schools. First, dummy

variables at the province level where the school is located. Second, the unemployment rate of the county where the school is located. Controlling for those variables, the differential in wages between teachers that work in public schools and the one that the average teacher of the population would earn in that sector should be explained by differences in unobservable abilities. Therefore, although our empirical strategy cannot fully discard alternative stories, our results are consistent with the existence of negative self-selection of teachers in public schools. We believe that differences in unobservable skill endowments is a more compelling explanation for our results than a story of unobservable differences in tastes.

The existence of negative self-selection based on unobservable skills brings important policy implications about how to attract better teachers into the public educations. The model developed in section 3 and our empirical results suggest that an efficient way of attracting better teachers to public schools is by increasing the flexibility of the legal framework regulating teachers' salaries in public schools to produce higher wage dispersion, similar to that in the private sector.

Our results suggest the existence of negative self-selection of teachers in public schools. The existence of negative self-selection brings important policy implications about how to attract better teachers into the public education. The model developed in section 3 and our empirical results suggest that an efficient way of attracting better teachers to public schools is by increasing the flexibility of the legal framework regulating teachers' salaries in public schools to produce higher wage dispersion, similar to that in the private sector.

To further understand the implications of teachers' negative selection in public schools, we will go back to the equations of the model developed in Section III.. The human capital of a student who attends a school in sector i depends on the sector-specific tasks employed in that sector. In turn, the amount of sector-specific tasks depends on skills that have observed and unobserved components, as highlighted by Aaronson et al. (2007) and Lazear (2003).

For simplicity, we assume that there is no heterogeneity in observable skills. That is, all teachers have observable skills equal to $\overline{s}$. Define $\mu_1 = b_{1m}\overline{s}$ and $\mu_2 = b_{2m}\overline{s}$. Self-selection causes the mean of log task employed in sector 1 to be less than the mean of log task 1 in the total population:

$$E\left(\ln t_1 | \ln w_1 > \ln w_2\right) = \mu_1 + \left(\frac{\sigma_{11} - \sigma_{12}}{\widetilde{\sigma}}\right)\lambda\left(c\right) \tag{10}$$

$$E\left(\ln t_1\right) = \mu_1 \tag{11}$$

Therefore, teachers who work in sector 1 actually produce on average a lower amount of task than the average population would produce if they worked there. Thus, students who attend public schools end up with a lower level of human capital compared with the average population. That is because not only observed but also unobserved skills are important in the task production of education, as summarized in equation (4).

Consider a policy that increase the flexibility of contracts that regulate salaries in sector 1. Assume that the regulatory framework in sector 1 is equalized to that of sector 2. In terms of the model, such a policy experiment implies an increase in σ_{11}. To make clear the effect of this change, we assume that $\sigma_{11}=\sigma_{22}$ after the implementation of the policy. Using equation (10), we observe that positive selection should be observed in both sectors and, thus, the mean log task in sector 1 increases after the implementation of this policy.

VII. Conclusions

Using data on Chilean teachers, we find evidence consistent with the existence of negative self-selection of teachers in public schools. A possible explanation to our results is the dichotomous labor regulation in public and private schools in Chile. On the one hand, a Teaching Statute sets the salaries of teachers in public schools and produces a very rigid wage structure heavily based on experience and training courses taken by teachers, with almost no compensation linked to the teachers' performance in the classroom. On the other hand, the private sector is regulated by the Labor Code, with very general and flexible rules for hiring, firing, and setting salaries, in the same way that interactions between employers and employees are regulated in the remaining private markets of the economy. The flexible regulation in this sector produces higher wage dispersion than in public schools. Teachers with higher unobserved skills choose the sector with greater wage dispersion because their probability of earning a higher wage is greater. Then, higher unobservable skills' teachers self-select in private schools whereas lower unobservable skills' teachers do in public schools.

The importance of our results is twofold. First, given the importance of teaching in students' academic achieving, they contribute to the understanding of why students who attend public schools have worse results than those attending private schools. Second, our results have direct policy implications. An efficient way of promoting better academic results in public schools would be increasing the flexibility of the legal framework regulating teachers' salaries in public schools to produce higher wage dispersion, similar to that in the private sector. This policy may encourage teachers with higher unobservable abilities to migrate from private to public schools and, in the end, improve the human capital of children attending the public education.

An interesting extension of this paper would be to measure how different rules in public schools affect teachers' behavior. When salaries do not depend on performance measures, workers have the incentive to shirk, as long as they are not caught doing so (e.g., when high monitoring costs exist). For instance, Foster and Rosenzweig (1994) find that "time-wage payment schemes and share-tenancy contracts reduce effort compared to piece-rate payment schemes" in the labor market. We can also find empirical evidence of shirking in publicly regulated sectors. Hall, Propper, and Van Reenen (2008) show that locations with "higher outside wages" may even have problems motivating highly qualified workers. The rigid wage structure of Chilean public schools provides an interesting

hypothesis with which to test teachers' shirking behavior.

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Table 1: Public Sector Wage Structure (2009)

Basic National Minimum Salary (BNMS)	Value per hour of contract[(a)](US$)
Preschool, primary and special education	18.40
Secondary education	19.36
Bonus based on teacher's work experience	
First 2 years	6.76% of BNMS
For every two additional years[(b)]	6.66% of BNMS
Bonus based on participation in training courses	40% of BNMS (Max.)
Bonus based on teacher's managerial responsibility	
Public headmasters	25% of BNMS
Other administrative personnel	20% of BNMS
Other teacher personnel	15% of BNMS
Bonus based on Professional Improvement Unit[(c)]	
From January to November 2009	11.74 (per month)
December 2009	12.27 (per month)
Other Bonuses	
Bonus based on teacher's professional degree	
Degree	68.18 (per month)
Major	22.72 (per month)
National holiday bonus	
Net salaries<953 (US$/month)	93.60 (per year)
Net salaries>953 (US$/month)	65.20 (per year)
Schooling Bonus[(d)]	
Net salaries≤953 (US$)	92.23 (per year)
Net salaries>953 (US$)	38.58 (per year)

Notes: (a) Typical job contracts consider the workweek to be between 30 and 44 hours. (b) This bonus establishes a maximum of 100% of BNMS for teachers with more than 30 years of experience. (c) From January 2010, the bonus based on the Professional Improvement Unit (Unidad de Mejoramiento Profesional) ceased to be paid. (d) For teachers with children between 4 and 24 years attending to preprimary, primary, secondary and postsecondary school.

Table 2: Wage Structure by Funding Type (2009)

School	Monthly Wages (US$)			
Funding Type	Mean	Std. Dev.	Min.	Max.
Public	1,113	437	434	4,800
Semiprivate and Private	1,220	724	406	13,000

Source: Teaching Longitudinal Survey (2009).

Table 3: Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Public school	1,109	0.3282	0.4697	0	1
Hourly Wage (U.S.)	1,109	7.83	10.92	0.0619	340
Male	1,109	0.1930	0.3948	0	1
Age	1,109	42.4156	7.9875	24	55
Mother with less than 8 years of schooling	1,109	0.3354	0.4724	0	1
Mother with 8-11 years of schooling	1,109	0.1785	0.3831	0	1
Mother with 12 years of schooling	1,109	0.3463	0.4760	0	1
Mother with more than 12 years of schooling	1,109	0.1398	0.3469	0	1
Father with less than 8 years of schooling	1,109	0.2615	0.4396	0	1
Father with 8-11 years of schooling	1,109	0.1542	0.3613	0	1
Father with 12 years of schooling	1,109	0.3796	0.4855	0	1
Father with more than 12 years of schooling	1,109	0.2047	0.4037	0	1
PSU score	1,109	591.1289	67.0447	300	790
Experience	1,109	16.5753	8.8443	0	35
Experience^2	1,109	352.8909	301.4492	0	1225
Training (thousand of hours)	1,109	0.6617	1.2491	0	11.4286
Municipality's unemployment rate	1,109	0.1027	0.0309	0	0.1909
High School dependence (1:Public)	1,109	0.5897	0.4921	0	1

Source: Teaching Longitudinal Survey (2009). Notes: (a) Public school is a dummy variable that takes the value of 1 if the school where the teacher worked in 2009 is public and 0 if it is semiprivate or private. (b) PSU score corresponds to the score that a teacher earned on a standardized admissions test to enter postsecondary education.

Table 4: Two-Stage Estimates (1)

Dependent Variable: Log of Hourly Wage	**Probit**	**OLS (Public schools)**
Male	-0.026	0.096**
	(0.125)	(0.045)
Mother with 8-11 years of schooling	-0.250	0.167**
	(0.155)	(0.073)
Mother with 12 years of schooling	-0.033	-0.032
	(0.144)	(0.055)
Mother with more than 12 years of education	0.227	0.012
	(0.190)	(0.068)
Father with 8-11 years of schooling	-0.212	0.106**
	(0.158)	(0.052)
Father with 12 years of schooling	-0.216	0.063
	(0.148)	(0.066)
Father with more than 12 years of schooling	-0.543***	0.128
	(0.180)	(0.090)
PSU score	-0.003***	0.001***
	(0.001)	(0.000)
Experience	-0.025	0.016**
	(0.023)	(0.008)
Experience^2	0.002***	0.000
	(0.001)	(0.000)
Training (thousand of hours)	0.224***	-0.060***
	(0.056)	(0.021)
Municipality's unemployment rate	1.154	-0.268
	(2.183)	(0.791)
Inverse Mills ratio		**-0.484*** **
		(0.176)
Province fixed effect	Yes	Yes
Constant	1.561**	7.648***
	(0.625)	(0.176)
Observations	1,109	364

Notes: (a) Probit regression is estimated including Public, Semiprivate and Private schools. (b) PSU score corresponds to the score that a teacher obtained on a standardized admissions test to enter postsecondary education. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Two-Stage Estimates (2)

Dependent Variable: Log of Hourly Wage	**Probit**	**OLS (Public schools)**
Male	0.097	0.07
	(0.138)	(0.047)
Mother with 8-11 years of schooling	-0.24	0.140*
	(0.166)	(0.074)
Mother with 12 years of schooling	0.003	-0.045
	(0.152)	(0.055)
Mother with more than 12 years of education	0.316	0.01
	(0.208)	(0.073)
Father with 8-11 years of schooling	-0.192	0.090*
	(0.166)	(0.052)
Father with 12 years of schooling	-0.168	0.037
	(0.156)	(0.064)
Father with more than 12 years of schooling	-0.381*	0.045
	(0.195)	(0.076)
PSU score	-0.002**	0.001***
	(0.001)	(0.000)
Experience	-0.018	0.014*
	(0.025)	(0.008)
Experience^2	0.002**	0.000
	(0.001)	(0.000)
Training (thousand of hours)	0.233***	-0.044**
	(0.067)	(0.018)
Municipality's unemployment rate	-3.82	0.873
	(2.539)	(0.919)
Inverse Mills ratio		**-0.346****
		(0.163)
Province fixed effect	Yes	Yes
Constant	1.208*	7.738***
	(0.654)	(0.171)
Observations	880	364

Notes: (a) Probit regression is estimated including Public and Semiprivate schools. (b) PSU score corresponds to the score that a teacher obtained on a standardized admissions test to enter postsecondary education. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Two-Stage Estimates with Exclusion Restrictions (1)

Dependent Variable: Log of Hourly Wage	**Probit**	**OLS (Public schools)**
Male	-0.009	0.095**
	(0.128)	(0.044)
Mother with 8-11 years of schooling	-0.244	0.128*
	(0.155)	(0.071)
Mother with 12 years of schooling	-0.016	-0.039
	(0.144)	(0.055)
Mother with more than 12 years of education	0.264	0.043
	(0.189)	(0.063)
Father with 8-11 years of schooling	-0.223	0.084
	(0.157)	(0.051)
Father with 12 years of schooling	-0.205	0.033
	(0.148)	(0.063)
Father with more than 12 years of schooling	-0.489***	0.05
	(0.182)	(0.078)
PSU score	-0.003***	0.001***
	(0.001)	(0.000)
Experience	-0.032	0.015**
	(0.024)	(0.008)
Experience^2	0.002***	0.000
	(0.001)	(0.000)
Training (thousand of hours)	0.224***	-0.033**
	(0.057)	(0.015)
Municipality's unemployment rate	0.833	-0.068
	(2.184)	(0.794)
High School dependence (1:Public)	**0.344*** **	
	(0.108)	
Inverse Mills ratio		**-0.232** **
		(0.114)
Province fixed effect	Yes	Yes
Constant	1.377**	7.675***
	(0.635)	(0.176)
Observations	1,109	364

Notes: (a) Probit regression is estimated including Public, Semi-private and Private schools. (b) PSU score corresponds to the score that a teacher obtained on a standardized admissions test to enter postsecondary education. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Two-Stage Estimates with Exclusion Restriction (2)

Dependent Variable: Log of Hourly Wage	**Probit**	**OLS (Public schools)**
Male	0.111	0.077*
	(0.140)	(0.046)
Mother with 8-11 years of schooling	-0.23	0.127*
	(0.166)	(0.073)
Mother with 12 years of schooling	0.02	-0.046
	(0.152)	(0.055)
Mother with more than 12 years of education	0.341	0.026
	(0.209)	(0.068)
Father with 8-11 years of schooling	-0.204	0.083
	(0.166)	(0.051)
Father with 12 years of schooling	-0.166	0.028
	(0.156)	(0.062)
Father with more than 12 years of schooling	-0.356*	0.031
	(0.197)	(0.074)
PSU score	-0.002**	0.001***
	(0.001)	(0.000)
Experience	-0.022	0.014*
	(0.025)	(0.008)
Experience^2	0.002**	0.000
	(0.001)	(0.000)
Training (thousand of hours)	0.234***	-0.035**
	(0.067)	(0.015)
Municipality's unemployment rate	-3.861	0.648
	(2.529)	(0.847)
High School dependence (1:Public)	**0.252****	
	(0.115)	
Inverse Mills ratio		**-0.255***
		(0.133)
Province fixed effect	Yes	Yes
Constant	1.089	7.726***
	(0.662)	(0.172)
Observations	880	364

Notes: (a) Probit regression is estimated including Public and Semi-private schools. (b) PSU score corresponds to the score that a teacher obtained on a standardized admissions test to enter postsecondary education. *** p<0.01, ** p<0.05, * p<0.1.