Essays on the Teachers' Labor Market

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ABSTRACT

The four chapters are organized in chronological order as my research interests have developed.

Chapter 1 begins with the motivation of my study in teachers' labor market. I employ a monopolistic screening model to show that there exist multiple equilibria in the educational system; a pooling equilibrium and a separating equilibrium. The model predicts that the pooling equilibrium is optimal only when the average quality of teacher applicants is high. Using data from the OECD, I examine the relation between teachers' earnings and teacher quality of the U.S. and Korea.

Chapter 2 focuses on teachers and their career dynamics, and the data is at teacher level. Using the Current Population Survey for 2001-2010, I show that public school teachers are paid less compared to other comparable college graduates in non-teaching sectors. By studying the change in earnings after career changes, I find the evidence of positive selection when teachers move into the non-teaching sectors and of negative selection when non-

teachers move into the teaching sector, which results in the decrease in the average teacher quality.

Chapter 3 looks at both teachers and school districts, and I use district-teacher matched dataset, based on the School and Staffing Survey (SASS) for 2007-2008. I employ a multilevel model and a propensity score matching to identify union effects in states with different legal environments for collective bargaining of teachers. I find that collective bargaining is neither necessary nor sufficient for unions to affect teachers' well-being. I show that meet-and-confer is a popular alternative to collective bargaining and that it is an important mechanism for unions to influence teachers' non-wage benefits.

Chapter 4 concerns school districts, and I use SASS district level data. I reevaluate the role of teachers unions on pay structure and districts' financial status. In contrasts to previous findings, I find that the variance of teachers' earnings is higher in more unionized settings. Moreover, I show that the financial status of districts with teachers unions is stronger than that of districts without the unions. I confirm that unionism is associated with less usage of performance pay system.

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I am dedicating this dissertation to my family and my advisor:

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Mother, Jungok Lee

Brother, Suseok Han

Sister-in-law, Misun Jung

And Advisor, Professor Richard Freeman

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Chapter 1: Multiple Equilibria in the Educational System: Case Studies on the U.S. and South Korea

This study employs a monopolistic screening model to show that there exist multiple equilibria in the educational system; a pooling equilibrium and a separating equilibrium. The model predicts that the optimal choice for school districts is the pooling equilibrium when the average quality of teacher applicants in the queue is high but the separating equilibrium when the average quality of applicants is low. In the pooling equilibrium, both low and high quality teachers are hired and all teachers receive high compensation. In the separating equilibrium, only the low quality teachers are hired at low level of compensation. Using data from the OECD, I compare the educational systems of the U.S. and South Korea and examine the relation between teachers' earnings and teacher quality. I show that the average quality of teacher applicants in Korea is high, and Korean educational system has achieved a pooling equilibrium. On the other hand, the average quality of teacher applicants in the U.S. is low, and the US educational system is currently operating at a separating equilibrium. Thus, it will be necessary to raise teacher compensation significantly to improve teacher quality in the U.S.

Key Words: monopolistic screening model, teacher quality, teacher salary, excess supply

1.1 Introduction

There is great variation in teacher salaries across countries; some countries pay their teachers considerably more than other countries do. Many believe that teacher salaries are positively associated with teacher quality, which leads to significant cross-country variation in educational outcomes. South Korea is considered as one of the examples that show a positive correlation between teacher salaries and teacher quality. According to *Education at a Glance* by OECD, teachers in South Korea earn high salaries by international standards, and students from South Korea perform at the very top on major international tests. Many educators and policy makers believe the high quality of Korean teachers as the key to this successful educational outcome.

However, empirical studies on the relation between teacher quality and teacher salaries show mixed findings. Some studies found the significantly positive and strong relationship between teacher salaries and teacher quality, measured by students' academic performance (Murnane, 1991; Ballow and Podgursky, 1997; Flyer and Rosen, 1997; Figlio and Lucas, 2000; Temin, 2002; Goldin, 2006; and Dolton and Marcenaro-Gutierrez, 2011). Others found either insignificant or weak relationship between teacher quality and teacher salaries (Hanushek, 1986; Betts, 1995; and Grogger, 1996).

One reason for the inconsistent results may be because the relationship between the two is not linear. For instance, the increase in teacher salaries may not raise the average teacher quality if teacher salaries are set too low or too high. If this is the case, a regression analysis will not be able to capture the true relationship. The standard OLS models will also produce spurious estimates if the variance of teacher quality distribution or teacher salary

distribution is too small. If I regress teacher quality, proxied by students' test score of the teacher, on teacher earnings, measured by annual base salary which has little variability across entities, the coefficient on teacher salary will be imprecisely estimated.

In this study, I use a monopolistic screening model from mechanism design literature to show that an educational system may be in one of the two types of equilibria; a pooling equilibrium and a separating equilibrium. In a pooling equilibrium, both low and high quality teachers are hired and all teachers receive high compensation. In a separating equilibrium, low quality teachers and high quality teachers receive different levels of compensations that are proportional to their quality type. The model predicts that the pooling equilibrium is optimal for school districts when the average quality of teacher applicants in the queue is high whereas the separating equilibrium is optimal when the average quality of teacher applicants is low. In the latter case, it is likely that only the low quality teachers are hired and they receive low salaries under certain conditions. As a simple application of the model, I compare the educational systems of the U.S. and Korea using the data from *Education at a Glance* by OECD. I show that the average quality of teacher applicants is low in the U.S. and the U.S has attained the separating equilibrium whereas and average teacher quality of applicants is high in Korea and Korea has achieved the pooling equilibrium.

Further, I discuss how the Korean educational system may be currently operating above the optimal pooling equilibrium. The higher salary above the equilibrium results in the excess supply of teacher applicants with high quality. There is a very long queue for teaching positions, which seems to contribute to social loss. In the U.S., on the other hand, even if there also exists a queue for teaching positions, the average quality of current stock of teacher applicants is low. Therefore, it is difficult for US school districts to recruit high quality

teachers, and a small raise in teacher salary may not bring a significant improvement to teacher quality.

This paper is organized as follows. In section two, I present the monopolistic screening model for multiple equilibria of educational system. Section three applies the model to the US and Korean educational systems. Section four discusses problems of excess supply of teachers. Section five lays out the policy implications for the US educational system, and the final section concludes with a brief summary.

1.2 Model with Two Equilibria

The model I employ is *monopolistic screening model* from mechanism design literature. This screening model allows me to design the employment contracts where there is pre-contractual asymmetric information. In this model, an employer (a principal or school district) tries to distinguish among potential employees (teachers) who have different unobservable characteristics assumed to be related to quality or productivity. A monopolistic screening model fits better than a competitive screening model for my study because public educational system works as if a single firm, a public school district, offers employment contracts to all teachers that it hires. Since the school district is on the demand side of the labor market, the model could be called "monopsonistic" screening model.

Suppose that a school principal (or a district principal) is trying to recruit new teachers from a pool of teacher applicants who have identical observable qualifications, such as college diploma, teaching certificates, and teaching experience. Thus, these ex-ante observables provide no information for the principal to determine who will turn out to be

better teachers. The applicants know their true types or at least know better than the principal. Suppose further that the new teachers automatically get tenure once they are hired.[1] This is a critical assumption as it describes the common situation where the principal has to stay with the teachers that he hires after the teachers reveal their true quality, which might be quite poor. Moreover, pay for performance is not available, so the principal cannot cut down the wage even if the teachers deliver poor teaching performance.

There are two types of applicants in the pool; high quality (θ_H) and low quality (θ_L). θ represents the quality/productivity of applicants and can be measured in monetary unit, with $\theta_H > \theta_L > 0$. The principal does not know the true type of applicants, but he has an ex-ante belief that the fraction of applicants of type θ_H is P_H = prob (θ_H) and the fraction of applicants of type θ_L is P_L = prob (θ_L) = $1 - P_H$ with $P_H, P_L \in [0,1]$. W_H (w_L) is the expected hourly wage that the principal offers to type θ_H (θ_L). The expected hours of work that type θ_H (θ_L) applicant is willing to put in at a given wage are denoted as e_H (e_L). e is standardized such that e=1 for a full-time (for instance, 40 hours a week) and e=0 for not working at all or reject the offer, so $e_H, e_L \in [0, 1]$.

A school produces educational output using a teacher as an input. It can measure education quality by using a proxy such as students' standardized test score or graduation rate. Denote $\pi(e)$ educational quality measured by students' test scores in monetary units when teachers work for e units of hours. The school produces the education with the quality of π_H (π_L) if it hires teachers of type θ_H (θ_L). High quality teachers always produce higher quality education for a given number of teaching hours, so $\pi_H(e) > \pi_L(e) > 0$. High quality teachers

[1] This assumption is realistic as few newly-hired teachers (less than 2%) are denied tenure due to poor performance once they are hired in the U.S. The detailed information about this is discussed in section three.

produce high quality education at an increasing rate with respect to e, so $\pi'_H(e) > \pi'_L(e) > 0$ for all e. The principal offers teacher applicants a menu of contracts which consist of a pair of wage and work hour: (w_H, e_H) for type θ_H applicants and (w_L, e_L) for type θ_L applicants. The contract that I focus in this study is *one time* "take-it-or-leave-it" offer. I assume the following form of utility function for applicants, which is widely used in the literature:

$$U_t(w_t, e_t, \theta_t) = w_t + \theta_t(1 - e_t), \qquad \text{t=}H \text{ or } L \tag{1}$$

If a type θ_H applicant rejects the offer, $e_H = 0$, so $w_H = 0$, which implies $U_H = \theta_H$. If the type θ_H applicant accepts the full time job offer, $e_H = 1$ and $U_H = w_H$. If a type θ_L applicant rejects the offer, $e_L = 0$ and $U_L = \theta_L$. If the type θ_L applicant accepts the full time job offer, $e_L = 1$ and $U_L = w_L$. For an applicant to accept the contract, he/she must be guaranteed a utility of at least, $\overline{U}_t$ a reservation utility for each type. Therefore, the contract must at least offer $\overline{U}_H = \theta_H$ for type θ_H applicants and $\overline{U}_L = \theta_L$ for type θ_L applicants. This assumption implies that high quality applicants have better outside opportunities, so they have higher level of reservation utility; $\overline{U}_H > \overline{U}_L > 0$.

The education quality depends on both the type of the teachers hired and the work hours they choose to undertake at a given wage. The gain the principal makes from offering the education is $\pi_H e_H - w_H$ if he hires type θ_H applicants, and $\pi_L e_L - w_L$ if he hires type θ_L applicants. Since the principal cannot distinguish the type with ex-ante observables, he has the following expected utility:

$$U_p = P_H(\pi_H e_H - w_H) + P_L(\pi_L e_L - w_L) \quad (2)$$

The principal's problem is to offer a set of contracts that maximize his expected utility from offering education with a certain quality, given the applicant's self-selection among the offered contracts. Therefore, the principal optimally chooses the pairs of contracts (w_H, e_H) and (w_L, e_L) by solving the following problem:

$$\underset{w_H, e_H, w_L, e_L}{Max} \; P_H(\pi_H e_H - w_H) + P_L(\pi_L e_L - w_L) \quad (3)$$

$$\text{s. t} \quad \text{(i)} \quad w_H + \theta_H(1 - e_H) \geq \theta_H$$

$$\text{(ii)} \quad w_L + \theta_L(1 - e_L) \geq \theta_L$$

$$\text{(iii)} \quad w_H + \theta_H(1 - e_H) \geq w_L + \theta_H(1 - e_L)$$

$$\text{(iv)} \quad w_L + \theta_L(1 - e_L) \geq w_H + \theta_L(1 - e_H)$$

Constraints (i) and (ii) are the reservation utility (individual rationality) constraints for the type θ_H applicants and the type θ_L applicants, respectively. Thus, each type of teachers should get paid at least their reservation utility level. Constraints (iii) and (iv) are the incentive compatibility constraints for the type θ_H applicants and the type θ_L applicants, respectively. In constraint (iii), the type θ_H applicants get the utility of $w_H + \theta_H(1 - e_H)$ if they tell the principal their true type, but they get the utility of $w_L + \theta_H(1 - e_L)$ if they claim otherwise. Therefore, constraint (iii) ensures that the type θ_H applicants get higher utility when they reveal their true type. Constraint (iv) implies that the type θ_L applicants get higher utility when they reveal their true type.

Lemma 1 Constraint (ii) is redundant, so the set of feasible contracts derived from the problem (3) is exactly the same as the set of feasible contracts when the constraint (ii) is dropped from the problem.

Proof When both constraint (iv) and constraint (i) are satisfied, and under the assumption of $\theta_H > \theta_L > 0$, we must have $w_L - \theta_L e_L \geq w_H - \theta_L e_H \geq w_H - \theta_H e_H \geq \theta_H \geq \theta_L$. Therefore, constraint (ii) is automatically satisfied.

Lemma 2 $e_L \geq e_H$ and $w_L \geq w_H$.

Proof When both constraint (iii) and constraint (iv) are satisfied, we have $\theta_L(e_H - e_L) \geq w_H - w_L \geq \theta_H(e_H - e_L)$. Since $\theta_H > \theta_L > 0$ by the assumption, it must be that $e_L \geq e_H$ and $w_L \geq w_H$.

Lemma 2 implies that the type θ_H applicants must have lower probability of accepting the offer or they must be willing to work fewer hours than the type θ_L applicants to signal their preference for a higher wage. Also, in the optimal contract, the type θ_L applicants cannot expect a lower wage than the wage of the type θ_H applicants.

Lemma 3 Constraint (i) and constraint (iv) are binding (hold with equality).

Proof *Lemma 1* states that constraint (ii) is redundant, so the problem (3) can be restated as:

$$\underset{w_H, e_H, w_L, e_L}{Max} \; P_H(\pi_H e_H - w_H) + P_L(\pi_L e_L - w_L) \tag{4}$$

s.t (i) $w_H + \theta_H(1-e_H) \geq \theta_H$

(iii) $w_H + \theta_H(1-e_H) \geq w_L + \theta_H(1-e_L)$

(iv) $w_L + \theta_L(1-e_L) \geq w_H + \theta_L(1-e_H)$

If I let $(\gamma, \phi_H, \phi_L) \geq 0$ be the multipliers of constraints (i), (iii), and (iv), respectively, the first two Kuhn-Tucker conditions along with the complementary slackness conditions for W_H and W_L, respectively, are:

(a) $-P_H + \gamma + \phi_H - \phi_L = 0$

(b) $-P_L - \phi_H + \phi_L = 0$

Condition (b) implies that $\phi_L > 0$ (if $\phi_L = 0$, $\phi_H = P_H = P_L = 0$, but this contradicts $P_H + P_L = 1$). Thus, constraint (iv) must bind at an optimal solution. If we add condition (a) and condition (b), and use $P_L = 1 - P_H$, we get $\gamma = 1$. Hence, constraint (i) also binds at an optimal solution.

Lemma 4 If the constraint (iv) is binding and $e_L \geq e_H$, constraint (iii) is redundant. Thus, the set of feasible contracts derived from the problem is exactly the same as the set of feasible contracts when constraint (iii) is dropped from the problem.

Proof Since constraint (iv) is binding, $w_L + \theta_L(1-e_L) = w_H + \theta_L(1-e_H)$. Rearranging it gives $w_L - w_H = \theta_L(e_L - e_H)$. If $e_L \geq e_H$, $w_L - w_H \leq \theta_L(e_L - e_H)$. So, it must be that $w_H + \theta_H(1-e_H) \geq w_L + \theta_H(1-e_L)$, which is constraint (iii).

The conditions for the problem are now simplified to two constraints, so the Lagrangian simplifies to:

$$L = [P_H(\pi_H e_H - w_H) + P_L(\pi_L e_L - w_L)] + \lambda[w_H + \theta_H(1-e_H) - \theta_H] + \gamma[w_L + \theta_L(1-e_L) - w_H - \theta_L(1-e_H)] \quad (5)$$

The first order conditions are:

(i)' $\frac{\partial L}{\partial w_L} = -P_L + \gamma = 0$

(ii)' $\frac{\partial L}{\partial w_H} = -P_H + \lambda - \gamma = 0$

(iii)' $\frac{\partial L}{\partial e_H} = P_H \pi_H - \lambda\theta_H + \gamma\theta_L = 0$

(iv)' $\frac{\partial L}{\partial e_H} = P_L \pi_L - \gamma\theta_L = 0$

From (i)', we have $\gamma = P_L$. From (ii)', $\lambda = \gamma + P_H = P_L + P_H = 1$. Since constraints (i) and constraint (iv) are binding, we have $w_H = \theta_H e_H$ and $w_L = \theta_H e_H + \theta_L e_L + \theta_L e_H$. By

plugging in $\gamma = P_L$ and $\lambda = 1$ along with these conditions derived from the two binding constraints, we have:

$$\begin{aligned} L &= P_H(\pi_H e_H - w_H) + P_L(\pi_L e_L - w_L) \\ &= P_H(\pi_H e_H - \theta_H e_H) + P_L(\pi_L e_L - \theta_H e_H - \theta_L e_L - \theta_L e_H) \\ &= P_H e_H(\pi_H - \theta_H) + P_L e_L(\pi_L - \theta_L) + P_L e_H(\theta_L - \theta_H) \\ &= P_H e_H\left[(\pi_H - \theta_H) + \frac{P_L}{P_H}(\theta_L - \theta_H)\right] + P_L e_L(\pi_L - \theta_L) \end{aligned} \tag{6}$$

If we denote the element inside the bracket $Q = (\pi_H - \theta_H) + \frac{P_L}{P_H}(\theta_L - \theta_H)$, then $L = P_H e_H Q + P_L e_L(\pi_L - \theta_L)$. Suppose that $\pi_L > \theta_L$, which implies that the value of type θ_L applicants worth more to the school than to themselves. This assumption explains the situation where the school cannot produce education without teachers and the school is still better off producing a low quality education with low quality teachers than producing no education at all. By the same argument, I assume $\pi_H > \theta_H$. Then, to maximize *L*, it must be the case that $e_L^* = 1$. In other words, type θ_L applicants are always willing to accept the full-time job offer. Depending on the sign of *A*, we now face two different types of equilibria.

Case I If $Q \geq 0$, $e_H^* = 1$; a pooling Equilibrium

We have a *pooling equilibrium* with $e_L^* = e_H^* = 1$ and $w_L^* = w_H^* = \theta_H$. It is optimal for the principal to hire both type θ_H applicants and the type θ_L applicants and to give them both

the high level of wage, θ_H. The unique solution is $(w_L^*, e_L^*) = (w_H^*, e_H^*) = (\theta_H, 1)$. Rewriting $Q \geq 0$ gives $P_H \geq \frac{\theta_H - \theta_L}{\pi_H - \theta_L}$. Under this condition, the educational system will operate at the pooling equilibrium.

Case II If $Q \leq 0$, $e_H^* = 0$; a separating equilibrium

In this case, we have a *separating equilibrium* with $e_L^* = 1$ and $e_H^* = 0$. The only teachers the principal get to hire are the type θ_L applicants and they get paid θ_L. The solutions are $(w_L^*, e_L^*) = (\theta_L, 1)$ and $(w_H^*, e_H^*) = (0,0)$.

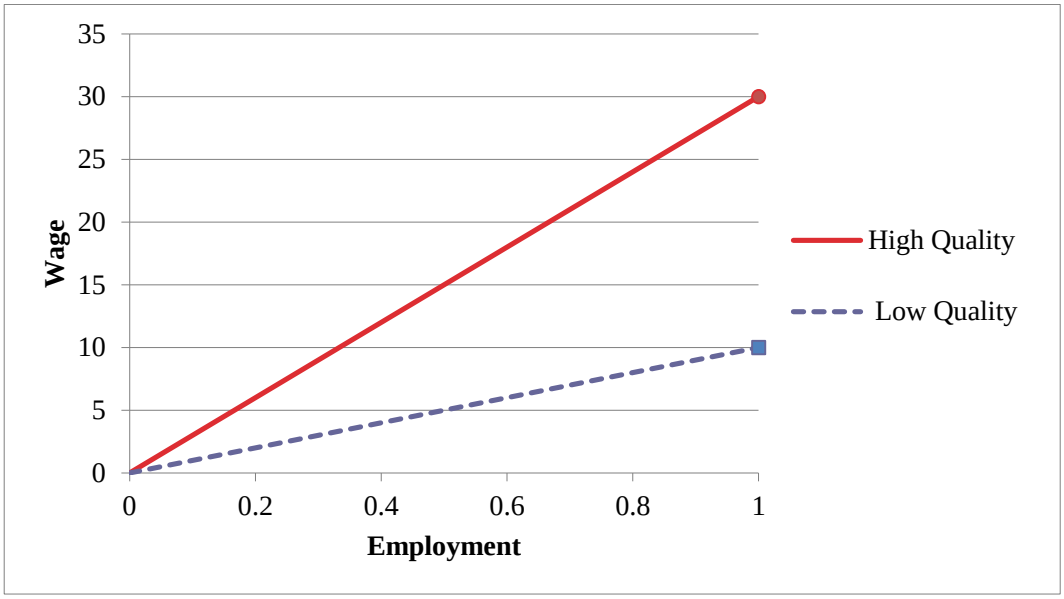

Figure 1.1: Optimal Contract
Note: When $\theta_L = 10$ and $\theta_H = 30$, the separating equilibrium is $(w_L^*, e_L^*) = (10,1)$ and $(w_H^*, e_H^*) = (0,0)$ while the pooling equilibrium is $(w_L^*, e_L^*) = (w_H^*, e_H^*) = (30,1)$.

Figure 1.1 depicts these two cases with simple numerical examples. Suppose that the type θ_L and the type θ_H applicants have qualities of θ_L =10 and θ_H =30, respectively. The separating equilibrium is $(w_L^*, e_L^*) = (10,1)$ for the type θ_L applicants and $(w_H^*, e_H^*) = (0,0)$ for the type θ_H applicants whereas the pooling equilibrium is $(w_L^*, e_L^*) = (w_H^*, e_H^*) = (30,1)$ for both quality types.

Then, under which circumstance will the principal choose the pooling equilibrium over the separating equilibrium? He will optimally select the pooling equilibrium if his utility is greater in Case I than in Case II. In other words, the principal will hire both types of teachers instead of hiring only the low quality teachers if;

$$U_{pooling} = P_H(\pi_H - \theta_H) + P_L(\pi_L - \theta_H) \geq P_L(\pi_L - \theta_L) = U_{seperating} \tag{7}$$

Simplifying this inequality gives us $P_H \geq \frac{\theta_H - \theta_L}{\pi_H - \theta_L}$, which is the equivalent condition for $Q \geq 0$. When the fraction of high quality applicants in the applicants' pool is above this threshold, $\frac{\theta_H - \theta_L}{\pi_H - \theta_L}$, the principal is better off hiring teachers from both quality types and pay them both higher wage of θ_H. If the fraction of high quality applicants is below the threshold, it is optimal to just hire lower quality applicants and pay them lower wage of θ_L.

The pooling equilibrium is more beneficial to a society than the separating equilibrium in the long run because the society that hires high quality teachers can provide higher quality education to children. The society, in return, will be equipped with higher level of human capital, and the fraction of higher quality teachers will naturally increase, which generates a

"virtuous cycle" across generations. In the next section, I make the comparison between Korean educational system and the US educational system as a simple application of the model.

Table 1.1: Students' Academic Achievement in International Tests

Year	South Korea	The U. S.
TIMSS: 8th grader mathematics test: ranking and average score		
1999	2nd / 38 countries, 587	19th/ 38 countries, 503
2003	2nd/ 44 countries, 589	15th/ 44 countries, 504
2007	2nd/ 48 countries, 597	9th/ 48 countries, 508
PISA: 15-year-old students mathematics literacy: ranking and average score		
2003	2nd / 29 OECD countries, 542	24th/ 29 OECD countries, 483
2006	1st/ 34 OECD countries, 547	17th/ 34 OECD countries, 547
2009	1st/ 34 OECD countries, 546	16th/ 34 OECD countries, 487
PISA: 15-year-old students reading literacy: ranking and average score		
2003	2nd/ 29 OECD countries, 534	19th/ 29 OECD countries, 495
2009	1st/ 34 OECD countries, 539	14th/ 34 OECD countries, 500

Source: TIMSS (Trends in International Mathematics and Science Study) 1999, 2003, and 2007 and PISA (Program for International Student Assessment) 2003, 2006, and 2009.

1.3 The Educational System of South Korea and the U. S.

Korean students have shown high academic achievements in reading, science, and mathematics on international tests whereas US students have performed far below the

expectation. Table 1.1 presents the average test scores and rankings of the two countries in the popular international tests for the last decade. There are many important factors to consider explaining the difference in the students' performance between the two countries.

Table 1.2 provides the descriptive statistics of the characteristics of the educational system of each country from the *Education at a Glance* report by OECD and from "*Basic Research on Academic Performance International Survey of Six Cities* (2006)" by Child Research Net. The first panel of Table 1.2 reports educational inputs from teachers, schools, and government. In 2009, the public education expenditure as a percentage of GDP is very similar for both countries at approximately 7-8%. The private source of education in total household education expenditure is 32% in the U.S. and 42% in Korea. When it comes to the expenditure per student for primary public education, measured in 2008 $ppp, the U.S. spends $10,229, while Korea spends about a half of that, $5,437. Since the private education expenditure takes up a larger portion of educational expenditure in Korea, it is not fair to compare these numbers directly. However, according to *Education at a Glance*, the U.S. spends the most per pupil among all developed nations[2]. The student-teacher ratio is much higher in Korea. The number of students per class in elementary school is 14 in the U.S. and 24 in Korea. In fact, Korea has the second highest student-teacher ratio among OECD countries after Mexico. The fraction of elementary school teachers with the master's degree is 50% in the U.S. but only 19% in Korea. Two sources of the education inputs that the U.S. educators believe to be critical, the student-teacher ratio and master's degree, seem to receive less attention in Korea.

[2] See OECD, *Education at a Glance* 2010, Table B1. A1. Only Luxembourg spends more than the U.S. at the primary education.

Table 1.2: Educational Inputs for Elementary school

	South Korea	The U.S.
Panel 1: Educational Inputs by Teachers, Schools, and Government		
Public Education Expenditure (Percentage of GDP)	7.1 %	7.6 %
The private source of educations of total household education expenditure	42 %	32 %
Expenditure on Primary Public Education per Student (2008 $ppp)	$5,437	$10,229
Starting teacher salaries (2008 $ppp)	$31,532	$35,999
Teacher salaries after 15 years (2008 $ppp)	$54,569	$44,172
Teacher salaries at top of the scale (2008 $ppp)	$87,452	$50,922
Teaching hours in 2008	840	1,097
Hourly teaching wage in 2008	$64.96	$40.3
Wage percentile in 2008	0.77	0.52
Students / teacher in 2008	24.1	14.3
% of Teachers with master's degree	19	50
% of Teachers leaving teaching career	0.7	9.2
% of female teachers in primary public education, 2005-2007	71.6	88.4
Panel 2: Educational Inputs by Students		
Participation in outside-of-school lessons	72.9%	8.2%
Time spent in outside-of-school lessons per week (hour)	7.16	1.45
Subjects of outside-of-school lessons, allowing multiple choices (%)	English (61.5), Sports (36.2), Music (35.3), Painting (15.8), Dance (3.2), Other (10.8)	Sports (75.5), Music (27.5), Dance (13.7), Paining (11.5), Foreign language (8.5), Other (10.7)

Source: OECD. *Education at a Glance.* (2010). Child Research Net, *Basic Research on Academic Performance International Survey of Six Cities* (2006)

In both countries, public schools hire teachers who meet certain qualifications. In the U.S, a typical applicant is required to have a bachelor's degree and to have a teaching certificate. Many states in the U.S. ask for master's degrees in addition to those requirements. In Korea, the same qualifications are required to become a teacher, but no master's degree is needed. Almost all public school teachers from both countries get tenure once they are hired[3]. Every public school teacher is guaranteed with tenure in Korea without any additional obligation. US public school teachers must teach for a certain period of time, called probationary period, which lasts usually 1-3 years, depending on school districts and states. Having the summer off is one of the perks of being a teacher in both countries. Basic benefits including a retirement pension and maternity leave are also very similar.

Another important point to address is the existence of teachers unions in both countries. In 1999, Korean government legalized teachers unions and also permitted teachers unions to engage in collective bargaining. Since then, the number of union members has been growing. There are two major teachers unions in Korea; Korean Teachers Union (KTU) and Korean Federation of Teachers' Association (KFTA). The KFTA is larger than the KTU in terms of the enrollment size, but the KTU is more actively exercising its bargaining power. Almost all public school teachers belong to one of the two teachers unions or both, with about a quarter of the teachers being members of the KTU. For there is a large variation with respect to the legal environment towards teachers unions and towards collective bargaining rights in the U.S., it is hard to compare the union effects in both countries. However, it should be noted

[3] In the U.S., very few teachers have been denied tenure within 1-3 years of their teaching period. According to New York Daily News, Newsweek, and The Los Angeles Times, less than 2% of new teachers were denied tenure. Newsweek reported that only 0.1% of new teachers was dismissed for poor performance between 2005 and 2008 in Chicago. In South Korea, every public school teacher gets tenure immediately after they are hired.

that teachers unions in Korea are politically very strong organizations just like teachers unions in the U.S.

The critical difference between the educational systems of the two countries is the competitiveness in joining teaching force. It is very difficult to become a public school teacher in Korea. The top 3-5% of senior high school class manages to enter the teacher preparation program in college to obtain the teaching certificate. Then, they need to pass the national teacher appointment test, which is administered by the states once a year. High college GPA is necessary to pass this test because the final score of test is weighted by the college GPA. The average acceptance rate for public school teachers among the graduates from the teacher preparation program between 2005 and 2008 is 7.2%. Thus, having to jump all these hurdles to become a public school teacher guarantees that the average academic quality of teachers in Korea is very high. A teacher is considered to be one of the most prestigious careers, partly due to Confucianism which emphasizes respect towards educators. The popularity of teaching career has increased even more as the job security becomes a great advantage in the wake of economic uncertainty that has been growing since the Asian Crisis in 1997. Public school teachers have been able to maintain high social status even among males. The fraction of female teachers in primary public education is higher in the U.S. than in the Korea (See Table 1.2). The competition for teaching careers keeps getting fiercer, which keeps the average quality of teachers high.

In the U. S., the story is quite the opposite. College GPA of teacher applicants is never asked during teacher hiring process, and obtaining teaching certificate is relatively easy. The tests are given multiple times per year, and the applicants can take the test as many times as they want, making the cumulative passing rate of the test virtually 100%. The job security of

public school teachers is also strong in US public schools, but teaching is not a popular career pick any more even among females as there exist many great opportunities available for them outside the teaching sector.

Reflecting this difference in teacher recruitment process, the salary that each country pays to public school teachers shows a big disparity. Table 1.2 shows the salary schedule for public school teachers in each country. After adjusted by 2008 $ppp, the initial teacher salary is higher in the U.S.; $35,999 in the U.S. and $31,532 in Korea. Teacher salary after 15 years of teaching experience, however, is higher in Korea: $54,569 in Korea and $44,172 in the U.S. Another important salary indicator, which is commonly used in the literature for teacher salaries, is the relative position of teacher salaries after 15 years of experience in income distribution of the entire population. Teacher salaries are located at about 50^{th} percentile in the income distribution in the U.S. while they are ranked 1^{st} on this metric with top teacher salaries at the 80^{th} percentile in Korea. Teacher salaries at top of the scale are also much higher in Korea: $87,452 in Korea and $50,922 in the U.S.

Figure 1.2.A describes the trend of teacher salaries between 1999 and 2009 for Korea and the U.S. Even though the starting salaries are lower for Korean teachers than for US teachers, the salaries increase at a much faster rate over their lifetime for Korean teachers than for US teachers. Thus, the salaries after 15 years of experience are much higher for Korean teachers compared to US teachers. Figure 1.2.B depicts the trend of the ratio of teacher salaries to GDP per capita, another common indicator to study relative salary position. Korean teachers initially earn slightly more than the GDP per capita, but they make more than twice that amount after 15 years.

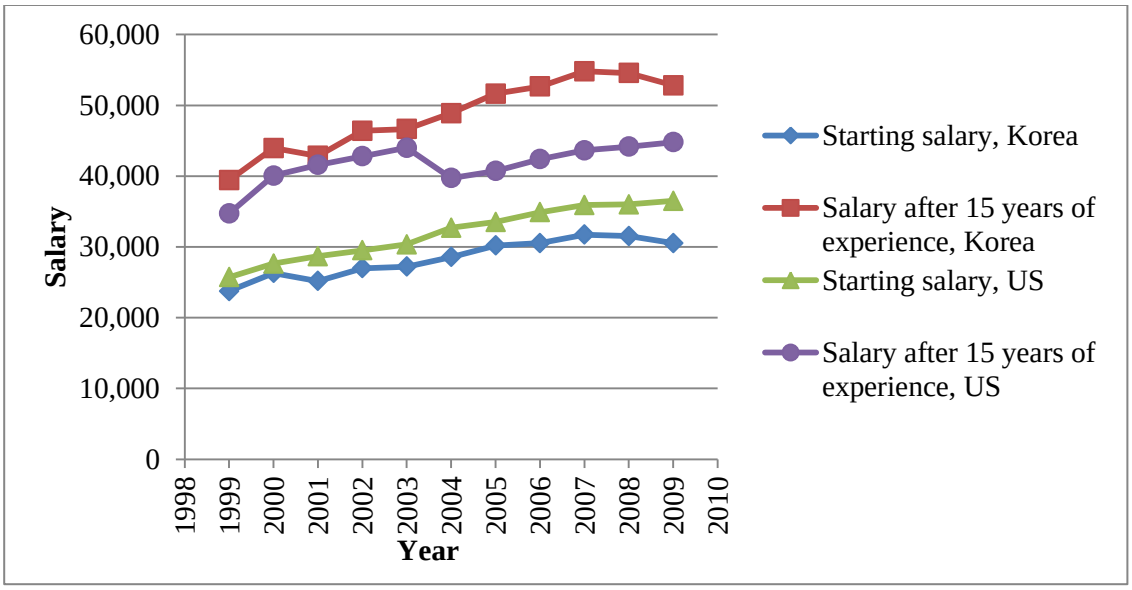

Figure 1.2.A: Teacher Salaries in Primary Education
Source: Education at Glance. 2001-2011. OECD.

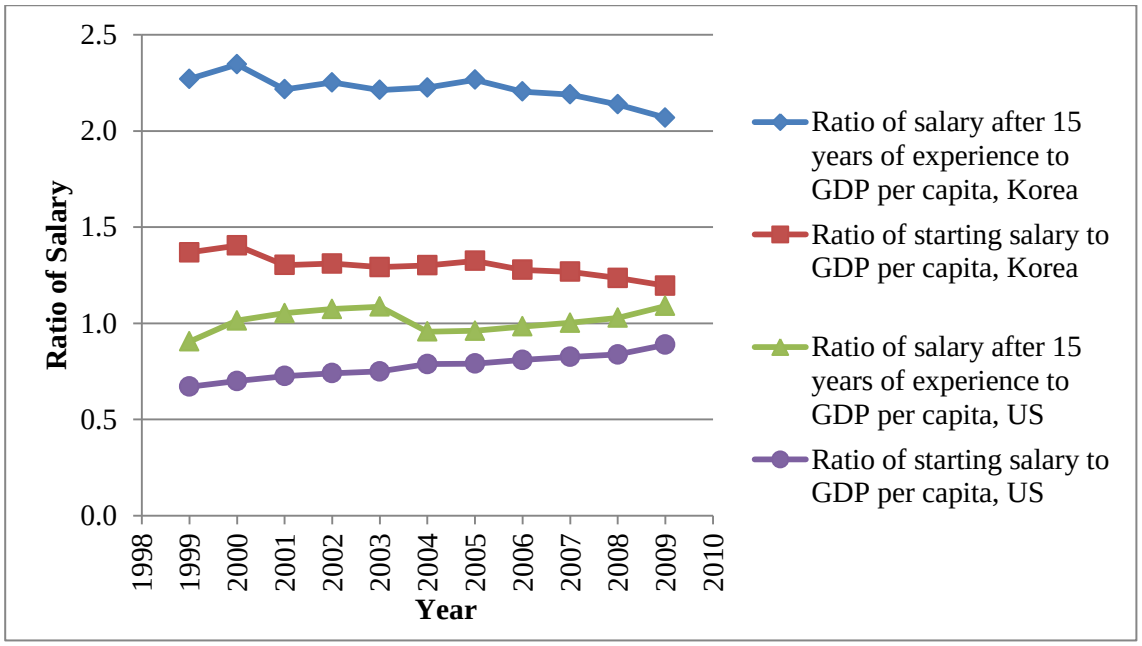

Figure 1.2.B: Ratio of Teacher Salaries in Primary Education
Source: Education at Glance. 2001-2011. OECD.

Figure 1.2.B also shows that the salaries of US teachers start much lower than the GDP per capita, although they show a steady increase over the last decade. With 15 years of

teaching experience, their salaries increase to the level of GDP per capita. Therefore, it is clear that Korean public school teachers get higher returns to experience than US teachers.

Both population growth rate and GDP growth rate can change the dynamics for the GDP per capita. Thus, the ratio of teacher salaries to GDP per capita can be a misleading measure for cross-country comparison of teacher salaries without considering fertility rate. The total fertility rate of Korea has been dropping fast, and the current total fertility rates is about 1.15, well below the population replacement rate of 2.1. Then, the ratio of teacher salaries to the GDP per capita can show a decreasing trend in Korea but a increasing trend in the U.S simply because of their fertility rate difference.

Another indicator for cross-country comparison of teacher salaries is the relative salary ratio between other occupations and teachers. Figure 1.3.A and Figure 1.3.B illustrate the trend of the salary ratio between the elementary school teachers and other occupations in the U.S. In general, the ratios of the average salary of other occupations to that of elementary school teachers have been increasing between 1999 and 2009. US teachers have been losing ground in their salary status relative to other occupations, except to the real estate brokers who have severely suffered from the recent housing bubble incidence.

In Korea, however, the trend is the opposite. According to Kim, Kim, and Han (2009), teachers' earnings relative to other professionals (accountants, lawyers, computer programmers, engineers, and professors) have increased considerably between 2001 and 2005. It indicates that Korean teachers' economic status relative to other occupations in the non-teaching sector has been growing over time.

According to *Education at a Glance* in 2008, the average teaching hours per year are 840 hours in Korea and 1,097 hours in the U.S. (See Table 1.2). In fact, US public school

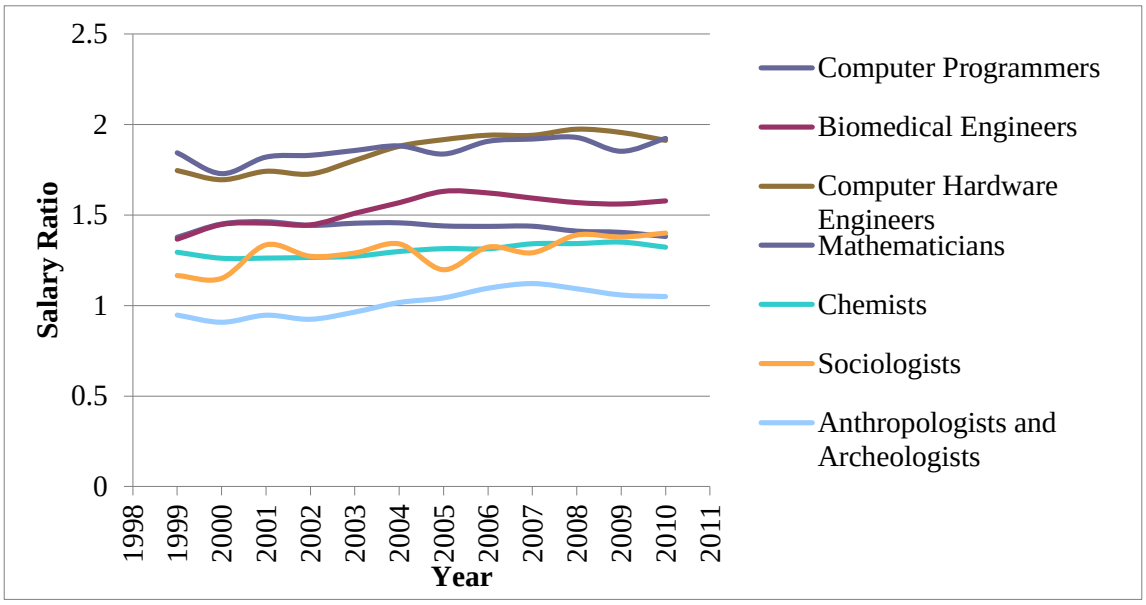

Figure 1.3.A: Ratio of Average Annual Salaries in the U.S.: Scientists to Elementary School Teachers
Source: *Education at a Glance*. 2001-2011. OECD.

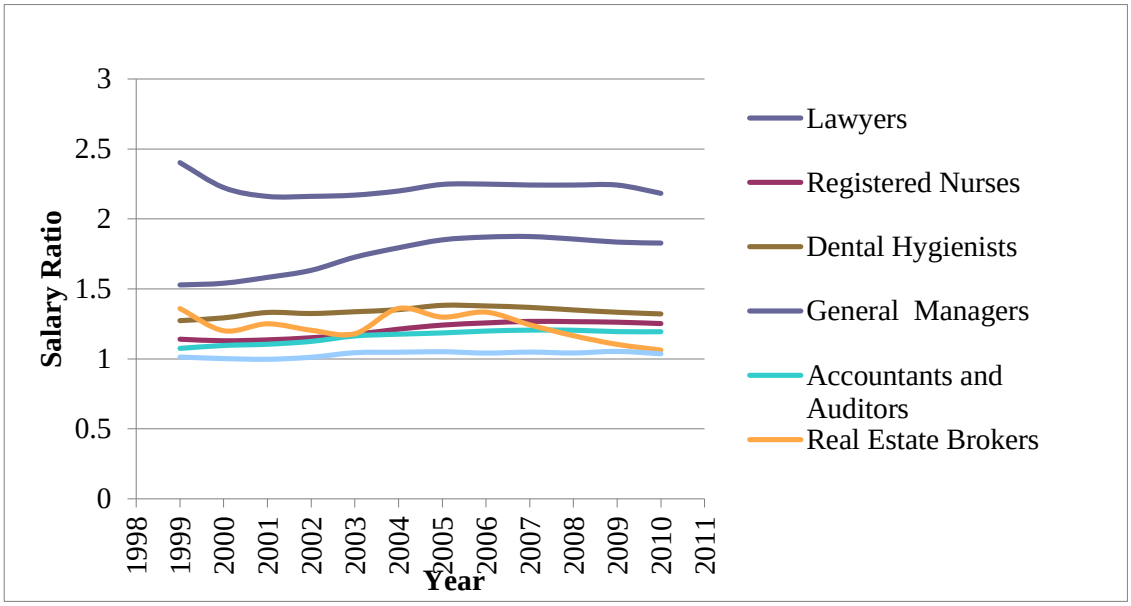

Figure 1.3.B: Ratio of Average Annual Salaries in the U.S.: Other Occupations to Elementary School Teachers
Source: *Education at a Glance*. 2001-2011. OECD.

teachers face the maximum teaching hours among OECD countries. The average number of days of schools is greater in Korea than in the U.S.; 220 days in Korea[4] and 180 days in the U.S.[5] It implies that US teachers have more teaching hours *per day* than Korean teachers do. Full-time teachers in both countries have about 40 work hours per week. Thus, more teaching hours per day implies less teaching preparation time, which can reduce the quality of lectures and teaching presentations in the US classrooms. Moreover, compared to Korean teachers, US teachers have heavier teaching workload, so their salaries per teaching hour are lower than those of Korean teachers; the average hourly teaching wage of public school teachers is $40 in the U.S. and $65 in Korea. Only five countries among 34 OECD countries (Czech Republic, Hungary, Israel, Mexico, and Poland) offer lower hourly teaching wages to public school teachers than the U.S. When we compare the ratio of average teacher salaries to the GDP per capita in 2008 $ppp, the U.S. is ranked in the bottom 5th among OECD countries, and Korea is ranked 1st. Not surprisingly, the teacher retention rate is much higher in Korea than in the U.S. The fraction of teachers leaving the teaching career is less than 1% in Korea but close to 10% in the U.S.[6] The fraction of male teachers in primary education is much higher in Korea (approximately 30%) than in the U.S. (approximately 10%). This may be because teacher compensation in the U.S. is not enough to attract males, most of whom are heads of their households.

What we observe in the US educational system is that teachers are getting paid less and the average quality of the teachers is low. On the other hand, Korean teachers are earning

[4] Saturday programs are common in Korea, but all classes compose of non-academic courses on Saturdays.

[5] The OECD average of the number of days of schools is 187 days.

[6] According to Teacher Attrition and Mobility Survey by National Center for Education Statistics, 8.5% of public school teachers left teaching profession during 2004-2005 and 8% during 2007-2008 academic years. The teacher attrition report by the ministry of education, science, and technology of Korea shows that 0.7% of teachers left the teaching sector during 2008-2009 academic year.

higher wages and exhibiting higher quality. In section two, I show that the condition for the principal preferring the pooling equilibrium to the separating equilibrium is $P_H \geq \frac{\theta_H - \theta_L}{\pi_H - \theta_L}$. First, I shall compare the two thresholds *K* and *A* for Korea and America, respectively; $K = \frac{\theta_H^K - \theta_L^K}{\pi_H^K - \theta_L^K}$ for Korea and $A = \frac{\theta_H^A - \theta_L^A}{\pi_H^A - \theta_L^A}$ for the U.S.

In Korea, almost all teacher applicants are academically well prepared, so even the lowest quality applicant (type θ_L^K) has high quality. Therefore, there is a small gap between the value of θ_H^K and that of θ_L^K, so the numerator $\pi_H^K - \theta_L^K$ becomes small. Many people in the applicants' pool would have low quality in the U.S as the competitiveness for a teaching career is relatively weak. Some of the applicants may have low college GPAs and barely have passed the teaching certificate test after multiple trials. Thus, the value of the low quality applicants in the U.S. is a lot lower than that of Korea. In other words, I can make the following critical assumption: $\theta_L^K > \theta_L^A$. In the U.S., there might be some high quality applicants who have the passion for teaching. They are willing to accept lower compensation than what they can earn from the non-teaching careers. When they are hired, they can produce a high quality education, π_H. It is reasonable to assume that the value of both π_H and θ_H are the same in both countries, and that type θ_H teachers in both countries have the same productivity. This implies that the high quality teachers in both countries can teach their students equally well. Thus, $\pi_H^K = \pi_H^A$ and $\theta_H^K = \theta_H^A$. Then, we have;

$$K - A = \frac{\theta_H^K - \theta_L^K}{\pi_H^K - \theta_L^K} - \frac{\theta_H^A - \theta_L^A}{\pi_H^A - \theta_L^A} = \frac{\theta_H^K - \theta_L^K}{\pi_H^K - \theta_L^K} - \frac{\theta_H^K - \theta_L^A}{\pi_H^K - \theta_L^A} = \frac{(\theta_H^K - \pi_H^K)(\theta_L^K - \theta_L^A)}{(\pi_H^K - \theta_L^K)(\pi_H^K - \theta_L^A)} < 0$$

as $\theta_H^K - \pi_H^K$ is negative by the assumption that the teacher's quality is worth more to schools than to teachers. Thus, $K < A$, which implies that the threshold to have a pooling equilibrium is lower for Korea.

This leads to an ultimate conclusion. It is more likely that the threshold condition will be satisfied in Korea because Korean threshold (*K*) is low, and more principals would find it optimal to hire both types of applicants and pay them an equally high wage. Since the US threshold (*A*) is high, it is harder to meet the condition for the pooling equilibrium. Therefore, for US principals, it is better to offer low wages and only the low quality applicants would accept the offer. Simple numerical examples can describe this story easily.

Figure 1.4 and Figure 1.5 illustrate the optimal contract for each country. Suppose that $\theta_H^K = \theta_H^A = 20$, $\pi_H^K = \pi_H^A = 25$, $\theta_L^K = 15$ and $\theta_L^A = 5$. In Korea, a pooling equilibrium can be reached, and the principals hire both types of applicants and pay both types high wages, $w = 20$, as long as $P_H \geq \frac{20-15}{25-15} = \frac{1}{2}$. This condition has been easily met in Korea, so all teachers earn high wages. On the other hand, US principals faces the condition of $P_H \geq \frac{20-5}{25-5} = \frac{3}{4}$, which is harder to be satisfied. As a result, a separating equilibrium is obtained. Teachers get paid low wages, $w = 5$, and only the low quality applicants accept the offer.

When the majority of the applicants have low quality, P_H is low, so the separating equilibrium, in which only the low quality applicants are hired, dominates the pooling equilibrium. My model takes the fraction of low quality applicants as given because the principal takes the quality of the current applicants' pool into a consideration for one time take-it-or-leave-it offers. Thus, the equilibrium portrays the one-time snap shot of a contract,

and it provides us with the optimal wage level for the given quality of applicants' pool. However, if we had observed the equilibria over time and drawn the locus of the US equilibria, the location of the equilibrium would be moving downward, which indicates that teacher salaries relative to the salaries of other non-teaching occupations has decreased over time in the U.S.

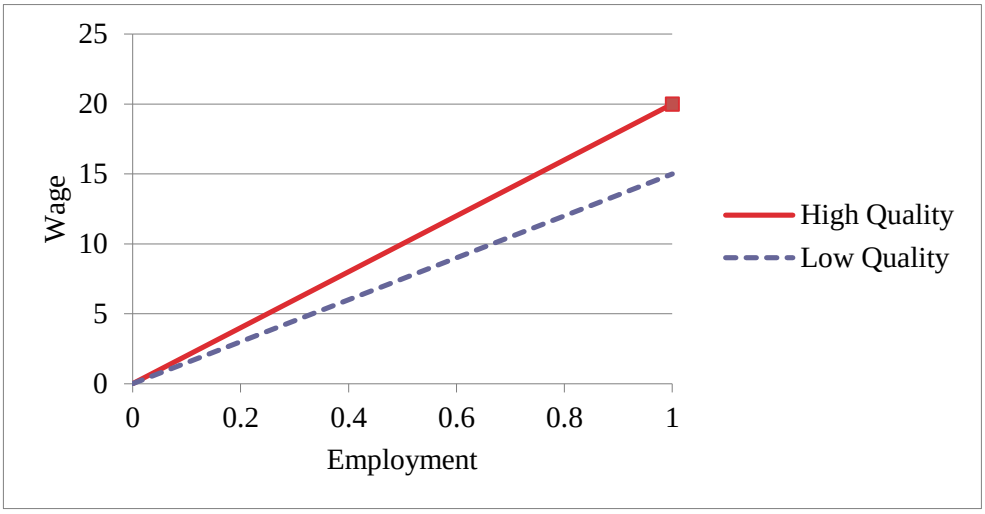

Figure 1.4: Korea, Pooling Equilibrium

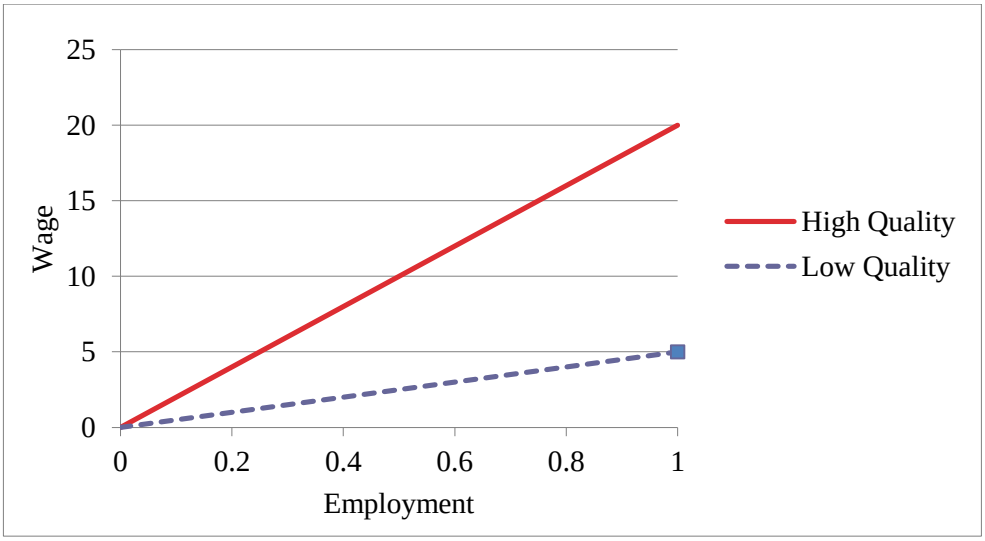

Figure 1.5: The US, Separating Equilibrium

As we see in Figure 1.1, the optimal wage for low quality applicant is θ_L. At the wage levels between θ_L and θ_H when *e*=1, the principal is overpaying the teachers of the low quality type. At this overpaid wage level, since the average quality of applicants is still low, there would be no significant educational gain with this extra wage expense unless the wage increases up to θ_H, at which the high quality applicants start to accept the offer.

My model assumes that there are two distinctive quality types (either θ_L or θ_H), but the quality type will be a continuous distribution in reality. Thus, it can be shown that the increase in wage for low quality teachers above θ_L may raise the average quality of the low type by a small amount. However, the majority of the applicants would be still low quality type because only few high quality applicants would be attracted to wage level of $\theta_L + \varepsilon$. As long as the variance of the distribution of θ is large, my prediction remains the same; a small increase in wage will not be able to attract a large number of high quality applicants enough to significantly change the average quality of teachers, and the educational improvement from the small increase in wage will be negligible. Putting it differently, a small shock to a separating equilibrium is not enough to move it to a pooling equilibrium. If one public school district increases teacher salaries by $1,000 trying to get out of the separating equilibrium only to see no improvement in educational outcome, no other school districts will follow this policy. Soon, the market would go back to the original separating equilibrium.

My study show consistent results with Temin (2002). He also presented the multiple equilibria of teachers' market in the U.S. using the Akerlof's "Lemon" model. He also argues that the U.S. is currently stuck at the lower level of equilibrium and cannot get out of it unless we pay a lot more to our teachers. It seems that the separating equilibrium is inferior to a pooling equilibrium although both equilibria are optimally selected. If an educational system

can be stuck at the inferior equilibrium, there could also be a case where an educational system is trapped in the superior equilibrium. In the next section, I show that Korea is one example which describes falling into a superior equilibrium trap can cause social loss.

1.4 Is Korean Educational System Golden?

If Korean educational system is currently operating at the pooling equilibrium, it means that the quality of teachers and the educational outcomes of students have reached a stable point where small increase/decrease in teacher salary cannot alter the teacher quality in Korea. However, whether Korea is actually on the equilibrium is questionable. Teachers' earnings relative to other professionals (accountants, lawyers, computer programmers, engineers, and professors) have been considerably increasing in Korea (Kim, Kim, and Han, 2009), but there is no evidence that teacher quality has also been growing. The pressure of the competition to become a teacher seems already at its peak, so further quality improvement from current level is quite hard to expect. Even one point in the teacher appointment test can determine success or failure, so the quality difference between teachers who pass the test and who fail the test would be almost negligible especially at the margin. Therefore, Korean educational system may be operating beyond the pooling equilibrium, where the raise in teacher salary does not induce any increase in teacher quality. The equilibrium force of the pooling equilibrium will work to bring any points beyond it back to the original equilibrium. In other words, Korea is stuck at this pooling equilibrium.

The optimal wage for the high quality teachers is θ_H^K, so Korea will be overpaying its teachers if it pays more than θ_H^K. The existence of a long queue to become a public school

teacher indicates that current teacher salary is set too high in Korea. Figure 1.6 illustrates the labor market situation where teachers' ongoing wage is higher than the equilibrium wage, and there is excess supply of teachers at current wage level. Suppose that the equilibrium is at (200, $50), which is a pooling equilibrium. Suppose further that the current hourly wage is set at $60, which is higher than the equilibrium wage of $50. This leads to the excess supply of teachers, so some teachers find themselves unemployed when the hourly wage is set above $50.

The problem of excess supply in teachers' labor market in Korea is quite severe. Among the graduates from teacher preparation program for secondary school teachers, the average employment rate is about 20% between 2000 and 2007. Out of 30,000 graduates each year, only about 6,000 people are hired as public school teachers after they pass the teacher appointment test.[7] As the national teacher appointment test is administered once a year, many people spend multiple years trying to pass the test. Most people who fail the test work as irregular public school teachers or eventually move into the private educational sector to work at private schools and tutoring institutions. The extremely low employment rate of teachers exacerbates the excess supply problem in the teachers' labor market, and the queue of teacher applicants is getting longer year by year.

High teacher salary helps sustaining the social status of teachers because it can attract many high quality people to the teaching sector. The typical "efficiency wage theory" explains this well. However, considering that the teacher applicants in the waiting period are people with high ability who continue to study to pass the teacher appointment test, the excess supply due to the above-equilibrium wage seem to cause social loss. Assuming that worker qualities in the teaching sector are positively associated with those in the non-teaching sector,

[7] See Kim (2009). Table 14. p 50.

the high quality people of the excess supply in the teaching sector forgo great opportunity costs. Had they started off their careers at non-teaching sectors, they would have contributed to social gain rather than to social loss.

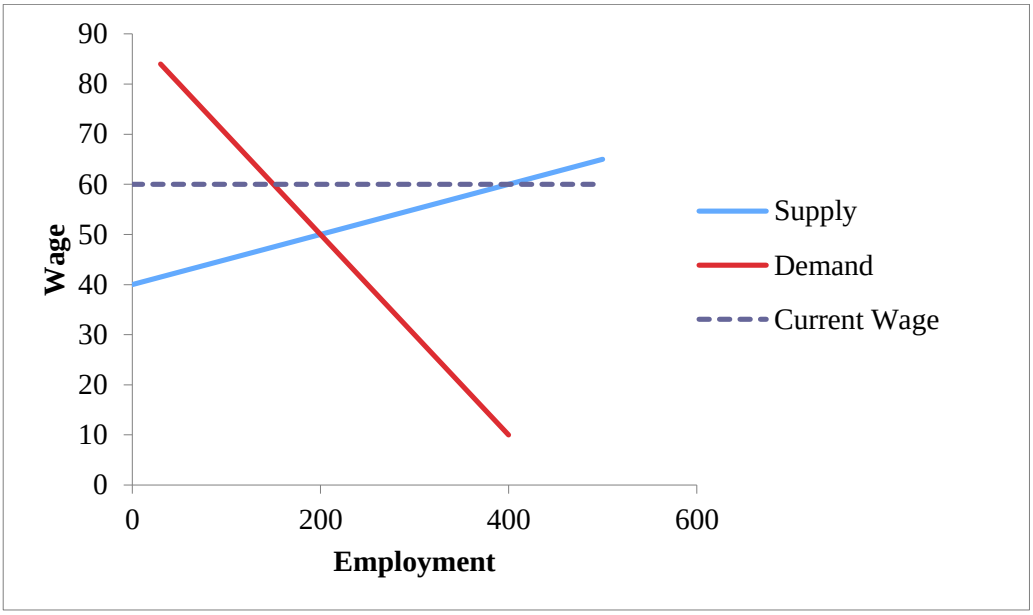

Figure 1.6: Teachers' Labor Market in Korea

The story shown in the Korean educational system describes how paying teachers too much also creates social problem. As Korea is trapped in the pooling equilibrium, overpaying teachers above the equilibrium can results in the excess supply of high quality teachers which does not contribute to the increase in the average teacher quality. However, Korean educational system is already passed the pooling equilibrium, so going back to the equilibrium will not be as difficult as jumping to a new equilibrium in the U.S. Since the average teacher quality is already high in Korea, a small decrease in teacher salary may not reduce the average teacher quality. Once an educational system reaches a pooling equilibrium, it will have more favorable trade-off between teacher quality and teacher salary than a

separating equilibrium. Therefore, an educational system operating at the separating equilibrium should aim for attaining the pooling equilibrium to exploit this advantageous trade-off.

1.5 Policy Implications for the U.S. educational system

The immediate impact of having low teacher quality is poor educational outcomes. Moreover, low teacher quality diminishes the returns of investment in human capital accumulation in the long run. Thus, the direct policy implication of my study is very straightforward. To improve the teacher quality, getting out of a separating equilibrium and move towards a pooling equilibrium must be the goal of the US educational reform. The problem is that moving from a separating equilibrium to a pooling equilibrium is not an easy task because government has to come up with extra revenue to pay higher wages to teachers. It may also take a long time to arrive at the new equilibrium. I make several suggestions that can improve the average quality of teachers and speed up the transition.

a) Pin down the determinants that make good teachers.

Many researchers have been trying to figure out which teacher characteristics are critical to improve students' academic performance. They have looked at many ex-ante observable teacher credentials including teaching certification status, advanced education degree, college major, and competitiveness of colleges. However, little evidence has been found that these qualifications, except teaching experience, can significantly increase students' academic achievement. Teaching experience is not a

useful hiring standard if most applicants are new to teaching. Nailing down some other teacher qualifications can help set better hiring standards for teachers.

b) Raise the standard for the minimum qualification for public school teachers.

Increasing the average value of θ_L will raise the average teacher quality. As the value of θ_L gets larger, the threshold for the pooling equilibrium becomes smaller. Then, it is easier to satisfy the condition to reach a pooling equilibrium. One way to increase the average value of θ_L is to raise the lower bar to become a teacher. For instance, screening the applicants by the minimum college GPA and by the course grade of their teaching subjects or increasing the passing scores for teaching certificate tests can increase θ_L. Raising the standards adds more competition among applicants, which can support higher teacher salaries.

c) Raise teacher salary *significantly*.

Teacher salaries should be at least comparable with what teachers can earn in the non-teaching sector. Unless the notion of "underpaid teachers" disappears, high quality people will refrain from entering the teaching sector. The small increase in teacher salaries can only incur additional education spending without improving average education quality. Manski (1987) also suggested that the average ability of the teaching force could be improved and the size of the teaching force could be maintained if the minimum ability standards were to be combined with sufficient salary increase. We may consider keeping the current wage schedule for existing

teachers and use the new wage schedule for new teachers who passed stricter screening processes.

d) Fire the *worst* teachers.

Giving tenure to all teachers does not seem to be a good strategy when the average quality of the teachers is already low. A documentary film, "*Waiting for Superman*", reveals the common practice called "The dance of the lemons". The principals trade their worst teachers, lemons, hoping that the new lemon they receive is better than the one they just got rid of. Firing the worst teachers, therefore, can eradicate this custom. In fact, firing the worst teacher seems a necessary task for any educational reform to work in the U.S. because it changes the composition of current stock of teachers. Assuming that spotting a few worst performing teachers is not a difficult task, we can expect an immediate positive impact on the average teacher quality of current teaching force by letting the worst-performing teachers go.

Many people have a very hopeful view towards the current education reform, which introduces the teacher evaluation and bonus system to public schools. The advocates of the pay for performance system believe that a low quality teacher could become a good quality teacher by providing simple financial incentives (Woessmann. 2011). According to a recent experimental study by National Center on Performance Incentives (NCPI) at Vanderbilt University (Springer et al. 2010), however, the bonus system of teacher pay did not show a significant effect on students' academic performance. Other researchers also found similar results (Ballou and Podgursky, 2001; Hanushek and Rivkin, 2004).

There is no accurate measurement for teachers' productivity. Besides, teacher evaluation is a complex task as it is subjective, labor-intensive, and possibly fraud-inducing. Recently, 178 schoolteachers and superintendents were accused of cheating on standardized tests in Atlanta. This was not the only incident related to cheating teachers for the last several years. D.C., California, Florida, and Massachusetts were among the other states reporting similar events. Even when schools invite the third party evaluators, the evaluation content itself may not be unbiased. Another concern is that having an evaluation on a regular basis is very costly. A recent estimate shows that the teacher evaluation system will cost Washington D.C. 7 million dollars a year. The incentive pay system, therefore, might not be a cost-effective method to improve educational outcome. Instead of putting lots of resources on implementing teacher evaluation, raising teacher salaries significantly enough to attract higher quality teachers and to retain them in the teaching sector might be a better strategy.

1.6 Conclusion

This study employs a monopolistic screening model to show that there exist multiple equilibria in the educational system; a pooling equilibrium and a separating equilibrium. In the pooling equilibrium, both low and high quality teachers are hired and all teachers receive high compensation. In the separating equilibrium, low quality teachers and high quality teachers get different levels of compensations. The model predicts that the pooling equilibrium becomes the optimal choice for school districts when the average quality of applicants in the queue is high, whereas the separating equilibrium becomes the optimal

choice when the average quality of applicants is low. In the latter case, only the low quality teachers are hired and they receive low salaries.

As the application of the model, I compare the educational systems of the U.S. and South Korea using data from OECD. I also examine the relation between teacher salaries measured by hourly teaching wage, and teacher quality measured by students' international test results. This study shows that the average quality of teacher applicants in the U.S. is low and the U.S. educational system is currently operating at a separating equilibrium. On the other hand, the average quality of teacher applicants of Korea is high, and its educational system has reached a pooling equilibrium. In the current US educational system, a small increase in teacher salary will not bring a significant improvement in teacher quality. Rather, a substantial raise in teacher salary is needed to achieve a considerable gain in educational outcomes by moving to a superior equilibrium.

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Chapter 2: Teacher Wage Penalty and Decrease in Teacher Quality: Evidence from Career Changes in CPS 2001-2010

This paper examines the relation between teachers' earnings and teacher quality. Using the Current Population Survey (CPS) and CPS Supplements for Occupation Mobility and Job Tenure between 2001 and 2010, I find that US public school teachers are paid less compared to other comparable college graduates in non-teaching sectors. By studying the change in teachers' earnings after career changes, I find the evidence of positive selection when teachers move into the non-teaching sectors and of negative selection when non-teachers move into the teaching sector, which results in the decrease in the average quality of public school teachers. Teachers unions are positively associated with teachers' earnings only in states that have collective bargaining laws, and they may serve as a mechanism to encourage the high quality teachers to remain in the teaching sector. In states without collective bargaining laws or where collective bargaining is prohibited, teachers face less favorable working conditions. In those states, the impacts of the positive selection and the negative selection are stronger, so the average quality of public school teachers may fall faster than in states with collective bargaining laws.

Key Words: teacher wage penalty, teacher quality, teachers unions, collective bargaining, positive selection, negative selection

2.1 Introduction

Disappointed with their students' performance in international tests, educators and school officials in the U.S. have been trying to improve the quality of public education. In particular, the quality of teaching forces has been pointed out as the key to a successful educational reform. Many blame teachers unions for being a hindrance to the educational reform. They point out that the teacher salaries keep increasing while the academic achievement of students still remains poor. They argue that public school teachers in the U.S. are being "overpaid" considering the decrease in teacher quality. Biggs and Richwine (2001) claimed in their article in *The Wall Street Journal* that there was no teacher wage penalty if they compared teachers and non-teachers with similar Armed Forces Qualification Test (AFQT) scores. Moreover, they argued that teachers were receiving 52% more in average compensation (including benefits) than they could earn in the non-teaching sectors. On the other hands, according to the research by National Education Association (NEA), teachers have been "underpaid" compared to other college graduates in non-teaching industries and the wage gap between non-teaching careers and teaching careers among college graduates was about 60% for males and 16% for females in 2000.

The standard approach by labor economists says that a queue for a specific occupation is an indication that the occupation is overpaying its workers. However, even with the queue of applicants in the teaching sector, it is also important to consider the quality of the applicants to determine whether teachers are truly overpaid or not. If the queue mostly consists of low quality people, it could be the case where teachers have been underpaid, so the high quality people no longer enter the teaching sector while only the low quality people

remain in the applicants' pool. Thus, it is critical to understand the dynamic relationship between teacher salaries and the quality of teachers that is associated with educational outcomes.

This paper utilizes the data from Current Population Survey merged Outgoing Rotation Group (CPS ORG) and CPS Supplements between 2001 and 2010. I find that the US public school teachers are paid less relative to other college graduates, controlling for relevant wage determinants. Young teachers who are in their 20s get teacher premium of 6%, but the premium quickly disappears and turns into teacher penalty over their lifetime. Teachers of age 30 or older earn 4% less than comparable college graduates in the non-teaching sector. The wage penalty for teachers is greater and more significant for male teachers than for female teachers.

My identification strategy is to study the change in earnings of teachers who move into non-teaching sectors and of non-teachers who move into teaching sectors. Comparing the changes in earnings after career changes provides additional evidence that public school teachers are losing grounds in their earnings. I find that public school teachers in their 30s and 40s increase their earnings when they move into non-teaching occupations. This is larger than the increase in earnings of non-teachers who change to other non-teaching occupations.

I use a simple two-sector version of Roy Model to show that there is positive selection when public school teachers move into the non-teaching sectors whereas there is negative selection when non-teachers move into the teaching sector. On average, teachers who leave the teaching profession have had higher pre-earnings than the teachers who remain in the teaching sector, but they still choose to leave the teaching sector for better earning opportunities in the non-teaching sectors. Non-teachers who change into the teaching sector

have had significantly lower pre-earnings than other non-teachers who stay in their careers. The difference in the pre-earnings between the career-stayers and career-changers suggest that this is beyond the simple case of compensating differentials.[8] Therefore, considering that the pre-earnings are the proxy for the ability/aptitude of workers, my study suggest that high quality teachers tend to leave teaching careers whereas low quality non-teachers tend to enter the teaching sector under the current pay scheme for teachers,

Studies on the effect of teachers unions face endogeneity problem of unionization. Teachers unions may behave differently under different legal environments towards collective bargaining of teachers. Thus, if a study does not take this into account, the estimates for union effects may suffer from omitted variable bias. To ease this problem, I classify 50 states into three categories based on their legal status regarding collective bargaining of teachers unions; states with compulsory collective bargaining laws, states that do not have collective bargaining laws but allow the collective bargaining to occur, and states that prohibit collective bargaining of public school teachers. The CPS ORG data reveals that teachers unions increase the teachers' earnings only in the states that have collective bargaining laws. In all three groups, public school teachers who leave the teaching career have had higher pre-earnings while non-teachers who enter the public school teaching sector have had lower pre-earnings. This pattern leads to the decrease in the average quality of public school teachers. The adverse trend is more substantial in the states that prohibit collective bargaining of teachers, where teachers face a larger wage penalty compared to their comparable non-teachers.

[8] According to compensating differentials, teachers switching into non-teaching sector are willing to take less benefits in exchange of higher wage whereas non-teachers moving into teaching sector are willing to take less wage and more benefits, but their total compensation should remain the same as long as they share the same wage determinants.

2.2 Literature on the Relation between Teacher Salaries and Teacher Quality

Many studies examine the relation between teacher salaries and educational outcomes using cross-country variations of teacher compensations. Dolton and Marcenaro-Gutierrez (2011) estimated that a 15% increase in teacher salaries raises student's test score in Trends in International Mathematics and Science Study (TIMSS) by 6-8% using the OECD cross-country data. Studies on teacher effectiveness found a significantly positive relationship between teacher quality and teacher salaries (Murnane, 1991; Ballow and Podgursky,1997; Flyer and Rosen, 1997; Figlio and Lucas, 2000; Temin, 2002; Goldin , 2006)[9]. Hanushek (1986), Betts (1995), and Grogger (1996), however, showed that teacher salaries have either insignificant or negligent effect on students' lives.

One of the hypotheses that explain the inconsistent findings is that the variation in teacher salaries may be too little to induce any significant change in the quality of teachers in some data. For instance, studies using state level data are more likely to find a significant effect of teacher salaries on teacher quality than those using school district level data, which has a smaller variation in teacher salaries especially if the school districts are from the same state. Cross-state variation of teacher salaries is smaller than cross-country variation. There is almost 40-percentile difference between the minimum and the maximum of the relative position of teacher salaries in the income distribution of the whole population among OECD countries. However, the relative position of teacher salaries in the income distribution of each state in the U.S. is between 47^{th} and 52^{nd} percentile. According to my calculation of the

[9] Note that we need an assumption that high quality teachers bring better educational outcome of the students. Most researchers agree that there is a large teacher fixed effect, which implies that there is a better quality teacher who consistently produces higher quality education. However, no consensus has been reached regarding which ex-ante qualifications, other than teaching experience, make them higher quality teachers.

average hourly earnings using CPS ORG, thirteen states pay their teachers more than the state's median wage, but no more than the 52nd percentile of state's income distribution[10].

Several researchers found that the average teacher quality have decreased over time in the U.S. Murnane et al. (1991) and Bacolod (2003) found a drop in the fraction of college graduates with high AFQT scores among teachers. Using the US Census data, Lakdawalla (2001) found that the relative schooling of teachers declined by about three years from the 1900 birth cohort to the 1950 birth cohort. Corcoran et al. (2004) found that the average quality of female teachers, measured by the quartile ranking based on their placement in the distribution of mathematics and verbal exams administered in their senior year of high school, fell since 1960. Hoxby and Leigh (2004) also found that the teachers' academic aptitude in the U.S. has decreased. They pointed out that increasing outside options that pay higher salaries to high quality females, who used to enter teaching professions, have drawn them to non-teaching career paths.

Another stream of researches on teacher salaries focuses on the effect of teachers unions on teacher compensations. Lipsky (1982), Ehrenberg and Schwarz (1986), and Freeman (1986) provided the reviews of early literature on union effects. According to the theory, the effect of unions on the level and structure of teacher salaries should be determined by unions' goals and their collective bargaining power. The empirical studies on the effect of teachers unions on teacher salaries have produced various estimates (Baugh and Stone, 1982; Freeman and Valletta, 1988; Gyourko and Tracy, 1991; Zwerling and Thomason, 1995; Belman, Heywood, and Lund, 1997; Hoxby, 1996; Lemke, 2004; Lovenheim, 2009; Hirsch, Macpherson, and Winters, 2011). It is commonly conceived that the union wage effects in the

[10] These states are California, Connecticut, Delaware, Hawaii, Massachusetts, Michigan, Montana, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia. All of these states, except West Virginia, have the collective bargaining laws of teachers unions.

public sector is smaller than those in the private sector ranging between 5% and 20% of wage premium.

Teachers unions also try to offer good working conditions and better fringe benefits to their members in addition to base salaries. They may improve other educational inputs such as student-teacher ratio and school districts' education expenditures. Due to the data limitation of the CPS, I focus on teachers' earnings measured by hourly wage. However, I discuss the relations between the non-wage benefits/working conditions and teacher wage in terms of compensating differentials.

2.3 The Roy Model for Career Changes

If teachers are paid less than comparable non-teachers, they should be able to have larger increase in their earnings, on average, when they change to non-teaching occupations than non-teachers who change to other non-teaching occupations. The fundamental problem to this approach is that the career change is an endogenous outcome of various optimizing decisions, in which people self-select the occupational sector that provides them with the highest expected earnings. I use Roy model to deal with the self-selection issue of career changers. In this section, I fully describe my version of the Roy model that is inspired by Borjas (1987) who used the simple two-sector Roy Model to discuss the self-selection problem of immigrants.

Consider two occupations; teachers (A) and non-teachers (B). Let W_A indicate the log (hourly earnings) for teachers, and it is given by $W_A = Y_A + \varepsilon_A$. ε_t represents the unobservable ability of a teacher and it is assumed to be normally distributed with mean zero and variance

of σ^2. Thus, $\varepsilon_t \sim N(0,\sigma_t^2)$ for t=A, B. If all teachers change their career to non-teachers, their log (hourly earnings) is denoted as W_B, and $W_B = Y_B + \varepsilon_B$ if we ignore the general equilibrium effect. Suppose that there is a cost in changing careers, C, and it is proportional to W_A. Following Borjas, I denote this cost $\pi = C/W_A$, which is a "time-equivalent" measure of career-changing cost. The correlation between the unobservable ability of teachers and non-teachers are given by:

$$\rho_{AB} = \frac{\sigma_{AB}}{\sigma_A \sigma_B} \text{ where } \sigma_{AB} = Cov(\varepsilon_A, \varepsilon_B) \quad (1)$$

Teachers will move into the non-teaching sector if $W_B - W_A - \pi > 0$, or equivalently, $(Y_B - Y_A - \pi) + (\varepsilon_B - \varepsilon_A) > 0$. Define the indicator variable I=1 if teachers change their career to non-teaching professions, and define $u \equiv \varepsilon_{\mathbf{B}} - \varepsilon_A$. The probability that a teacher chooses to move into the non-teaching sector is given by:

$$P = \Pr(I = 1) = \Pr[(Y_B - Y_A - \pi) + u > 0] = \Pr[u > (Y_A - Y_B + \pi)]$$

$$= \Pr[\frac{u}{\sigma_u} > \frac{Y_A - Y_B + \pi}{\sigma_u}] = \Pr[\frac{u}{\sigma_u} > z] = 1 - \Phi(z) \quad (2)$$

where $z = \frac{Y_A - Y_B + \pi}{\sigma_u}$ and $\Phi(z)$ is the CDF of the standard normal distribution. Then, the larger the value of z is the lower the probability of teachers moving into the non-teaching

sector is. So, $\frac{\partial P}{\partial Y_A} < 0$, $\frac{\partial P}{\partial Y_B} > 0$, and $\frac{\partial P}{\partial \pi} < 0$. If teachers earn higher wages, the probability that they move into the non-teaching sector falls. If non-teachers earn higher wages, on the other hand, the probability that teachers move into the non-teaching sector increases. To make the story more interesting, I focus on the case where $Y_A \approx Y_B$.

The expected earnings in the teaching sector for the teachers who choose to move into the non-teaching sector are given by:

$$E(W_A|I=1) = Y_A + E\left[\varepsilon_A \left| \frac{u}{\sigma_u} > z \right.\right] = Y_A + \sigma_A E\left[\frac{\varepsilon_A}{\sigma_A} \left| \frac{u}{\sigma_u} > z \right.\right] = Y_A + \rho_{Au}\sigma_A E\left[\frac{u}{\sigma_u} \left| \frac{u}{\sigma_u} > z \right.\right]$$

$$= Y_A + \rho_{Au}\sigma_A\left[\frac{\phi(z)}{\Phi(-z)}\right] = Y_A + \frac{\sigma_A\sigma_B}{\sigma_u}\left[\rho_{AB} - \frac{\sigma_A}{\sigma_B}\right]\left[\frac{\phi(z)}{\Phi(-z)}\right] \quad (3)$$

The expected earnings in the non-teaching sector for the teachers who choose to move into the non-teaching sector are given by:

$$E(W_B|I=1) = Y_B + E\left[\varepsilon_B \left| \frac{u}{\sigma_u} > z \right.\right] = Y_B + \frac{\sigma_A\sigma_B}{\sigma_u}\left[\frac{\sigma_B}{\sigma_A} - \rho_{AB}\right]\left[\frac{\phi(z)}{\Phi(-z)}\right] \quad (4)$$

where $\rho_{Au} = \frac{Cov(\varepsilon_A, u)}{\sigma_A\sigma_u} = \frac{Cov(\varepsilon_A, \varepsilon_B) - \sigma_A^2}{\sigma_A\sigma_u}$ and $\rho_{AB} = \frac{Cov(\varepsilon_A, \varepsilon_B)}{\sigma_A\sigma_B}$.

Equation (3) implies that whether the teachers who change into the non-teaching sector earn more or less than the average teachers in the teaching sector depends on

$\rho_{AB} > / < \frac{\sigma_A}{\sigma_B}$. Equation (4) implies that whether the teachers who change into the non-teaching sector earn more or less than the average non-teachers in the non-teaching sector depends on $\rho_{AB} > / < \frac{\sigma_B}{\sigma_A}$. Define $Q_A \equiv E(\varepsilon_A | I = 1)$ and $Q_B \equiv E(\varepsilon_B | I = 1)$ to be the expected value of the unobserved ability of teachers and non-teachers, respectively, given that the teachers choose to move into the non-teaching sector.

I discuss two cases in which the self-selection changes the expected wages in the Roy Model: positive selection and negative selection. The positive selection implies that the teachers who move into the non-teaching sector are positively selected in the ability distribution of teachers, and they are also above the mean in the ability distribution of non-teachers. The positive selection will occur if $Q_A > 0$ and $Q_B > 0$, which is equivalent to $\frac{\sigma_B}{\sigma_A} > 1$ and $\rho_{AB} > \min\left(\frac{\sigma_A}{\sigma_B}, \frac{\sigma_B}{\sigma_A}\right)$. When these two conditions are satisfied, the high quality teachers are more likely to move into the non-teaching sector to take advantage of higher returns to ability. More specifically, the two conditions are:

i) $\frac{\sigma_B}{\sigma_A} > 1$: This condition indicates that the non-teaching sectors have more dispersed income distribution than the teaching sector does. Thus, the returns to ability are higher in the non-teaching sectors than in the teaching sector. In Table 2.1, the standard deviations of weekly earnings and hourly earnings are larger in non-teaching sectors ($681.32 and $15.36, respectively) than those in the teaching sector ($427.94 and $10.39, respectively). Therefore, this condition is satisfied.

ii) $\rho_{AB} > \min\left(\frac{\sigma_A}{\sigma_B}, \frac{\sigma_B}{\sigma_A}\right)$: This indicates that the correlation between the ability that is relevant both in the teaching sector and in the non-teaching sector is sufficiently high. High ability (thus high quality) teachers will move into the non-teaching sector only if their ability is highly correlated with the ability that are valued in the non-teaching sectors. Chingos and West (2012) found that high-value-added teachers earned more than low-value-added teachers after they left for other jobs in the non-teaching sectors. This suggests that the opportunity wages in the non-teaching sectors are positively correlated with teacher effectiveness. Given their findings, the second condition is also satisfied.

Negative selection occurs if non-teachers are negatively selected in the ability distribution of non-teachers, and they are also below the mean of the ability distribution of teachers when they move into the teaching sector. The conditions necessary for this negative selection to happen are the opposite of the conditions of the positive selection; the non-teaching sectors have more dispersed wage distribution than the teaching sector, and the correlation between the ability that is relevant both in the teaching and in the non-teaching sector is also sufficiently high. When these conditions are met, the low ability people will want to move to the teaching sector to take advantage of the narrower wage distribution of teaching occupations.

2.4 Data and the Legal Settings towards Collective Bargaining

The primary data source I use is the Current Population Survey merged Outgoing Rotation Group (CPS ORG) files for 2001 through 2010. CPS ORG is not a panel data as the households are not tracked once they move. However, every household that enters the CPS is interviewed each month for 4 months, then ignored for 8 months, and then interviewed again for 4 more months. So, we get to observe the same individuals in the same household twice in a year if they do not move. I drop the observations if the value for either weekly earnings or work hours is missing to make a use of hourly earnings that are calculated by the weekly earnings on the primary job divided by usual hours worked per week on that job. I restrict the sample to full time workers, who have the usual work hours per week of 30 or above. The earnings data is truncated at the bottom 1 percentile, and I focus on the people at least with college degrees. I define the public school teachers as primary school teachers, secondary school teachers, special education teachers, and other instructors who are public sector employees.

I also utilize the data from the CPS Supplements for Occupation Mobility and Job Tenure (SOMJT). Between 2001 and 2010, the CPS SOMJT is reported in January, except for the year of 2001 and 2005, in which February file provides the data. The CPS SOMJT is not available for the year of 2003. I create the pooled cross-sectional dataset using CPS SOMJT 2001 through 2010 files. This dataset provides additional information that CPS MORG file does not have. In particular, it provides valuable information about labor force activities of people with multiple jobs. These include the number of jobs that people have, characteristics of their second jobs, and their occupation mobility.

Table 2.1: Descriptive Statistics by Occupation

College Graduates Only

VARIABLES	Public School Teachers			Private School Teachers			Non-Teachers		
	All	Male	Female	All	Male	Female	All	Male	Female
Weekly earning ($)	965.52 (427.94)	1,036.9 (470.42)	939.2 (408.04)	881.49 (447.98)	986.64 (502.25)	842.63 (419.62)	1,193.67 (681.32)	1,334.02 (725.35)	1,009.88 (574.46)
Usual work hours	43.37 (6.86)	43.77 (7.35)	43.21 (6.66)	43.12 (6.96)	44.05 (7.76)	42.77 (6.61)	43.7 (7.55)	44.94 (8.16)	42.25 (6.36)
Hourly earnings ($)	22.63 (10.39)	24.2 (11.54)	22.05 (9.87)	20.76 (10.75)	22.85 (12.01)	19.99 (10.15)	27.41 (15.36)	29.69 (16.14)	23.79 (13.5)
% of female workers	73.06	n/a	n/a	73.02	n/a	n/a	43.3	n/a	n/a
Female/male earnings ratio (hourly earnings)	.91	n/a	n/a	.87	n/a	n/a	.79	n/a	n/a
Union membership (%)	64.46	64.66	64.39	27.78	26.14	28.38	9.25	8.46	10.28
% of people with master's degree	46.86	47.62	46.58	40.12	43.92	38.71	21.77	21.52	22.08
% of people with professional school or Doctorate degree	2.39	3.29	2.06	3.38	5.72	2.52	9.94	11.46	7.94
Work experience (years)	19.82	19.55	19.93	19.54	19.41	19.6	19.08	19.87	18.01
US citizen (%)	95.4	94.91	95.53	92.6	92.71	92.56	85.04	84.72	85.46
Non-white (%)	10.9	9.0	11.56	10.5	10.18	10.62	16.53	14.52	19.17
Hispanic (%)	4.59	4.9	4.47	3.92	3.19	4.19	4.93	4.67	5.25
% of people with multiple job*	10.11	15.6	9.08	9.61	13.2	8.12	5.31	5.33	5.29
N	31,315	8,435	22,880	6,152	1,660	4,492	348,664	199,691	155,696

Source: CPS MORG, 2001-2010. Standard deviation in parentheses.

*CPS Supplements for Occupation Mobility and Job Tenure, 2001-2010. January supplement is used, except for 2001 and 2005 in which February is employed and 2003, in which the supplement for Occupation Mobility and Job Tenure is not available

On average, both weekly and hourly earnings are lower for public school teachers than for non-teachers. The fraction of female workers and earnings ratio of female to male is higher for public school teachers. The fraction of people with master's degree, union membership, and the US citizenship is also higher for public school teachers. The fraction of people with professional school or doctorate degree, however, is the smallest for public school teachers. A larger fraction of public school teachers has multiple jobs than non-teachers do.

States have different legal environments towards collective bargaining. These legal environments are quite exogenous factors because they have not changed much over time for the past 3-4 decades. The legal environments influence states' unionization, so the effect of teachers unions may differ across different legal settings. To deal with this issue, I classify all 51 states into three different categories depending on their legal status towards collective bargaining of public school teachers.[11] The first group is composed of 35 states that have compulsory collective bargaining laws.[12] The second group consists of 9 states that do not have collective bargaining laws, but these states permit collective bargaining to occur if local unions can pressure local school boards into accepting it in their school districts.[13] The third group prohibits the collective bargaining of public school teachers. There are 7 states in this

[11] The source for the information on collective bargaining laws and agency fees are from "Teacher Monopoly, Bargaining, and Compulsory Unionism, and Deduction Revocation Table", National Right to Work Foundation(2010). For reference, I also use Table 2-2, p. 54-55, Moe (2011).

[12] These states are Alaska, California, Connecticut, Delaware, DC, Florida, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Hampshire, Nebraska, Nevada, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Vermont, Washington, and Wisconsin.

[13] These states are Alabama, Arkansas, Colorado, Kentucky, Louisiana, Missouri, Utah, West Virginia, and Wyoming.

group.[14] I call the first group "High-CB", the second group "Low-CB", and the third group "No-CB".

Table 2.2 provides the summary statistics of public school teachers for each group of states. High-CB group has the biggest union membership rate (75.4%) and the biggest collective bargaining coverage (93.7%) among all three groups. High-CB group pays the highest nominal salaries to teachers, has the highest fraction of teachers with master's degree, and has the smallest fraction of female teachers. Low-CB group has a union density of 50%, but less than 30% of public school teachers are covered by collective bargaining agreements. No-CB group prohibits the collective bargaining, but some teachers still join teachers unions, and the average union membership rate of public school teachers is 27.5%.

There are two limitations in the use of CPS ORG that deserve special attention. The first is the possible measurement error in the earnings data. Table 2.3 reports the earnings for the summer months (July and August) and non-summer months. Male non-teachers report lower average weekly earnings ($1,319<$1,337) and lower average hourly earnings ($29.49<29.74) during summer months, and these differences are statistically significant at 1% significance level. On average, however, male teachers in public schools make higher weekly earnings ($1,056>$1,035) and higher hourly earnings ($25.06> $24.14) during summer months. Some schools provide an option for the teachers to decide whether they want to be paid over 10 months or for the entire year. If they are paid over a 12-month period, then their annual salary is divided by the number of pay periods in 12 months. In this case, they choose to receive lower payments in order to get paid all year long. Thus, the fact that the average earnings of male teachers are higher over the summer than during the school year seems quite odd. My conjecture is that some teachers have multiple jobs during the summer and they

[14] These states are Arizona, Georgia, Mississippi, North Carolina, South Carolina, Texas, and Virginia.

Table 2.2: Descriptive Statistics of Public School Teachers by Group

College Graduates Only

VARIABLES	High-CB group		Low-CB group	No-CB group
List of states	Alaska California Connecticut DC Delaware Florida Hawaii Idaho Illinois Indiana Iowa Kansas Maine Maryland Massachusetts Michigan Minnesota Montana	Nebraska Nevada New Hampshire New Jersey New Mexico New York North Dakota Ohio Oklahoma Oregon Pennsylvania Rhode Island South Dakota Tennessee Vermont Washington Wisconsin	Alabama Arkansas Colorado Kentucky Louisiana Missouri Utah West Virginia Wyoming	Arizona Georgia Mississippi North Carolina South Carolina Texas Virginia
Union membership	.754 (.431)		.50 (.499)	.275 (.446)
Collective bargaining coverage (%)	93.7		29.6	0
Weekly earnings ($)	1,003 (446)		851 (349)	886 (371)
Hourly earnings ($)	23.6 (10.9)		19.9 (8.4)	20.53 (8.72)
% of US citizen	94.88		98.2	95.32
% of Non-white	10.05		19.19	16.01
% of Hispanic	4.15		1.85	8.71
% of female teachers in public education	71.27		74.73	79.04
% of teachers with Master's degree	49.36		46.23	36.06
% of teachers with Professional school or Doctorate degree	2.32		2.03	2.38
N	22,419		3,937	4,959

Source: CPS MORG. The list of states in each group and the collective bargaining coverage data is from Moe (2011), Table 2-2. Standard deviation in parentheses.

might have added the earnings from their second jobs to their regular teacher salaries. I regressed earnings on the dummy variable for summer months to check if this would seriously jeopardize the reliability of the data. The dummy variable did not show a significant association with earnings, so it seems acceptable to use a full-year sample. However, this measurement error would systematically bias the estimates if people have added (but never subtracted) their earnings from their other jobs to their primary earnings.

Table 2.3: Comparison between Summer and Non-summer Months in CPS

College Graduates Only

	Public School Teachers		**Private School Teachers**		**Non-Teachers**	
	Male	Female	Male	Female	Male	Female
Weekly earnings ($)						
Summer	**1056.44**	902.76	**994.57**	893.27	1319.37	1011.81
	(486.14)	(422.45)	(515.89)	(455.62)	(702.45)	(570.95)
Non-summer	1035.45	941.68	985.84	838.91	**1336.91**	1008.94
	(469.21)	(406.94)	(501.01)	(416.67)	(713.05)	(536.21)
Hourly earnings ($)						
Summer	**25.06**	21.58	**23.61**	21.34	29.49	23.92
	(11.57)	(9.95)	(12.02)	(10.92)	(15.03)	(12.64)
Non-summer	24.14	22.08	22.78	19.88	**29.74**	23.76
	(11.53)	(22.09)	(12.00)	(10.08)	(15.16)	(12.48)

Source: CPS MORG, 2001-2010. Standard deviation in parentheses.

A research commissioned by the Texas State Teachers Association in 2010 shows that 40 percent of teachers work a second job during the school year and 56 percent during the summer. 62 percent of teachers working outside the classroom say that the main reason they have multiple jobs is to make ends meet. On average, teachers spend 15.2 hours per week on their second jobs during the school year in Texas. According to the CPS Supplements

between 2001 and 2010, almost 10% of public school teachers have more than one job while less than 3% of non-teachers have more than one job. Among college graduates, 15.6% of male public school teachers have more than one job while 5.3% of male non-teachers have more than one job (See Table 2.1). 1.6% of the male public school teachers and 0.5% of male non-teachers have three or more jobs.[15] Even though there is a large gap in the magnitude between the survey by Texas State Teachers Association and the CPS Supplements regarding the fraction of people with multiple jobs (40 % vs. 10%)[16], it is clear that, on average, a larger fraction of teachers work for more than one job compared to non-teachers. Therefore, to the extent that some respondents may have combined all of their earnings together, the earnings data in the CPS has some unreliability.

The other limitation is the measurement problem of collective bargaining coverage calculated from the CPS. Only if a person is not a union member does CPS ask whether or not the person is covered by collective bargaining. Thus, when people calculate the collective bargaining coverage using the CPS, they usually presume that all union members are covered by collective bargaining. The fraction of workers covered by collective bargaining is assumed to be the sum of all union members and non-members who answered that they are covered by collective bargaining. This is a serious misspecification in assessing the true collective bargaining coverage of public school teachers for two reasons. First, not all union members are covered by collective bargaining. In states that prohibit collective bargaining of teachers,

[15] The top 10 second jobs for public school teachers are 1) private school teachers 2) post-secondary school teachers 3) coaches 4) retail salesperson 5) musicians 6) farmers and ranchers 7) religious activities directors 8) waiters/waitress 9) janitors and building cleaners 10) supervisor/managers of retail salespersons.

[16] One of the reasons for this discrepancy is that some survey questions ask teachers to count afterschool program as a second job.

members of teachers unions are not covered by collective bargaining. Second, some teachers who are not union members may not know if they are covered by collective bargaining or not.

There is an alternative source for the union coverage data; the Survey of Schools and Staffing Survey (SASS) conducted by the National Center for Education Statistics (NCES). The survey is completed by school district administrators, who know better about the collective bargaining status of the teachers in their district, so the union coverage data from the SASS can be calculated at the school district level. Therefore, SASS provides more accurate data on collective bargaining coverage of teachers than the CPS. For this reason, Hirsch et al. (2011) used both CPS and SASS to study the effect of collective bargaining on teacher salaries.

Table 2.4 summarizes the descriptive statistics on the unionization using both SASS and CPS. For each data source, the first column reports the union density by state and the second column reports the collective bargaining status by state. There is a substantial discrepancy between the SASS and the CPS in the unionism measures, in particular the collective bargaining coverage. To see how big the measurement errors are in the CPS, I regress the collective bargaining coverage calculated from CPS on the collective bargaining coverage from SASS[17]. Table 2.5 reports the empirical results.

In Panel A of Table 2.5, the collective bargaining coverage calculated from the CPS shows a strong association with the one reported from the SASS in High-CB group. In Low-CB group, however, the collective bargaining coverage from the CPS shows some unreliability, as the coefficients for the SASS are insignificant. For the states that prohibit

[17] I used the values reported in table 2.2 in Moe (2011). He uses the average values from SASS between 2003-2004 and 2007-2008 academic years, as the unionization and collective bargaining of teachers in each state is quite stable over time.

Table 2.4: Unionization and Collective Bargaining of Public School Teachers

By State

States	SASS[1]		CPS[2]	
	Percent of teachers unionized	Percent covered by collective bargaining	Percent of teachers unionized	Percent covered by collective bargaining[3]
Alabama	84	2	58	61
Alaska	90	99	77	77
Arizona	51	0	41	46
Arkansas	36	17	28	33
California	96	98	79	79
Colorado	69	76	56	59
Connecticut	100	95	84	84
DC	93	100	63	65
Delaware	93	100	71	73
Florida	61	100	44	50
Georgia	55	0	26	31
Hawaii	98	100	80	80
Idaho	66	95	43	51
Illinois	95	96	82	82
Indiana	81	99	62	65
Iowa	75	98	63	67
Kansas	60	88	42	50
Kentucky	60	21	37	45
Louisiana	61	19	29	34
Maine	79	98	63	68
Maryland	86	100	69	71
Massachusetts	97	98	80	81
Michigan	99	94	81	82
Minnesota	99	93	83	83
Mississippi	35	0	18	27
Missouri	76	8	45	51
Montana	85	90	67	68
Nebraska	85	93	65	68
Nevada	72	100	59	63
New Hampshire	81	99	70	72
New Jersey	99	95	85	86
New Mexico	41	56	36	45
New York	99	95	87	87
N. Carolina	49	0	16	21
N. Dakota	77	85	53	61
Ohio	95	97	79	80
Oklahoma	59	63	40	45

Table 2.4: Unionization and Collective Bargaining of Public School Teachers (Cont.)

States	SASS[1]		CPS[2]	
	Percent of teachers unionized	Percent covered by collective bargaining	Percent of teachers unionized	Percent covered by collective bargaining[3]
Oregon	97	99	82	83
Pennsylvania	96	98	84	84
Rhode Island	99	93	87	87
S. Carolina	28	0	15	22
S. Dakota	56	88	38	44
Tennessee	65	84	36	42
Texas	65	0	29	35
Utah	70	84	50	51
Vermont	84	98	67	70
Virginia	53	0	28	32
Washington	98	97	81	81
West Virginia	75	0	62	64
Wisconsin	99	98	80	81
Wyoming	56	40	41	46
U.S. Average	79	64	58	61

[1]The data for SASS is from Moe (2011. Table 2-2), in which he reported the average values from SASS between 2003-2004 and 2007-2008.
[2]The data for CPS MORG is from between 2001 and 2010.
[3]This is calculated as the sum of union members and non-union members who answered that they are covered by collective bargaining.

collective bargaining, No-CB group, I cannot investigate this relationship because the values for the collective bargaining coverage from SASS are zero for all states. However, the average collective bargaining coverage calculated from CPS is almost 30%, which is far from zero. In Panel B, on the other hand, the coefficients of union density from the SASS are significant in all groups, which suggest that union density data from the CPS is sufficiently close to the one from the SASS. Therefore, in my analysis, I focus on the union membership data rather than collective bargaining data, in the CPS to assess the strength of unionism.

Table 2.5: The Measure of Unionization using CPS and SASS

By Group

Public School Teachers

	High-CB group	Low-CB group	No-CB group
Panel A: Dependent Variable: Collective bargaining coverage calculated from CPS			
CB coverage from SASS	.741***(.207)	.015(.110)	NA
Adjusted R^2	.246	.002	NA
N	35	9	7
Panel B: Dependent Variable: Union density from CPS			
Union Density from SASS	.961***(.052)	.706***(.128)	.446***(.096)
Adjusted R^2	.925	.642	.366
N	35	9	7

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Survey of Schools and Staffing Survey (SASS) from Moe (2011, Table 2.2). The collective bargaining coverage is the average values of 2003-2004 and 2007-2008 academic year. The average collective bargaining coverage in No-CB group is zero.

2.5 Empirical Strategies

Hurley (2004) showed that the wage gap between non-teaching careers and teaching careers among college graduates has been increasing since 1940, and it was about 60% for males and 16% for females in 2000. He argued that the real wage differentials among college graduates would be even larger because more teachers have master's degrees than their comparison group. The wage gap reported in this study is the unconditional wage differentials between public school teachers and non-teachers among college graduates. Murnane et al. (1991) also stated that a large wage gap exist between teacher salaries and the salaries for the college graduates with the same major, but they did not consider other wage determinants. Using CPS data from 1977-1999, Temin (2002) found that the females with the years of

schooling of seventeen or above working in the non-teaching occupations made 40% more than the ones working in the teaching career in 1999, also uncontrolling for other wage determinants.

The first part of my empirical analyses builds on these studies by directly comparing earnings among the college graduates, but I control for other wage determinants and individual attributes such as potential work experience, union status, industries, occupations, worker class, metropolitan region, marital status, race, and ethnicity. State fixed effects and year fixed effects are also added in my regression models. Rather than using the entire population, I focus on the population with the college degrees since most public school teachers are college graduates. This approach can provide the direct evidence if teachers are paid less relative to other comparable college graduates with similar worker characteristics.

The second part of my empirical studies focuses on the changes in earnings after people change their careers. The Roy model predicts that if (i) the non-teaching sectors have more dispersed income distribution than the teaching sector does and (ii) the unobservable abilities are highly correlated between the teaching sector and the non-teaching sectors, positive selection occurs when teachers move into the non-teaching sectors but negative selection occurs when non-teachers move into the teaching sector. In other words, when these two conditions are satisfied, the high quality teachers are more likely to move into the non-teaching sectors for higher returns to ability, and the low quality non-teachers are more likely to move into the teaching sector to take advantage of narrower income distribution.

First, I investigate if public school teachers are paid less than their comparable non-teachers. The most straightforward way is to directly estimate a wage premium or a wage handicap for public school teachers. The general wage equation I estimate is:

$$\text{Log (Hourly Earnings)} = \beta_0 + \beta_1 Teacher + \beta_2 X_1 + u \quad (5)$$

where *Teacher* is a dummy variable for public school teachers, X_1 is the vector of wage determinants, and u is the error terms that are unobservable. X includes education, gender, race, ethnicity, marital status, citizenship status, and potential work experience, which is proxied by age–years of schooling–6, interaction between gender and potential experience, union membership status, metropolitan regions, worker class, broad industry dummies, and a dummy for private school teacher. Time fixed effects are included to control for period-specific shocks that hit all states, such as financial crisis in 2008. I also add state fixed effects to control for unobservable state characteristics that do not change over time. The standard error is clustered within states. β_1 measures the effect of being a public school teacher on Log (hourly earnings). When its sign is positive (negative), public school teachers have a wage premium (penalty). I also run the regressions for different age groups separately to see if how teachers' work experience affects their earnings.

Then, I examine the effect of wage determinants on earnings for three occupational groups: public school teachers, private school teachers, and non-teachers. The wage equations I estimate for each group is:

$$\text{Log (Hourly Earnings of each occupational group)} = \alpha_0 + \alpha_1 X_2 + u \quad (6)$$

where X_2 is the vector of other wage determinants in each group. For teachers, variables of occupation, industry and worker class are excluded to avoid perfect multicollinearity. For

non-teacher group, I add broad occupation dummies, broad industry dummies, and worker class dummies to reduce the omitted variable bias.

If public school teachers are truly underpaid than comparable non-teachers, then they must have better alternative opportunities in the non-teaching sectors. They should have larger increases in their earnings after they move into the non-teaching sectors than non-teachers who change the careers to other non-teaching occupations. To verify this, I assess the change in earnings of public school teachers who change to non-teaching professions and of non-teachers who change to teaching professions. During one-year period, some people change their careers (career-changers) while others remain in their occupations (career-stayers). The changes in earnings of career-stayers can be interpreted as returns to experience of current occupations. The changes in earnings of career-changers can be interpreted as the wage premium/penalty of holding previous occupations. Most wage determinants including individual characteristics such as gender, race, ethnicity, citizenship status, education status, marital status, metropolitan area, and the states which they live in, do not change (or change little) during one year. The only thing that changes is their careers which is the driving force for the changes in earnings. Thus, I directly compare the differences in earnings by using individual fixed effects model:

$$\text{Log (Hourly Earnings}_{i2}) = \pi_i + \delta Career_{i2} + u_{i2} \quad (7)$$

$$\text{Log (Hourly Earnings}_{i1}) = \pi_i + \gamma Career_{i1} + u_{i1} \quad (8)$$

$$\Delta = (7) - (8) = (\delta - \gamma)(Career_{i2} - Career_{i1}) + (u_{i2} - u_{i1}) \quad (9)$$

where π_i is the individual characteristics that do not change over time, and $Career_{it}$ represents the occupation at period t=1 or 2. The effect of a career change on changes in earnings is $\delta - \gamma$, which has no meaningful interpretation. Δ, the changes in earnings, however, tells us which career path offers higher or smaller increase in earnings after one year. When Δ is small, it can be interpreted as a percentage change in hourly earnings. If the sign of Δ is positive (negative) for a career changer, it suggests that the person could have earned more (less) if he/she were working for the new occupation. Thus, it implies that there is wage penalty (premium) in holding previous occupation.

One important estimation issue is the work experience that people had built up at previous occupations. In many cases, people will lose the value of the work experience when they start a new career. The CPS does not provide the data about how long the person has been working at a current job, so it is hard to know exactly how much experience people have accumulated. To deal with this issue, I look at the changes in earning for different age groups since it is reasonable to assume that the older the person is the greater the work experience is. Another approach is to use the standard work experience formula (age – years of schooling – 6) as a proxy. The earnings will increase even if people just stay in their current occupations as they receive returns to experience over the year, and it can set the base line. I look into the changes in earnings for ten different career paths for various age groups and work experience groups:

1) Change from a public school teacher to another public school teacher
2) Change from a public school teacher to a non-teaching occupation
3) Change from a private school teacher to a public school teacher

4) Change from a private school teacher to a non-teaching occupation
5) Change from a non-teaching occupation to another non-teaching occupation
6) Change from a non-teaching occupation to a public school teacher
7) Change from a non-teaching occupation to a private school teacher
8) Stay teaching in a public school
9) Stay teaching in a private school
10) Stay in a non-teaching occupation

Next, I attempt to deal with the endogeneity problem of unionization by analyzing the union effects separately for different groups of states that have same legal environment toward collective bargaining of teachers unions. I examine if teachers unions in each group have different effects on teachers' earnings by utilizing two datasets. I use the CPS ORG to measure the effect of union membership. I combine CPS ORG data and the collective bargaining data from the SASS to estimate both the effect of collective bargaining and the effect of union membership on teachers' earnings. The model I estimate for each group using CPS ORG is:

$$\text{Log (Hourly Earnings)} = \beta_0 + \beta_1 Teacher + \beta_2 Union + \beta_3 (Teacher * Union) + \beta_4 X + u \qquad (10)$$

where *Union* is a dummy variable for a union member. I add the interaction term between public school teachers and teachers union ($Teacher * Union$) to see if the effect of unions on earnings differs between teachers and non-teachers. β_2 measures the union wage premium for non-teachers while $\beta_2 + \beta_3$ measures the union wage premium for public school teachers. For

the combined dataset of the SASS and CPS ORG, I add the information on the collective bargaining coverage of each state from the SASS, which is reported in Table 4, into the model (10).

Intuitively, the effect of teachers unions on teachers' earnings would be more significant and greater in states that have collective bargaining laws, while the effect is either insignificant or smaller in states that prohibit the collective bargaining of public school teachers. To check whether the union effects are proportional to the strength of the legal environment for teachers' bargaining rights, I estimate the following model for each group separately:

$$\text{Log (Teachers' hourly earnings)} = \beta_0 + \beta_1 TeachersUnions + \beta_2 X + u \quad (11)$$

where $TeachersUnions$ indicates if a teacher is the member of teachers unions.

Lastly, I compare the changes in earnings of ten career paths during one-year period for each group separately to examine if career dynamics differ in different legal environment towards collective bargaining. For this analysis, I estimate the same model (9) by age groups.

2.6 Results

Table 2.6 summarizes the result from regression model (5). Overall, public school teachers earn 3.3% less than other comparable college graduates who work in the non-teaching sector. The wage penalty is 7.8% for male public school teachers and 1.6% for female public school teachers. The gender difference in the wage penalty explains why the

teaching sector is still dominated by females. There exists a wage premium of 8% for public school teachers in their 20s, but it quickly disappears. The wage premium turns into the wage handicap for public school teachers in their 30s or above. Even though young public school teachers are paid better than their comparable non-teachers, it is only for a brief period of their career path. Thus, public school teachers are paid less compared to other college graduates considering their lifetime income.

Table 2.6: Wage Premium/Penalty of Public School Teachers

By Age group and gender

College graduates only

Dependent Variable: Log (hourly earnings)

Age Group	All	Male	Female
All ages	-.033 (.009)***	-.078 (.014) ***	-.016 (.008)**
< 30 years old	.081 (.015)***	.095 (.025)***	.063 (.013)***
30 - 39 years old	-.043 (.015)***	-.088 (.027)***	-.031 (.015)**
40 - 49 years old	-.031 (.010)***	-.066 (.020)***	-.017 (.011)*
50 - 59 years old	-.026 (.010)**	-.060 (.019)***	-.009 (.010)
> 59 years old	-.085 (.024)***	-.137 (.041)***	-.064 (.021)***

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Control variables: a dummy for higher education(master's degree or above), potential experience and its square, categorical dummies for race, ethnicity, metropolitan area, population size, marital status, worker class, and broad industry, a dummy for family head, union status, citizenship status and private school teachers. All regressions employ state FE and time FE. All regressions use persons' composited final weight.

Why does the teacher premium in their 20s quickly disappear? To answer this question, I first investigate the effects of wage determinants on earnings by occupational group. Table 2.7 reports the coefficients and standard errors estimated from model (6). The returns to master's degrees are higher for teachers (13.5%) than for non-teachers (11%). The returns to higher level of education (professional school degree and doctorate degree) are

Table 2.7: Wage Determinants by Occupation

College graduates only

Dependent Variable: Dependent Variable: Log (hourly earnings)

VARIABLES	**Public School Teacher**	**Private School Teacher**	**Other Occupations**
Master's degree	.135 ***	.136 ***	.109 ***
	(.007)	(.014)	(.004)
Professional school or Doctorate degree	.201 ***	.104 **	.216 ***
	(.0203)	(.046)	(.0108)
Male	.0001	.003	.059 ***
	(.018)	(.050)	(.005)
Potential experience	.021 ***	.012 ***	.025 ***
	(.002)	(.004)	(.0007)
Potential experience^2	-.0003 ***	-.0002 *	-.0005 ***
	(.000)	(.000)	(.00001)
Male*experience	.006 ***	.009 *	.007***
	(.0016)	(.005)	(.0006)
Male*experience^2	-.00007 **	-.000	-.0001 ***
	(.00003)	(.0001)	(.00001)
Metropolitan area	.096 ***	.156 ***	.133 ***
	(.013)	(.03)	(.012)
Union membership	.057 ***	.166 ***	.053***
	(.014)	(.020)	(.006)
Black	-.026	-.014	-.115 ***
	(.018)	(.028)	(.006)
Indian	.0522	.124	-.071 ***
	(.068)	(.095)	(.017)
Asian	.007	.101*	-.007
	(.027)	(.051)	(.008)
Other	-.021	.057 *	-.007
	(.054)	(.034)	(.013)
Hispanic	.014	.093 ***	-.076 ***
	(.008)	(.017)	(.007)
State FE	YES	YES	YES
Year FE	YES	YES	YES
Clustered SE	YES	YES	YES
Adjusted R^2	0.216	0.194	0.253
N	31,142	6,114	347,170

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Other control variables: For teachers, categorical dummies for population size and marital status, a dummy for family head and citizenship status are used. For non-teachers, categorical dummies for worker class, broad industry, and broad occupation are also included. All regressions employ state FE and time FE. All regressions use persons' composited final weights.

slightly lower for public school teachers, but much lower for private school teachers. The returns to experience are also lower for teachers than for non-teachers. The coefficients for both male and the interaction between male and experience are significant at 1% level in non-teaching sectors, which suggest that the returns to experience is higher for male non-teachers than for female non-teachers. Therefore, for those who have master's degree in their 20s, teaching career may look attractive because the beginning teachers' wage is higher than the beginning non-teaching wage, but this wage premium wanes over time and more quickly so for male teachers partly due to low returns to experience in the teaching sector. This also provides evidence why the attrition rate is so high especially among new teachers[18].

The nominal income should be higher in metropolitan area to compensate for higher living costs and to keep the real income stable. However, public school teachers receive smaller premium (9.6%) than non-teachers (13.3%) who live in the same metropolitan regions. Thus, teachers in the urban districts face even worse wage penalty than teachers in rural districts, and this will contribute to the problem of low teacher retention rate in urban area.

The effects of unions on earnings are slightly higher in the teaching sector (5.7%) than in the non-teaching sectors (5.3%) when focused only on college graduates. Considering the substantial difference of the average union membership between the teaching sector (64%) and the non-teaching sectors (9.5%), the difference of the union effects on earnings between the two sectors is quite small. In the later analysis, I show that the average union effect presented in Table 2.7 is misleading because the union effects on teachers' earnings significantly differ depending on the legal environments towards collective bargaining.

[18] See Carroll and Foster (2010). According to the survey administered by NCTAF (National Commission on Teaching and America's Future), the teacher attrition rate has been steadily increasing since mid-90s, and it is about 46% in 2010 for a new teacher whose teaching experience is less than five years.

According to compensating differentials, public school teachers take less salary than non-teachers in exchange for better fringe benefits. This implies that they should earn more hourly earnings and fewer benefits when they move to the non-teaching sectors such that the total compensations for teachers and non-teachers with the same wage determinants are commensurate. If compensating differentials can explain the entire difference in hourly earnings between teachers and non-teachers, then teachers should make higher hourly earnings if they change to non-teaching occupations just enough to make up for the wage penalty that have been receiving in the teaching sector so that their total compensations in both sectors remain the same. However, if public school teachers have been paid less compared to non-teachers, then their total compensation will be lower than that of non-teachers. In this case, when they move to the non-teaching sectors (ignoring self-selection issue for now), their hourly earnings will be greater in magnitude than the wage penalty that they have received in the teaching sector. Thus, public school teachers will be able to receive higher total compensation after they change to the non-teaching sector. To verify this, I examine the changes in earnings for teachers and non-teachers after they change careers. Table 2.8 presents the changes in earnings during the one-year period for ten career paths by age group estimated from the model (9).

I first discuss career dynamics and changes in earnings for teachers. In the top panel for all-ages group, public school teachers have steeper increase in their earnings, on average, when they change into non-teaching sectors (3.81%) than non-teachers do when they change their careers to other non-teaching careers (3.14%). The 3.81% increase in hourly earnings of public school teachers is larger than their wage penalty of 3.3% in Table 2.6, and the pattern is observed for both male teachers (8.57% > 7.08%) and female teachers (3.29% > 1.6%).

Table 2.8: The Change in Earnings after Career Change by Age Group

College Graduates Only

Dependent Variable: Δ = Log (After hourly earnings) – Log (Before hourly earnings)

	All		Male		Female	
	N	**Δ**	**N**	**Δ**	**N**	**Δ**
All ages						
All Career changers	30185	.0364	17239	.0332	12946	.0406
Public school teacher to other public school teacher	962	.0582	345	.1055	617	.0318
Public school teacher to non-teacher	433	.0381	121	.0857	312	.0329
Private school teacher to public school teacher	72	-.032	28	-.063	44	-.012
Private school teacher to non-teacher	143	.0464	49	.2932	94	-.082
Non-teacher to other non-teacher	27765	.0314	16497	.0304	11268	.0318
Non-teacher to public school teacher	457	.0660	103	.1133	354	.0523
Non-teacher to private school teacher	176	.0189	43	.0193	133	.0189
All stayers	39039	.0415	20488	.0449	18551	.0378
Stay teaching at public school	4325	.0488	1084	.0680	3241	.0424
Stay teaching at private school	819	.0498	209	.0127	610	.0626
Stay in non-teaching	33895	.0404	19195	.0440	14700	.0358
< 30 years old						
All Career changers	4140	.0826	2022	.0717	2118	.0927
Public school teacher to other public school teacher	114	.2421	43	.2123	71	.2602
Public school teacher to non-teacher	56	.0971	14	.0840	42	.1109
Private school teacher to public school teacher	4	.0310	0		4	.0310
Private school teacher to non-teacher	21	-.045	4	.2455	17	-.113
Non-teacher to other non-teacher	3817	.0770	1931	.0688	1886	.0868
Non-teacher to public school teacher	68	.1052	17	.1780	51	.0809
Non-teacher to private school teacher	38	.1001	7	-.132	31	.1524
All stayers	4436	.0649	1960	.0734	2474	.0581
Stay teaching at public school	501	.0373	115	.0301	386	.0390
Stay teaching at private school	117	.0668	34	.0509	83	.0734
Stay in non-teaching	3818	.0692	1811	.0770	2005	.0615
30 - 39 years old						
All Career changers	8245	.0433	4725	.0464	3520	.0392
Public school teacher to other public school teacher	237	.0272	87	.1032	150	-.017
Public school teacher to non-teacher	127	.1001	37	.1963	90	.0706
Private school teacher to public school teacher	20	.0811	11	.0583	9	.1089
Private school teacher to non-teacher	37	.1226	15	.2751	22	.0188
Non-teacher to other non-teacher	7643	.0426	4525	.0435	3118	.0414
Non-teacher to public school teacher	101	.0373	23	.0422	78	.0358
Non-teacher to private school teacher	39	-.054	13	-.044	26	-.059
All stayers	10402	.0530	5643	.0617	4759	.0425

Table 2.8: The Change in Earnings after Career Change by Age Group (Cont.)

Stay teaching at public school	1035	.0583	297	.0829	738	.0544
Stay teaching at private school	211	.0836	61	.0372	150	.1025
Stay in non-teaching	9156	.0665	5285	.0697	3871	.0479
40 - 49 years old						
All Career changers	9129	.0288	5310	.0300	3819	.0271
Public school teacher to other public school teacher	281	.0226	90	-.003	191	.0346
Public school teacher to non-teacher	112	.0455	32	.1306	80	.0310
Private school teacher to public school teacher	21	.0514	10	.0870	11	.0192
Private school teacher to non-teacher	34	-.01	13	.1191	21	-.089
Non-teacher to other non-teacher	8460	.0282	5113	.0293	3347	.0265
Non-teacher to public school teacher	128	.1123	27	.2141	101	.0851
Non-teacher to private school teacher	50	-.063	9	-.025	41	-.071
All stayers	11772	.0353	6196	.0358	5576	.0346
Stay teaching at public school	1220	.0441	305	.0683	915	.0370
Stay teaching at private school	221	.0345	43	-.084	178	.0631
Stay in non-teaching	10331	.0342	5848	.0350	4483	.0330
50 - 59 years old						
All Career changers	7017	.0188	4138	.0103	2879	.0311
Public school teacher to other public school teacher	285	.0510	105	.0702	180	-.019
Public school teacher to non-teacher	114	.0335	33	.1709	81	.0129
Private school teacher to public school teacher	19	-.035	5	-.276	14	.0516
Private school teacher to non-teacher	37	.1682	12	.7364	25	-.105
Non-teacher to other non-teacher	6342	.0167	3934	.0039	2409	.0378
Non-teacher to public school teacher	126	.0590	28	.0775	98	.0524
Non-teacher to private school teacher	32	.1003	8	.1268	24	.0915
All stayers	9966	.0305	5230	.0286	4736	.0326
Stay teaching at public school	1356	.0509	312	.0580	1044	.0488
Stay teaching at private school	224	.0519	60	.0514	164	.0520
Stay in non-teaching	8386	.0267	4858	.0265	3528	.0269
> 60 years old						
All Career changers	1654	.0035	1044	.0069	610	-.002
Public school teacher to other public school teacher	45	.0249	20	.0304	25	.0206
Public school teacher to non-teacher	24	-.13	5	.3819	19	-.264
Private school teacher to public school teacher	8	-.555	2	-.943	6	-.425
Private school teacher to non-teacher	14	-.204	5	-.224	9	-.192
Non-teacher to other non-teacher	1503	.0117	994	.0073	509	.0203
Non-teacher to public school teacher	34	-.071	8	-.034	26	-.083
Non-teacher to private school teacher	17	.0935	6	.2555	11	.0051
All stayers	2463	.0260	1457	.0389	1006	.0074
Stay teaching at public school	213	-.014	55	.0149	158	-.025
Stay teaching at private school	46	-.084	11	-.076	35	-.087
Stay in non-teaching	2204	.0322	1391	.0407	813	.0176

This suggests that public school teachers can make hourly earnings that are more than enough to make up for the wage penalty of the teaching career when they move to the non-teaching sectors. It suggests that public school teachers are underpaid to the extent that they could have made higher total compensation if they had started at non-teaching occupations. Compensating differentials, therefore, cannot fully explain the wage gap in hourly earnings between the teaching and the non-teaching sectors.

The second panel of Table 2.8 shows changes in earnings for people in their 20s. During one-year period, non-teachers who stay in their careers have significantly higher increase in their earning (6.92%) than public school teachers who remain in the teaching sector (3.73%). Thus, the returns to experience of public school teachers are almost a half of the returns to experience of non-teachers for this age group. Public school teachers who move into the non-teaching sectors in their 20s have a huge increase in their earnings (9.71%) as opposed to staying in the same teaching positions (3.73%). Recall that public school teachers in their 20s have a wage premium of 8% (See Table 2.6). Public school teachers in their 20s who leave the teaching career even with the wage premium are more likely to be high quality teacher. For them, the teacher premium might not be enough to encourage them to stay in the teaching sector because they have even better earning opportunities outside the teaching sector. The low returns to experience for young teachers might also encourage them to leave their classrooms.

The third, fourth, and fifth panel of Table 2.8 show the changes in earnings for people in their 30s, 40s, and 50s and above, respectively. When public school teachers in their 30s move into the non-teaching sectors, they also have considerably higher increase in earnings. Public school teachers in their 40s have slightly higher pay increase when they move into the

non-teaching sectors. Public school teachers in their 50s and above are better off staying in their careers even though they face a wage penalty. Public school teachers in their 40s and 50s have higher returns to experience than non-teachers of the same age groups.

I now discuss career dynamics and changes in earnings for non-teachers. In all-ages group, non-teachers who move into the teaching sector increase their earnings (6.6%) more than non-teachers who change to other non-teaching occupations (3.14%). Non-teachers in their 20s can take advantage of teacher wage premium by moving into the teaching sector. Non-teachers in their 40s and 50s also have larger increase in their earnings when they move into the teaching sector. Considering that teachers in their 40s and 50s face a wage penalty (see Table 2.6), non-teachers in these age groups who still decide to become teachers having a large increase in their earnings are more likely to be low quality people or less successful in their previous careers.

I also analyze the changes in earnings after career changes from model (9) by potential experience group, and Table 2.9 summarizes the results. For people with less than 20 years of experience, public school teachers have steeper increase in their earnings when they move into the non-teaching sectors than non-teachers do when they change to other non-teaching occupations. This is the same result as the age group analysis reported in Table 2.8, which implies that public school teachers are underpaid in a sense that they could have obtained higher earnings had they started off as non-teaching careers. Moreover, the returns to experience with less than 10 years of experience are 3% for public school teachers and 7% for non-teachers. The returns to experience for public school teachers with higher experience (between 11 and 20 years) are larger than for non-teachers, so the salary schedule for public school teachers seems to put more weight on seniority. Non-teachers between 10 and 30 years

Table 2.9: The Change in Earnings after Career Change by Experience Group

College graduates only

Dependent Variable: Δ = Log (After hourly earnings) – Log (Before hourly earnings)

	All		Male		Female	
	N	Δ	**N**	Δ	**N**	Δ
Potential experience ≤ 5 : semi-equivalent to age group of < 30 years old						
All Career changers	3138	.0944	1498	.0837	1640	.1041
Public school teacher to other public school teacher	87	.2728	31	.2036	56	.3104
Public school teacher to non-teacher	50	.0931	10	.0183	40	.1137
Private school teacher to public school teacher	3	.2401	0		3	.2401
Private school teacher to non-teacher	16	-.026	3	.1311	13	-.046
Non-teacher to other non-teacher	2872	.0899	1430	.0854	1442	.0983
Non-teacher to public school teacher	59	.1396	13	.2351	46	.1027
Non-teacher to private school teacher	34	-.006	7	-.122	27	.0239
All stayers	3682	.0750	1639	.0903	2043	.0661
Stay teaching at public school	399	.0429	93	.0170	306	.0528
Stay teaching at private school	95	.0640	25	.1201	70	.0431
Stay in non-teaching	3188	.0782	1521	.0949	1667	.0677
Potential experience ≤ 10: semi-equivalent to age group of < 39 years old						
All Career changers	7071	.0654	3628	.0596	3443	.0711
Public school teacher to other public school teacher	218	.1521	82	.1564	136	.1496
Public school teacher to non-teacher	114	.0928	30	.0785	84	.0962
Private school teacher to public school teacher	11	.1155	5	.0682	6	.1550
Private school teacher to non-teacher	37	.0832	11	.2399	26	.0167
Non-teacher to other non-teacher	6489	.0620	3447	.0582	3042	.0664
Non-teacher to public school teacher	109	.0413	27	.0665	82	.0326
Non-teacher to private school teacher	52	.0846	14	-.008	38	.1187
All stayers	8512	.0665	4133	.0810	4379	.0529
Stay teaching at public school	900	.0313	239	.0416	661	.0276
Stay teaching at private school	192	.1089	59	.1430	133	.0937
Stay in non-teaching	7420	.0697	3835	.0825	3585	.0560
11 ≤ Potential experience ≤ 20: semi-equivalent to age group of 40 - 49 years old						
All Career changers	8721	.0347	5204	.0382	3517	.0340
Public school teacher to other public school teacher	229	.0086	82	.0514	147	-.015
Public school teacher to non-teacher	109	.1826	33	.3662	76	.1085
Private school teacher to public school teacher	19	.1459	11	.1318	8	.1732
Private school teacher to non-teacher	37	-.015	17	.1135	20	-.133
Non-teacher to other non-teacher	8138	.0334	5006	.0344	3132	.0320
Non-teacher to public school teacher	105	.0980	28	.2545	77	.0466
Non-teacher to private school teacher	42	-.125	11	-.154	31	-.115
All stayers	10986	.0434	6011	.0455	4975	.0408

Table 2.9: The Change in Earnings after Career Change by Experience Group (Cont.)

Stay teaching at public school	1103	.0741	300	.1054	803	.0635
Stay teaching at private school	220	.0283	54	-.149	166	.0914
Stay in non-teaching	9663	.0398	5657	.0442	4006	.0336
21 ≤ Potential experience ≤ 30: semi-equivalent to age group of 50 - 59 years old						
All Career changers	8989	.0323	5137	.0315	3852	.0334
Public school teacher to other public school teacher	338	.0452	118	.1007	220	.0157
Public school teacher to non-teacher	137	-.022	37	.0193	100	-.048
Private school teacher to public school teacher	23	.0251	7	.0037	16	.0352
Private school teacher to non-teacher	39	-.074	10	.0401	29	-.114
Non-teacher to other non-teacher	8213	.0321	4911	.0309	3302	.0367
Non-teacher to public school teacher	140	.1065	30	.0651	110	.1136
Non-teacher to private school teacher	48	.0213	7	.1695	41	-.004
All stayers	11993	.0309	6229	.0313	5764	.0324
Stay teaching at public school	1437	.0411	335	.0811	1102	.0328
Stay teaching at private school	251	.0382	58	.0021	193	.0475
Stay in non-teaching	10305	.0293	5836	.0288	4469	.0320
31 ≤ Potential experience: semi-equivalent to age group of > 60 years old						
All Career changers	5422	.0068	3314	-.001	2108	.0187
Public school teacher to other public school teacher	185	.0204	68	.0874	117	-.019
Public school teacher to non-teacher	77	-.053	22	-.034	55	-.06
Private school teacher to public school teacher	17	-.38	5	-.714	12	-.241
Private school teacher to non-teacher	33	.1823	13	.6142	20	-.098
Non-teacher to other non-teacher	4935	.0078	3169	-.004	1766	.0289
Non-teacher to public school teacher	100	-.017	18	.0051	82	-.022
Non-teacher to private school teacher	31	.0865	11	.1320	20	.0615
All stayers	7583	.0292	4142	.0322	3441	.0256
Stay teaching at public school	889	.0416	212	.0224	677	.0476
Stay teaching at private school	154	.0141	37	.0754	117	-.005
Stay in non-teaching	6540	.0279	3893	.0324	2647	.0214

of experience gain larger increase in their earnings when they move into the public school teaching sector. Considering that the returns to experience are low for new teachers, these non-teachers who move into the teaching sector with good experience in their previous careers are likely to be low quality people.

To address the self-selection problem of career changes, I use the Roy model. The model predicts that high ability teachers are more likely to move into the non-teaching sectors

(positive selection) and that low ability non-teachers are more likely to move into the teaching sector (negative selection). Table 2.8 and Table 2.9 showed that younger public school teachers with less experience earn more when they move into the non-teaching sectors, and older non-teachers with more experience are better off moving into the teaching sector. However, it is not yet clear whether these younger teachers who move into the non-teaching sectors are the high quality people and whether older non-teachers who move into the teaching sector are the low quality people. Comparing the pre-earnings (hourly earnings that people reported during the first interview) of career-changers and career-stayers provides the supporting evidence.

Table 2.10 provides the summary statistics of pre-earnings, measured in hourly wage, for public school teachers and non-teachers. The first panel summarizes the pre-earnings for all-ages group, and the second panel presents the pre-earnings for younger age group (age<40) of teachers and older (40<age<60) age group of non-teachers. The first panel shows that, overall, public school teachers who stay in their current teaching position had lower pre-earnings, and teachers who move into the non-teaching sectors had higher pre-earnings. This pattern becomes more apparent in the second panel. For young males, public school teachers who move out of the teaching sector have higher pre-earnings ($23.94) than public school teachers who stay in their teaching positions ($21.11), and this difference is statistically significant at the 10% level. Therefore, public school teachers who move into the non-teaching sectors are, on average, high aptitude teachers with higher-earnings ability
than the public school teachers who stay in current teaching positions, and this provides evidence for positive selection.

Table 2.10: Pre-Earnings for Teachers and Non-teachers

College Graduates Only

	Male		Female	
	N	**Hourly Earnings($)**	**N**	**Hourly Earnings($)**
Panel 1: All-Ages Group				
Public school teachers				
Stay teaching at public school	1,048	24.02	3,241	21.82
Change to other public school teacher	345	24.09	617	23.27
Change to non-teaching career	121	25.11	312	22.10
Non-teachers				
Stay in non-teaching career	19,195	30.51	14,700	25.01
Change to other non-teaching career	16,497	29.98	11,268	23.75
Change to private school teacher	43	24.94	133	21.14
Change to public school teacher	103	**24.01**	354	**22.51**
Panel 2: Younger Teachers and Older Non-teachers				
Public school teachers (age <40)				
Stay teaching at public school	456	21.11	1,207	19.73
Change to other public school teacher	138	21.47	239	21.01
Change to non-teaching career	55	23.94	143	20.83
Non-teachers (40< age <60)				
Stay in non-teaching career	10,135	32.34	7,618	26.18
Change to other non-teaching career	8,525	32.29	5,387	25.42
Change to private school teacher	16	25.87	60	23.09
Change to public school teacher	52	**25.80**	185	**24.87**

Source: CPS MORG, 2001-2010

Figure 2.1 displays the distributions for pre-earnings and after-earnings of public school teachers by gender with box plots. The left and right side of the box is the 25^{th} percentile and 75^{th} percentile, respectively, and the vertical line near the middle of the box indicates the 50^{th} percentile. There are many dots to the right of the whisker, which implies that this is a heavy-tailed distribution. Compared to the distribution of pre-earnings of public school teachers who stay in their careers (the first box plot of each gender), the distribution of

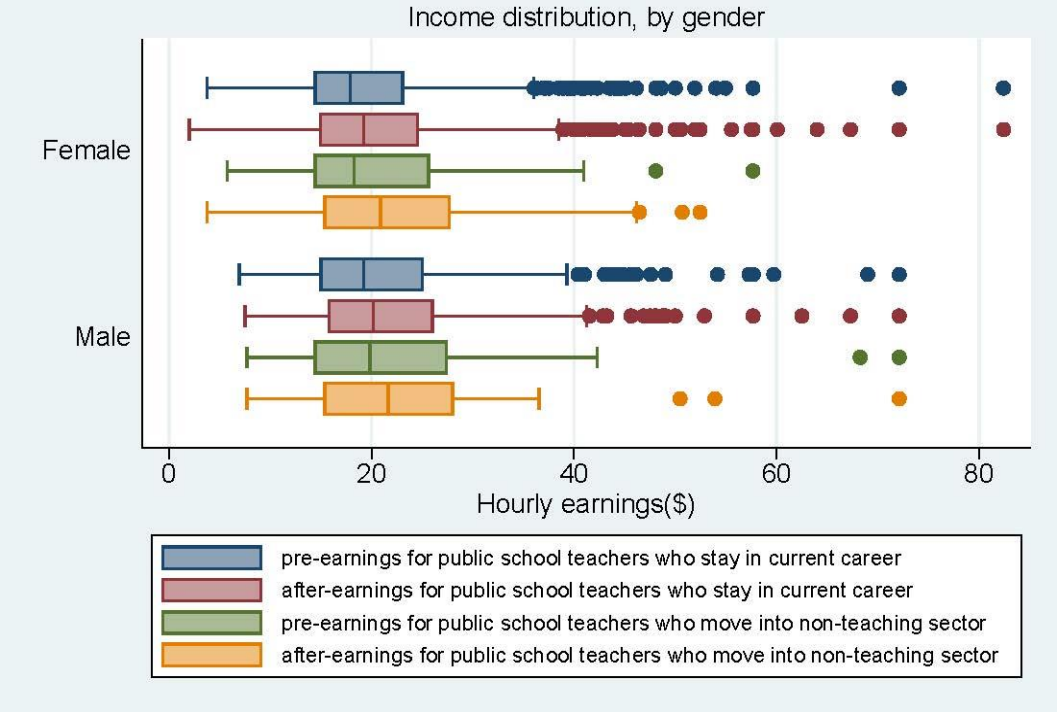

Figure 2.1: Changes in Earnings of Public School Teachers

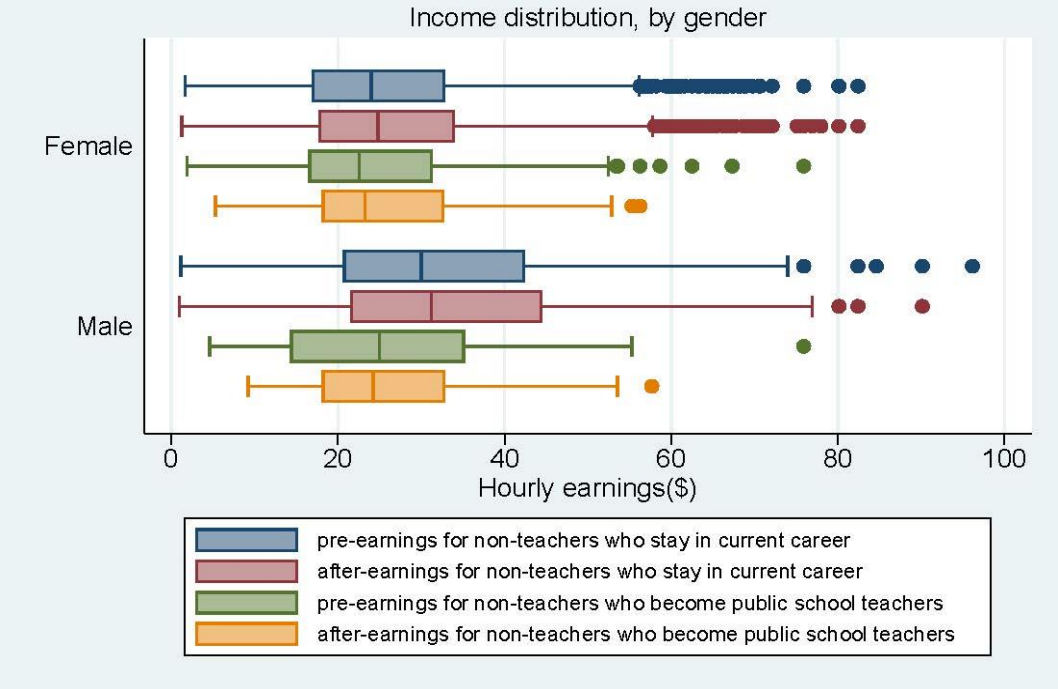

Figure 2.2: Changes in Earnings of Non-teachers

pre-earnings of public school teachers who move into the non-teaching sectors (the third box plot of each gender) is slightly to the right. The after-earning distribution for public school teachers who leave the teaching professions (the fourth box plot of each gender) is also more to the right than the after-earning distribution for career stayers (the second box plot of each gender). The median of after-earning distribution is much higher for public school teachers who move the into non-teaching sectors than that of public school teachers who stay in their careers. Thus, public school teachers who leave the teaching sector are more likely to be higher aptitude teachers with higher-earnings ability than public school teachers who remain in the teaching sector.

For non-teachers, the story is the opposite. Table 2.10 shows that on average non-teachers who stay in their careers had higher pre-earnings, and that non-teachers who move into the teaching sector had lower pre-earnings. In all-ages group, the pre-earnings of male non-teachers who move into the teaching sector is the lowest ($24.01) among all career paths. Older male non-teachers who move into the teaching sector have much lower pre-earnings ($25.80) than older non-teachers who stay in their careers ($32.34), and the difference of the pre-earnings is significant at the 1% level.

In Figure 2.2, pre-earnings distribution of non-teachers who move into the teaching sector (the third box plot of each gender) is significantly to the left of the pre-earnings distribution of non-teachers who stay in their careers (the first box plot of each gender). This pattern is more conspicuous for male non-teachers. The after-earnings distribution of non-teachers who move into the teaching sector (the fourth box plot of each gender) is also to the left of the after-earnings distribution of non-teachers who stay in their careers (the second box plot of each gender). Thus, the negative selection finds the supporting evidence; non-teachers

who move into the teaching sector had lower pre-earnings than other non-teachers who remain in their career, so they are more likely to be lower aptitude people with lower-earnings ability.

If what we observe is a simple case of compensating differentials, every public school teacher should have the same chance to make better hourly earnings in exchange for less fringe benefits if they move into the non-teaching sector, and there is no reason to find the significant differences in the pre-earnings between the teachers who remain in the teaching sector and who move into the non-teaching sector. By the same argument, we should not observe the difference in the pre-earnings between non-teachers who stay in their careers and who move into the teaching sector. However, we do find a significant difference in the pre-earnings distribution between career-stayers and career-changers among public school teachers and non-teachers, which strongly suggests that career-changers and career-stayers belong to the different parts of the ability distribution of the relevant population in each occupational group.

The top 10 career picks for public school teachers who move into the non-teaching sectors are education administrators, managers, secretaries, librarians, counselors, preschool or kindergarten teachers, teacher assistants, coaches, postsecondary teachers, and registered nurses. Many non-teachers who have had these occupations also move into the teaching sector. However, among these new public school teachers who moved from non-teaching sectors, there are people who used to be in low-skilled jobs such as cashiers, janitors, building cleaners, dining room helper, cargo and freight agents, and movers. For these people, especially who move into the teaching career in the later stage of their career path, teachers'

earnings may look attractive even though teachers actually face a wage penalty in older and high-experience group.

Low teacher salaries attract young people with low quality into teacher preparation programs. Even though some high quality teachers with passion for teaching initially enter the teaching career, it is very likely that they leave the teaching profession before they can build up 10 years of experience. Public school teachers with low quality remain in the teaching sector, and non-teachers with low ability are moving into the teaching sector. Therefore, the average quality of public school teachers will decrease.

Next, I investigate union effects on teachers' earnings under different legal environments towards collective bargaining of teachers. Table 2.11 presents the results from model (10). In the High-CB group, on average, public school teachers earn less than non-teachers by 7.8%. The effect of unions on earnings of non-teaching occupations is 4.4%, and the effect of teachers unions on teachers' earnings is 12% (4.4%+7.5%). Since teachers who are members of teachers unions can earn 12% more than non-members, there is a strong incentive for public school teachers to join the unions. In the Low-CB group, public school teachers face insignificant wage penalty of 1.8%. The effect of unions on earnings of non-teaching occupations is about 3.8%, but teachers unions have a slightly positive effect of0 .06% (3.79% – 3.73%) on teachers' earnings. In the No-CB group, public school teachers make 2.3% less earnings than non-teachers, but this is not significant. The union effects on earnings of non-teaching occupations is about 4.5%, but teachers unions have almost negligible effect of -0.2 % (4.5% – 4.7%) on teachers' earnings. Without collective bargaining power, union membership status has no significant effect on teachers' hourly earnings.

Table 2.11: The Effect of Teachers Unions on Earnings by Group, CPS
College Graduates Only

Dependent variable: Log (hourly earnings)

VARIABLES	**High-CB group**	**Low-CB group**	**No-CB group**
Public school teacher	-.078***	-.018	-.0235
	(.0145)	(.0258)	(.0201)
Union membership	.0441***	.0379***	.0445***
	(.0057)	(.0056)	(.0121)
Public school teacher x Union	.075***	-.0373	-.0469**
	(.021)	(.0292)	(.0234)
Master's degree	.0881***	.078***	.0796***
	(.0034)	(.008)	(.007)
Male	.0551***	.0635***	.0819***
	(.0042)	(.0132)	(.0115)
Potential experience (Exp)	.0238***	.0242***	.0234***
	(.0009)	(.0024)	(.0016)
Exp^2	-.0004***	-.0005*	-.0004***
	(1.96e-05)	(5.98e-05)	(4.12e-05)
Exp x Male	.0078***	.0085***	.0066***
	(.0008)	(.0027)	(.0014)
Exp^2 x Male	-.0001***	-.0001**	-.0001**
	(2.11e-05)	(6.77e-05)	(3.95e-05)
Metropolitan	.142***	.0701***	.117***
	(.0125)	(.0203)	(.0252)
Black	-.1081***	-.0817***	-.1206***
	(.007)	(.0101)	(.0065)
Indian	-.0542***	-.1199	-.068*
	(.0198)	(.0772)	(.0405)
Asian	-.0060	-.0162	.0245*
	(.0108)	(.0188)	(.0144)
Other	-.0023	-.1410***	.0169
	(.0151)	(.0468)	(.0181)
Hispanic	-.0615***	-.0650***	-.0818***
	(.0051)	(.0206)	(.0101)
Constant	2.6302***	2.5284***	2.5185***
	(.0129)	(.0198)	(.0305)
Other control variables	YES	YES	YES
State FE	YES	YES	YES
Year FE	YES	YES	YES
Clustered SE	YES	YES	YES
Adjusted R^2	.308	.312	.304
N	291,775	39,860	52,791

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Other control variables: a dummy for family head, citizenship status, and private school teacher, categorical dummies for population size, marital status, worker class, broad industry and broad occupation. All regressions employ state FE and time FE and use persons' composited final weight.

As an attempt to reduce the omitted variable bias due to states' legal status towards collective bargaining in measuring union effects on teachers' earnings, I add states' collective bargaining coverage from the SASS (See Table 4). Table 2.12 shows the results estimated from model (10) with the addition of the variable for collective bargaining coverage.[19] In the High-CB group, states with 100% collective bargaining coverage pay their teachers 20% more than states with 0% collective bargaining coverage. The effect of collective bargaining on teachers' earnings is also significant but much smaller for the Low-CB group than for the High-CB group. In sum, collective bargaining coverage has a significantly positive effect, on teachers' earnings.

I also analyze the effect of teachers unions for each group within the teaching sector using CPS ORG. Table 2.13 summarizes the results from model (11). In the High-CB group, union membership has a significantly positive effect on teacher's earnings. The members of teachers unions earn the wage premium of 9.34% over non-members. In the Low-CB group and the No-CB group, union membership has no significant effect on teachers' earnings. The returns to master's degree and the returns to teaching experience are the lowest in the No-CB group. The returns to professional or doctorate degree of the No-CB group, however, are the largest. Less than 3% of public school teachers have these degrees, so the high returns to higher level of education works as if the average teachers without higher level of education are being penalized in the No-CB group. Male teachers in the No-CB group have a considerably large wage premium of 7.47% over female teachers. Approximately 80% of teachers are females in the No-CB group (See Table 2.2), which is the highest female fraction

[19] Since the collective bargaining measures use the average value of collective bargaining coverage of each state between 2003-2004 and 2007-2008 academic years, I cannot employ state fixed effect, which requires the variation within each state.

Table 2.12: The Effect of Teachers Unions on Earnings by Group, CPS & SASS
College Graduates Only

Dependent variable: Log (hourly earnings)

VARIABLES	**High-CB group**	**Low-CB group**	**No-CB group**
Public school teacher	-.0854***	-.0237	-.0268*
	(.0124)	(.0181)	(.0154)
Collective bargaining	.0022***	.0007***	n/a
	(.0001)	(9.2e-05)	n/a
Union membership	.0598***	.0406***	.0405***
	(.0043)	(.0116)	(.0132)
Public school teacher x Union	.0775***	-.0311	-.0439**
	(.0119)	(.0221)	(.0182)
Master's degree	.090***	.0789***	.0814***
	(.0028)	(.0064)	(.006)
Male	.0545***	.0620***	.0791***
	(.0067)	(.0171)	(.0134)
Potential experience (Exp)	.0240***	.0243***	.0234***
	(.0006)	(.0014)	(.0010)
Exp^2	-.0004***	-.0005*	-.0004***
	(1.96e-05)	(3.72e-05)	(2.25e-05)
Exp x Male	.0081***	.0086***	.0069***
	.0008	(.0019)	(.0015)
Exp^2 x Male	-.0001***	-.0001**	-.0001**
	(1.10e-05)	(4.67e-05)	(3.72e-05)
Metropolitan	.206***	.0651***	.121***
	(.0041)	(.0121)	(.0092)
Black	-.1076***	-.0792***	-.1200***
	(.0052)	(.0122)	(.0076)
Indian	-.0477***	-.1282**	-.0694**
	(.0151)	(.0617)	(.0273)
Asian	.0136**	-.0135	.0220
	(.0058)	(.0149)	(.0141)
Other	.006	-.137***	.0113
	(.009)	(0.0499)	(.0221)
Hispanic	-.0511***	-.0614***	-.0996***
	(.006)	(.0173)	(.0124)
Constant	2.327***	2.5011***	2.5784***
	(.0178)	(.0223)	(.0202)
Other control variables	YES	YES	YES
State FE	NO	NO	NO
Year FE	YES	YES	YES
Adjusted R^2	0.264	.301	.304
N	291,775	39,860	52,791

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Other control variables: a dummy for family head, citizenship status, and private school teacher, categorical dummies for population size, marital status, worker class, broad industry and broad occupation. All regressions use persons' composited final weight.

Table 2.13: The Effect of Teachers Unions on Teachers' Earnings by Group, CPS

College Graduates Only

Dependent variable: Log (hourly earnings of public school teachers)

VARIABLES	**High-CB group**	**Low-CB group**	**No-CB group**
Teachers unions membership	.0934***	-.0082	.0037
	(.0171)	(.02674)	(.0138)
Master's degree	.139 ***	.124***	.1196***
	(.0092)	(.0155)	(.0175)
Professional school or Doctorate degree	.1826***	.2336***	.2552***
	(.0217)	(.0442)	(.0263)
Male	-.0245	.0859	.0747**
	(.0217)	(.0615)	(.0338)
Potential experience (Exp)	.0231***	.0252***	.0163 ***
	(.0017)	(.0046)	(.002)
Exp^2	-.0004***	-.00044***	-.0002 ***
	(4.0e-05)	(.0008)	(.0000)
Exp x Male	.007***	.0029	.0001
	(.002)	(5.8e-05)	(.004)
Exp^2 x Male	-.0001**	-.00002	-3.74e-06
	(5.1e-05)	(.0001)	(.0001)
Metropolitan	.1062***	.0795**	.0807***
	(.0135)	(.0306)	(.0253)
Black	-.0556*	.0281	.0007
	(.0331)	(.0354)	(.0108)
Indian	.0432	-.1676	.0954
	(.0581)	(.1385)	(.1650)
Asian	.0007	-.0016	.0043
	(.0527)	(.0995)	(.0425)
Other	-.0032	-.6203	.1836*
	(.0278)	(.5572)	(.1042)
Hispanic	.0162**	.0006	.0479***
	(.0067)	(.0758)	(.0112)
Constant	2.604***	2.366***	2.489***
	(.0319)	(.0355)	(.0273)
State FE	YES	YES	YES
Year FE	YES	YES	YES
Adjusted R^2	0.217	0.195	0.182
N	22,329	3,854	4,959

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Other control variables: a dummy for family head and citizenship status, categorical dummies for population size and marital status. All regressions employ state FE and time FE. All regressions use persons' composited final weight.

among all three groups. Therefore, the average female public school teachers seem to face the worst salary schedule in the No-CB group than in other groups.

Next, I explore the earning dynamics of career-stayers and career-changers in the teaching sector by group of states. Table 2.14 presents the summary from model (9) by group. The High-CB group shows a very different pattern from the other two groups. The first panel of Table 2.14 shows the results for all-ages group. For the High-CB group, moving to other teaching positions is the best option for public school teachers as it can bring the largest increase in earnings (6.11%). Leaving for the non-teaching sectors provides higher wage increase (3.87%) than staying in current teaching positions at public schools (3.6%), but the difference is small. Non-teachers in the High-CB group are better off staying in their careers (4.05%). In the Low-CB and No-CB group, however, public school teachers are much better off staying in their current teaching position, and on average moving into the non-teaching sectors is the least attractive option for public school teachers. Non-teachers in these two groups find it very appealing to move into the public school teaching sector as they increase their earnings considerably by doing so.

The analysis of specific age group is presented in the subsequent panels of Table 2.14. In the High-CB group, public school teachers in their 20s through 40s who move into the non-teaching sectors have a large increase in their earnings. Non-teachers in their 40s who move into the public school teaching sector can receive higher earnings than they can by staying in their current occupations. Non-teachers who are in their 50s and above are better off staying in their current non-teaching career paths. In the Low-CB and the No-CB group, in most age groups, it is more advantageous for public school teachers to stay in the teaching sector, with

Table 2.14: The Changes in Earnings after Career Change by Group

College Graduates Only

Dependent Variable: Δ=Log (After hourly earnings) – Log (Before hourly earnings)

	High-CB group		Low-CB group		No-CB group	
	N	**Δ**	**N**	**Δ**	**N**	**Δ**
All ages						
All Career changers	22910	.0401	3059	.0358	4234	.0216
Public school teacher to other public school teacher	696	.0611	126	.0582	148	.0215
Public school teacher to non- teacher	311	.0387	53	.0454	73	.0146
Private school teacher to public school teacher	51	.0066	7	.0976	12	-.2319
Private school teacher to non- teacher	109	.0869	17	-.0629	20	-.1514
Non-teacher to other non-teacher	21153	.0396	2784	.0347	3838	.0207
Non-teacher to public school teacher	302	.0394	48	.0738	104	.1161
Non-teacher to private school teacher	141	.0237	9	-.0122	23	-.0151
All stayers	29756	.0403	4261	.0440	5057	.0465
Stay teaching at public school	3105	.0360	547	.0758	677	.0847
Stay teaching at private school	628	.0552	79	.0551	110	-.0034
Stay in non-teaching	26023	.0405	3635	.0389	4270	.0417
< 30 years old						
All Career changers	3163	.0877	425	.0903	539	.0519
Public school teacher to other public school teacher	81	.3101	14	.2040	18	-.0093
Public school teacher to non- teacher	44	.0898	6	.1373	7	-.0114
Private school teacher to public school teacher	2	.3442	0		1	.0332
Private school teacher to non- teacher	15	-.0022	1	-.141	5	-.2096
Non-teacher to other non-teacher	2931	.0804	395	.0918	480	.0548
Non-teacher to public school teacher	42	.1816	5	-.3290	20	.0399
Non-teacher to private school teacher	30	.0832	2	.0041	6	.2161
All stayers	3378	.0832	446	.0671	616	.0495
Stay teaching at public school	353	.0248	59	.1472	92	.0355
Stay teaching at private school	92	.0248	9	-.0074	14	.0870
Stay in non-teaching	2933	.0728	378	.0579	510	.0510
30 - 39 years old						
All Career changers	6185	.0520	875	.0457	1193	-.0015
Public school teacher to other public school teacher	165	.0298	29	.0631	45	.0099
Public school teacher to non- teacher	88	.1453	14	-.0851	25	.0492
Private school teacher to public school teacher	16	.1150	1	-.1397	3	-.0265
Private school teacher to non- teacher	23	.2665	10	-.0669	6	-.3748
Non-teacher to other non-teacher	5758	.0508	799	.0502	1090	-.0018
Non-teacher to public school teacher	68	.0135	15	.0567	19	.0990
Non-teacher to private school teacher	30	-.0598	4	.053	3	-.0999
All stayers	7809	.0512	1183	.0477	1443	.0701

Table 2.14: The Changes in Earnings after Career Change by Group (Cont.)

Stay teaching at public school	722	.0456	148	.0653	173	.1374
Stay teaching at private school	164	.0940	19	-.0130	28	.0433
Stay in non-teaching	6923	.0507	1016	.0462	1242	.0613
40 - 49 years old						
All Career changers	6973	.0307	859	.0313	1311	.0309
Public school teacher to other public school teacher	204	-.0024	34	.0370	47	.0859
Public school teacher to non- teacher	72	.0717	20	.0063	21	-.0135
Private school teacher to public school teacher	15	.0676	3	.1632	2	-.2572
Private school teacher to non- teacher	30	-.0645	2	.0425	2	.7612
Non-teacher to other non-teacher	6496	.0316	784	.0305	1193	.0268
Non-teacher to public school teacher	81	.0908	11	.1224	33	.1194
Non-teacher to private school teacher	41	-.0477	1	.0274	8	-.1523
All stayers	8986	-.0477	1262	.0372	1507	.0454
Stay teaching at public school	858	.0252	164	.1116	192	.0847
Stay teaching at private school	166	.0181	24	.1450	33	.0315
Stay in non-teaching	7962	.0345	1074	.0234	1282	.0399
50 - 59 years old						
All Career changers	5335	.0202	736	.0034	949	.0162
Public school teacher to other public school teacher	215	.0497	42	.0599	31	.0351
Public school teacher to non- teacher	89	-.0741	11	.1739	16	.0459
Private school teacher to public school teacher	12	-.0904	3	.1112	4	.0238
Private school teacher to non- teacher	29	.2851	3	-.2403	6	-.2090
Non-teacher to other non-teacher	4820	.0201	659	-.0061	860	.0089
Non-teacher to public school teacher	91	-.0190	13	.1687	22	.2958
Non-teacher to private school teacher	27	.1027	1	.2242	4	.0530
All stayers	7651	.0306	1113	.0383	1211	.0193
Stay teaching at public school	1014	.0558	156	.0448	186	.0413
Stay teaching at private school	174	.0772	24	.0211	24	-.1232
Stay in non-teaching	6463	.0256	933	.0377	1001	.0186
> 60 years old						
All Career changers	1254	-.0014	164	.0104	242	.0393
Public school teacher to other public school teacher	31	.0743	7	.0192	7	-.1881
Public school teacher to non- teacher	18	-.1803	2	.2525	4	-.0931
Private school teacher to public school teacher	6	-.3534	0		2	-1.159
Private school teacher to non- teacher	12	-.2457	1	.0952	1	0
Non-teacher to other non-teacher	1148	.0051	147	.0041	215	.0718
Non-teacher to public school teacher	20	-.1253	4	.2448	10	-.0888
Non-teacher to private school teacher	13	.1404	1	-.5849	2	-.1698
All stayers	1932	.0190	257	.0446	280	.0421
Stay teaching at public school	158	-.0508	20	-.0794	34	.1869
Stay teaching at private school	32	-.1137	3	.2270	11	-.0823
Stay in non-teaching	1742	.0278	234	.0529	235	.0270

the exception of teachers of their 50s. Regardless of age groups, in these groups, non-teachers find it more attractive to move into the teaching sector.

Table 2.15 provides the summary statistics for pre-earnings for teachers and for non-teachers by group. The first panel is for public school teachers, and the second panel is for non-teachers. In all three groups, the pre-earnings of male public school teachers who stay in current teaching positions are lower than the pre-earnings of male public school teachers who move into the non-teaching sectors. Thus, the positive selection occurs when public school teachers move into the non-teaching sectors; public school teachers who had higher earnings ability move into the non-teaching sectors, which have more dispersed income distribution. On the other hand, non-teachers who move into the teaching sector have the lowest pre-earnings in all three groups. Since public school teachers face a wage penalty on average, the fact that the non-teachers with the lowest pre-earnings still move into the teaching sector suggests that the negative selection occurs in this case; non-teachers with lower earnings ability are more likely to move into the teaching sector, which has narrower income distribution. Through the processes of positive and negative selection, the average qualities of public school teachers in all three groups fall.

The difference of the pre-earnings of teachers between career-stayers and career-changers are more apparent in the Low-CB and the No-CB group than in the High-CB group. In the No-CB group, the pre-earnings of male teachers who move into the non-teaching sectors ($24.49) is larger than those of male teachers who stay in their careers ($20.08) by more than $4, and the difference is statistically significant at the 1% level. Recall that public school teachers obtained larger increase in their earnings when they stayed in current teaching positions in the No-CB group (See Table 2.14). Therefore, teachers leaving the teaching

profession in the No-CB group are more likely to be higher aptitude teachers who are unsatisfied with their earnings, which are still higher on average than the earnings of career-stayers in the teaching sector. Meanwhile, in the High-CB group, the pre-earnings of male teachers who move into the non-teaching sectors ($25.34) is not significantly different from the pre-earnings of male teachers who stay in their careers ($24.17).

Table 2.15: Pre-Earnings for Teachers and Non-Teachers by Group

College Graduates Only

Dependent Variable: Hourly earnings ($)

Career Path	High-CB		Low-CB		No-CB	
	Male	Female	Male	Female	Male	Female
Panel 1: Public School Teachers						
Stay teaching at public school	24.27	23.09	22.03	18.35	20.08	19.31
Change to other public school teacher	24.67	24.27	20.15	20.62	24.11	20.97
Change to non-teaching career	**25.34**	23.93	**23.38**	18.48	**24.49**	21.90
Panel 2: Non-Teachers						
Stay in non-teaching career	30.71	25.42	29.10	23.01	30.42	24.14
Change to other non-teaching career	30.22	24.22	27.78	22.06	30.33	23.43
Change to public school teacher	**25.46**	24.01	**19.75**	19.69	**19.79**	19.10

Source: CPS MORG, 2001-2010

Figure 2.3.A and 2.3.B illustrate the positive selection of the career change from public school teachers to non-teachers for the High-CB group (Group 1) and for the No-CB group (Group 3), respectively. In both groups, the median of pre-earnings of teachers moving into the non-teaching sectors (the third box plot) is higher than that of teachers staying in the teaching sector (the first box plot), but the difference of the median is more

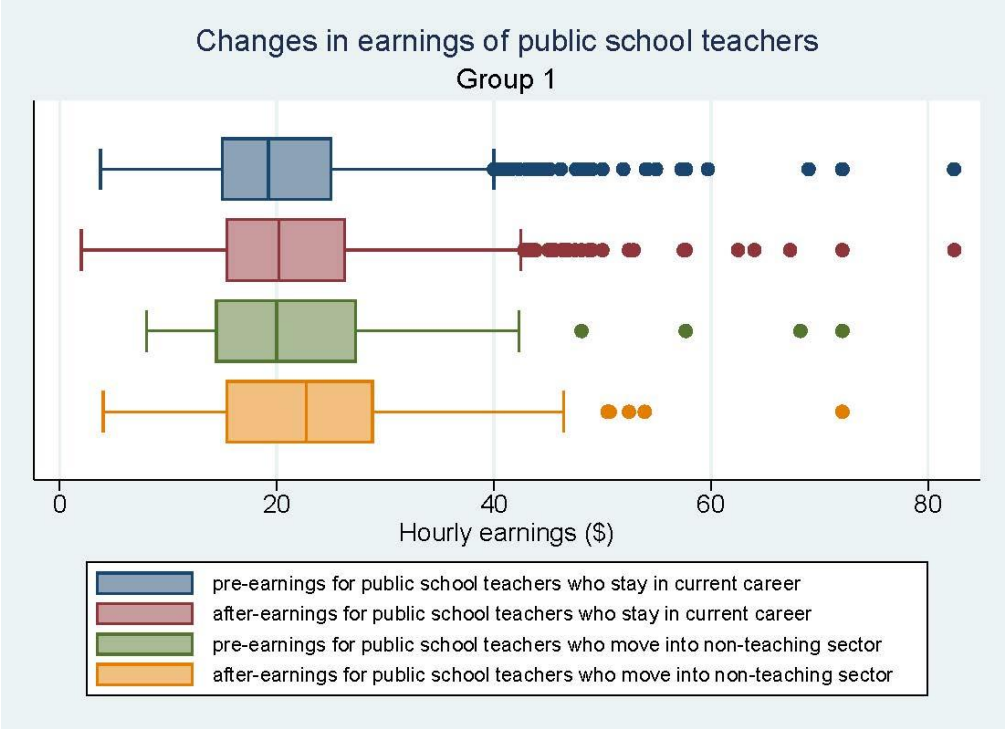

Figure 2.3.A: Changes in Earnings for Public School Teachers in the High-CB Group

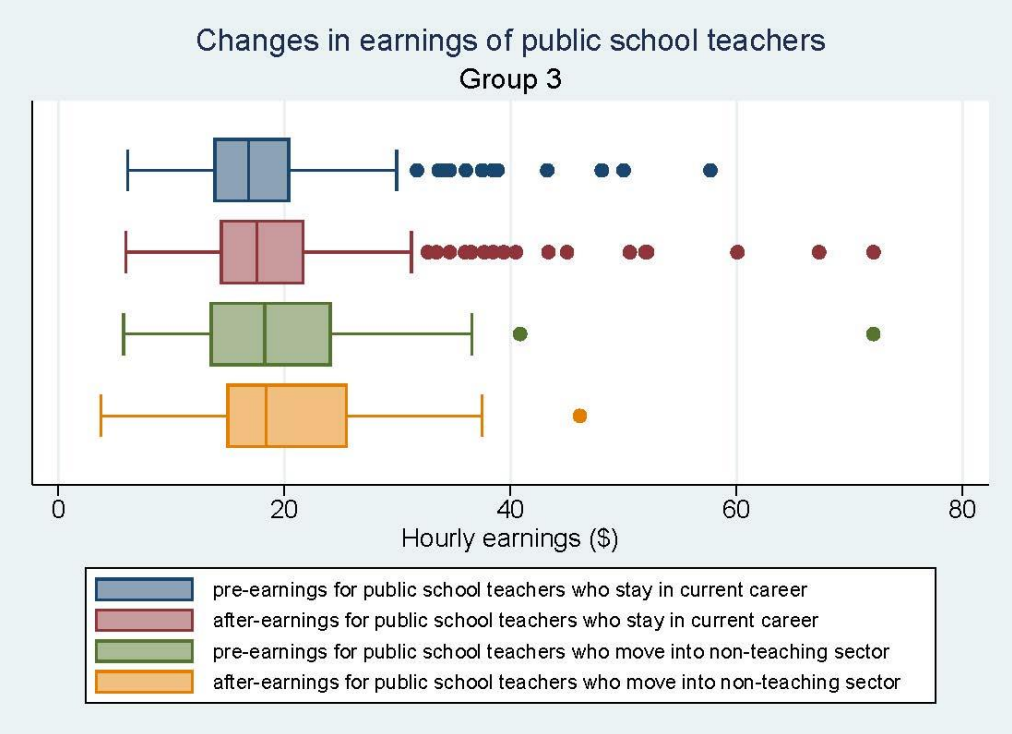

Figure 2.3.B: Changes in Earnings for Public School Teachers in the No-CB Group

conspicuous in the No-CB group than in High-CB group. The box of the pre-earning distribution for career-changing teachers (the third box plot) is also more to the right of the box of the pre-earning distribution for career-staying teachers (the first box plot) in the No-CB group than in the High-CB group. This suggests that the average quality of the public school teachers who leave the teaching profession in the No-CB group might be higher than the one in the High-CB group. The difference of pre-earnings of non-teachers between career changers and career stayers are also larger in the Low-CB and the No-CB group than the one in the High-CB group. In the No-CB group, male non-teachers who move into the teaching sector have pre-earnings ($19.79) which is lower than the pre-earnings of male non-teachers who stay in their careers ($30.42) by more than $10. For the High-CB group, there is a smaller difference ($5) in the pre-earnings between male non-teachers who stay in current careers ($30.71) and who move to the teaching sector ($25.46). The difference between the pre-earnings of career changers and of career stayers in both the High-CB and the No-CB group are statistically significant at the 1% of significance level. Since the variance in earnings is larger for the High-CB group (See Table 2.10), the larger difference of pre-earnings between career-changers and career-stayers in the Low-CB and the No-CB group suggests that there may be a greater distributional change in worker quality after the career changes in the Low-CB and the No-CB group.

Figure 2.4.A and 2.4.B portray these distributional differences for non-teachers for the High-CB group (Group 1) and the No-CB group (Group 3), respectively. For both groups, the non-teachers who move into the teaching sector (the third box plot) have lower median than the non-teachers who stay in their occupations (the first box plot), but the difference is much larger in the No-CB group than in the High-CB group. In the No-CB

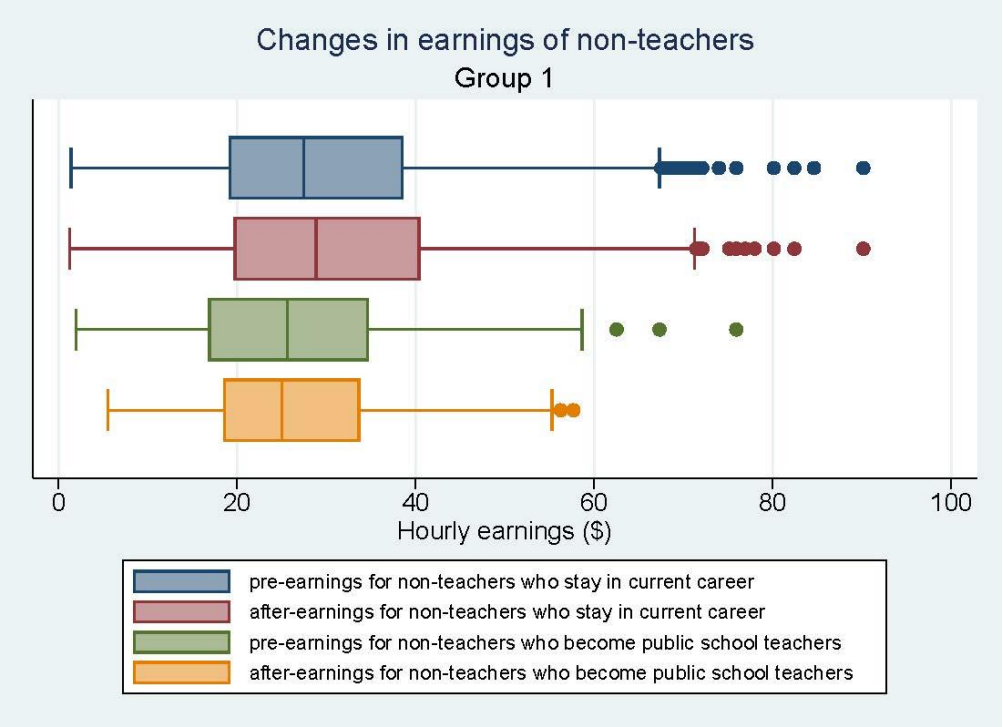

Figure 2.4.A: Changes in Earnings for Non-Teachers in the High-CB Group

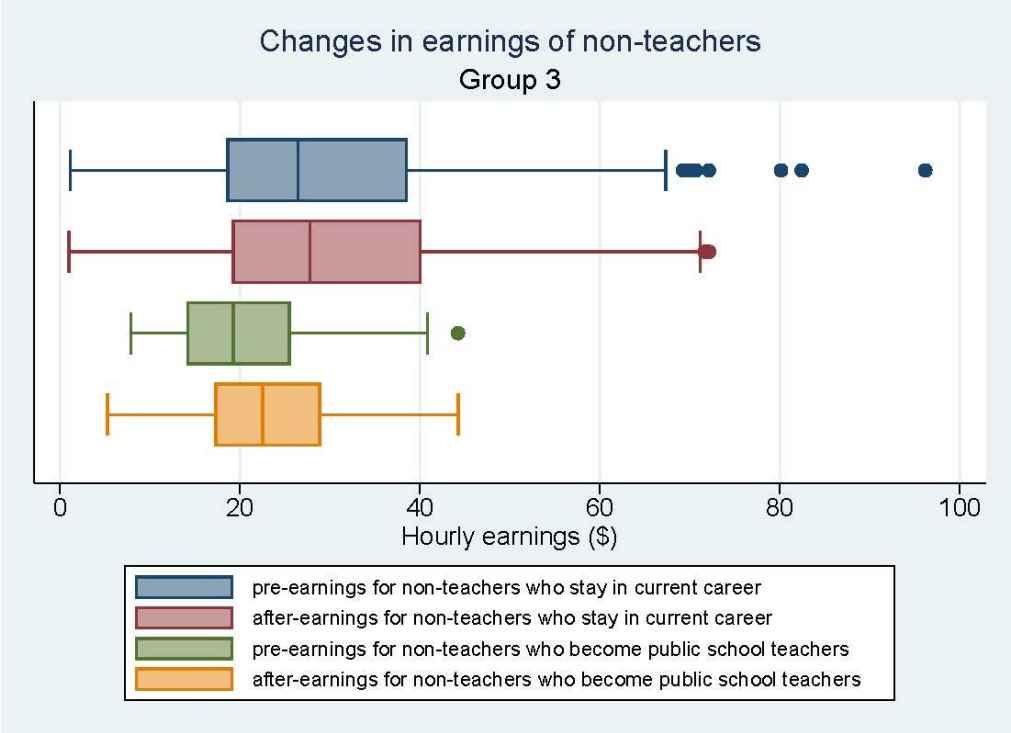

Figure 2.4.B: Changes in Earnings for Non-Teachers in the No-CB Group

group, therefore, the average quality of public school teachers might be even lower than the one in the High-CB group because more teachers with higher quality tend to leave the teaching profession and more non-teachers with lower quality tend to join the teaching force.

In sum, in all three groups, positive selection and negative selection occur through the career changing process in a way that the average teacher quality decreases. The magnitude of the positive and the negative selection is the strongest in the No-CB group. Only in the High-CB group, which has collective bargaining laws for teachers, teachers unions effectively increase teachers' earnings. There also exist more favorable teacher salary schedule such as higher returns to experience and higher returns to master's degree (See Table 2.12 and Table 2.13) in the High-CB group than in the other two groups. Hence, the High-CB group provides more incentives for high quality teacher to remain in the teaching sector even though many high quality teachers still move into the non-teaching sectors for better earning opportunities. As a result, the average teacher quality will be higher in the High-CB group than in the Low-CB and the No-CB group.

2.7 Conclusion

This paper examines the relation between teachers' earnings and teacher quality. Using the CPS and CPS Supplements for Occupation Mobility and Job Tenure between 2001 and 2010, I show that US public school teachers are paid less compared to other comparable college graduates working in the non-teaching sectors. Applying the Roy model, I find that public school teachers with high aptitude tend to leave the teaching professions in the early stage of their careers as they find it more advantageous to move into the non-teaching sectors,

which is the case of positive selection. Also, I find that non-teachers with low aptitude are more likely to move into the teaching sector, which shows the pattern of negative selection. Through the positive and negative selection processes, the average quality of public school teachers falls.

I discuss the different legal environments towards collective bargaining, and show that teachers still unionize in states that do not allow collective bargaining of teachers. It seems vital to understand the roles of teachers unions with and without bargaining power because the effects of teachers unions in different legal environments towards collective bargaining substantially differ. Teachers unions can undo some of the teachers' wage penalty by successfully raising teachers' earnings, returns to education, and returns to experience, but their effects are significant only in states with collective bargaining laws. In states that do not have collective bargaining laws and prohibit collective bargaining of teachers unions, unions have insignificant effects on teachers' earnings, and teachers face less favorable compensation scheme than non-teachers. In those states, the impacts of the positive selection and the negative selection on the ability distribution are stronger, so the average quality of public school teachers may decrease faster than in states with collective bargaining laws.

My study only focused on the hourly wage of workers due to the data limitation. Unions may affect working conditions and benefits of employees, and the legal environment toward collective bargaining of each state will surely play important roles for them to establish certain aspect of employer-employee relationship. Therefore, more research is needed to fully understand what unions can do beyond influencing salaries under different legal settings towards collective bargaining.

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Chapter 3: The Impact of Teachers Unions on Teachers' Well-being under Different Legal Environments: Evidence from Districts and Teachers Matched Data

This paper examines how teachers unions affect teachers' economic conditions using an employer-employee matched dataset based on the School and Staffing Survey and School Districts Finance Survey for 2007-2008. I employ a multilevel (hierarchical) model and propensity score matching to identify union effects in states with different legal environments for collective bargaining of public school teachers. Three major findings emerge from my empirical analysis. First, collective bargaining is neither necessary nor sufficient for teachers unions to affect teachers' work lives. About half of the teachers join unions even in the states that outlaw collective bargaining. Also, in the absence of any written agreements, teachers gain from unions via meet-and-confer agreements or higher union density. Second, the effects of teachers unions are multi-dimensional. Teachers unions improve teachers' working condition and/or non-wage benefits as well as teachers' salaries. Third, teachers unions affect working conditions and non-wage benefits in a way that trades off with teacher salaries, as expected from a compensating differential analysis.

Key words: employer-employee matched data, collective bargaining, meet-and-confer, agency fees, multilevel (hierarchical) linear model, propensity score matching, working conditions, non-wage benefits.

3.1 Introduction

Over half of union workers in the U.S. work in the public sector. Public school teachers make up the single largest group of unionized public sector workers. In 2010, governments employed approximately 3.2 million public school teachers, of whom about 70% reported that they were union members. The majority of union members belong to the National Education Association, about 25% of members to the American Federation of Teachers, and the rest to small local groups.

In the 2000s, there was a considerable public controversy over the effect that teachers unions had on the compensation of teachers and the operation of an educational system. Many blamed unions for raising pays far above what teachers might have earned in other jobs and for creating an inflexible and inefficient educational system. Some politicians and policy makers blamed public sector unions, including teachers unions, for state or municipal financial problems or as a barrier to resolving those problems. Defenders of unions rebutted these charges. Recently, the decisions by legislatures in Wisconsin and Ohio to restrict collective bargaining and the movement to overturn those decisions attained national attention.

How large an effect, if any, do teachers unions have on the compensation and work conditions of teachers? By what mechanisms do teachers unions affect the economic status of school districts? To answer these questions, I have combined two surveys from Department of Education, the School and Staffing Survey (SASS) and School Districts Finance Survey (SDFS) for 2007-2008, to create a district-teacher matched dataset. This data provides a

unique picture of the relation between teachers unions, teacher pays/working conditions, and the financial status of school districts.

The legal environment of a state towards teachers unions certainly influences the strength of unionization of public school teachers. This study estimates union-nonunion differentials, the union effect, across states with widely varying legal environments for unions, ranging from those that prohibit collective bargaining (e.g. Texas or Virginia) to those that encourage collective bargaining (e.g. New York or Massachusetts). Unlike previous studies on the union effects, which tend to focus on a single measure of unionization, I conduct a comprehensive analysis on union effects using various measures of unionization at different levels. The variations I use to identify the union effects are the contractual status between school districts and the unions, union density of school districts, and union membership of public school teachers.

The datasets I use are observational rather than experimental, which makes it difficult to reach conclusions about causation. I mitigate this problem by using two approaches. First, I contrast my outcomes of interests across legal environments, which were largely determined by the states' legislation that was set several decades ago. Since the legislation has not changed much over time, the legal environment is fairly exogenous variation source for teacher unionization. Second, I compare the union/non-union differentials within the similar legal environment using multilevel (hierarchical) linear models and propensity score matching to minimize the omitted variable bias and/or selection bias involving unionization.

My analysis reveals that some widely held views about teacher unionization, public sector unionization more broadly, are more myth than reality. Many people believe that few workers will join unions if a state bans collective bargaining and that collective bargaining is

the sole source of power for unions. However, my data show that in the states that ban collective bargaining of teachers, about half of the teachers still join teachers unions. Moreover, even in those states, unions are correlated with teacher salaries or work conditions. A substantial number of school districts have legally unenforceable agreements with the unions, called "meet-and-confer agreements," which also affect the teacher compensations. I find that the meet-and-confer is the main form of agreement in states that do not allow collective bargaining of public school teachers, but it is also found in states where collective bargaining is permissible.

I also find that the union effects vary among the outcomes of interests depending on states' legal environments towards teachers unions. In some legal environments, the data shows larger union-nonunion differentials in working condition, measured by the number of contract days, than in base salaries of teachers. In other legal environments, districts' union density rather than contractual status appears to affect outcomes. In addition, I find that there exist trade-offs between base salaries and working condition and between base salaries and non-wage benefits. Teachers in the legal settings encouraging collective bargaining face more favorable trade-offs than teachers in the legal settings that are against collective bargaining.

This paper is organized as follows. Section two provides the review of previous literature on unions and my research contribution. Section three describes the different legal settings in which teachers unions operate across states and school districts. Section four presents the data sources and explains how I have created the master dataset for the study. Section five lays out the empirical strategies and econometric models that guide my analysis. Section six presents the empirical results. In section seven, I conclude with a brief summary of findings.

3.2 Literature on the Effects of Teachers Unions

Most studies have found that teachers unions played important roles in raising teacher salaries. Reviews of the literature in the 1980s by Lipsky (1982), Freeman (1986), and Ehrenberg and Schwarz (1986) showed that teachers unions were associated with higher salaries, but that the union wage differential was smaller among the workers in the public sector than in the private sector in general. Baugh and Stone (1982) and Freeman and Valletta (1988) found a union/non-union gap on teacher salaries to be 12-22 percent using Current Population Survey (CPS) data. Gyourko and Tracy (1991) estimated unions' wage effects of about 10 percent in the absence of the controls for individual teacher characteristics. Belman, Heywood, and Lund (1997) reported similar estimates using CPS outgoing rotation file for 1991.

Other studies have looked at the prevalence of teachers unions across the states with different legal environment (for instance, whether a state allows collective bargaining or not) or across school districts with diverse contractual status (for instance, whether a school district has a collective bargaining agreement with teachers union). Hoxby (1996) estimated the union effects on teacher salaries to be about 5 percent using panel data on school districts. Zwerling and Thomason (1995) estimated that a 10-percentage-point increase in states' union density raised the highest teacher salaries by 2.6 percent and the lowest teacher salaries by 0.2 percent. Using a district level dataset, Lemke (2004) estimated the union premium to be 7.6 percent for public school teachers in rural areas of Pennsylvania. Using the CPS from 2000 to 2009 and the School and Staffing Survey (SASS) for 1999-2000 district level data, Hirsch et

al. (2011) estimated the effect of union coverage to be as little as 1 percent to as high as 20 percent.

Studies of private sector unionism invariably have found that unions had larger effects on working conditions or non-wage benefits than on salaries or wages (Freeman and Medoff, 1984; Budd, 2007; Hirsch et al., 1997). The analyses of teachers unions found the similar results. Delaney (1985) found that school districts with collective bargaining agreements had larger "fringe benefit index" compared to school districts without collective bargaining in Illinois. Eberts and Stone (1984) showed that bargaining had a larger effect on non-wage benefits than on wages using the public school data in New York. Podgursky (2003) argued that teachers unions effectively increased fringe benefits, measured by the pension contributions, for their members in Chicago public schools. Fringe benefits and working conditions must be studied in terms of compensating differentials with salaries, as they are also a part of the compensation package for teachers. The evidence on compensating differentials has been mixed. Delaney (1988) found that unions achieved gains in both wages and non-wage benefits while Eberts and Stone (1985) found the evidence for trade-offs between teacher salaries and fringe benefits/working conditions.

My research builds on these previous studies on teachers unions and makes several important contributions. First, I utilize a district-teacher matched dataset, which make it possible for me to incorporate the influence of the financial status of school districts on outcomes of my interests. Second, my data allows me to conduct a more complete analysis on teachers unions using various measures of unionism at different levels such as legal environments of states, contractual status and union density of school districts and union membership of teachers. Third, I investigate the role of unions beyond collective bargaining

and identify the mechanism through which the unions affect the outcomes of interests in the absence of the bargaining agreement. Especially, my study provides the point estimate of the effect of meet-and-confer on outcomes of interest, which makes it a unique finding in literature. Fourth, I attempt to solve the endogeneity problem of unionization by employing multilevel (hierarchical) linear models and propensity score matching within the same legal environment towards teachers unions.

3.3 Legal Environments and Contractual Status for Teachers Unions

Until the recent efforts to constrain or eliminate collective bargaining rights of teachers in Midwestern states, the legal settings for unionization have not changed much over the past 30 to 40 years. For the period covered by my analysis, collective bargaining laws covering teachers represent fixed legal environments. For instance, a state that allowed collective bargaining of teachers three decades ago still allow it in 2007. Contractual status of school districts is also quite static, so districts that have collective bargaining agreements with teachers unions in 2007 are likely to have had such agreements in 1970s and 1980s.[20] Thus, these legal backgrounds regarding collective bargaining provide fairly exogenous variation for unionism.

Following Moe (2011), I define the legal environment towards teachers unions based on the strength of legal framework regarding teachers unions; whether a state allows collective bargaining for teachers unions and whether it allows agency fees so that teachers

[20] "Teacher Monopoly, Bargaining, and Compulsory Unionism, and Deduction Revocation Table" by National Right to Work Foundation, 2010.

who do not join the union also pay for the collective bargaining services.[21] I use this definition to classify 50 states into four groups.[22] Table 3.2 presents the classification in detail. The first group, which I call High-CB group, is composed of 23 states that have collective bargaining laws and that allow the unions and school districts to negotiate mandatory agency fees for non-union members. The second group, Med-CB states, has collective bargaining laws but prohibit mandatory agency fees. There are 11 states in this group, and they are located in the Midwest and South. The third group, Low-CB states, allows local school districts to sign collective bargaining agreements but do not require them to bargain with the union. The local union must be strong enough to convince its school district to bargain and sign an agreement, and 9 states fit into this group. The fourth group, No-CB states, bans collective bargaining of teachers unions, and there are 7 states in this group. All states but one, Arizona, are located in the South. [23]

There exist three contractual statuses between teachers unions and school districts, collective bargaining, meet-and-confer, and no agreement. All unions and school districts, except the unions in No-CB group, can sign collective bargaining agreements. These agreements determine teacher pay and conditions of work environment, and they are legally binding. In High-CB and Mid-CB group, the law mandates that school districts bargain with a union that gains recognition as the bargaining agent, but the law does not require that the two sides reach an agreement. In some cases, the two sides do not come to the resolution to sign

[21] The law also requires that the union represent those workers, for instance with grievance procedures.
[22] The information on collective bargaining laws and agency fees is from "Teacher Monopoly, Bargaining, and Compulsory Unionism, and Deduction Revocation Table", National Right to Work Foundation (2010). For reference, I also use Table 2-2, pp.54-55, Moe (2011).
[23] According to Federal Election Commission (http://www.fec.gov/pubrec/electionresults.shtml), most of High-CB states are "blue states" according to the average margins of victory in the last five presidential elections between 1992 and 2008. Eight out of eleven states in Med-CB group are "red states." Low-CB group consists of both "red states" in the South and "purple states" whose voting pattern is mixed in national elections. All states in No-CB group are "red states."

the bargaining contracts. When the negotiation between the two fails to reach an agreement, a legal bargaining impasse occurs. Then, both sides have several options: seeking help from mediators, fact finders, or arbitrators. In some states, arbitration is mandatory, often as an alternative to the right to strike. When all the efforts for the resolution to impasse fail, teachers may choose to strike, as we saw in Chicago very recently.[24]

In all states, districts and unions can choose to take a different path. They can have meet-and-confer agreements, in which they exchange information, opinions, and proposals to reach a resolution on matters within the scope of representation prior to the adoption by the districts of its final budget for the ensuing year. Unlike the collective bargaining agreements that produce legally binding contracts, the outcomes of meet-and-confer agreements are not legally enforceable. In some school districts, even in High-CB and Med-CB group with collective bargaining laws, unions do not have any agreement with their districts.

Regardless of states' legal environment or districts' contractual status, teachers unions can engage in activities using their political power. The union activities include lobbying school districts to grant teachers higher wages or better non-wage benefits and helping elect members of the school board that are favorably inclined to the unions' demands. Thus, union density of school districts and union membership of individual teachers provide additional mechanism through which unions can affect work lives of teachers and economic status of school districts.

[24] In many states such as Alaska, California, Colorado, Hawaii, Illinois, Louisiana, Minesota, Montana, Ohio, Oregon, Pennsylvania, Vermont, and Wisconsin, public school teachers have the right to strike. These states usually limit this right under the respective labor laws. Where teachers do not have the right to strike, state laws often impose monetary or similar penalties on those who strike illegally. In Indiana, Massachusetts, Michigan, and Washington, strikes by public employees are prohibited but have occurred during 2000-2007.

As noted in section 3.2, some earlier work has related outcomes to school districts' union density or to teachers union membership. However, if a study does not consider states' legal environments towards collective bargaining, the estimated effect of union density may misconstrue the density with states' overall perspective towards collective bargaining. The legal environment of a state almost certainly affects the contractual status of school districts within the state and the attractiveness of unions to teachers. Thus, it influences union density and the ability of unions to deliver benefits to their members. My study examine the interplay of the legal environment, the contractual status, and the union density to conduct a more elaborate analysis for assessing what unions do in the educational sector and in the public sector more broadly, than the standard analysis of unions in the private sector.[25]

Studies that simply include a dummy variable to indicate if a state allows collective bargaining or not would fail to take into account the variation in collective bargaining coverage (i.e. union density) of districts within the state. My study goes beyond the previous analyses of public sector unionism as it utilizes a wide array of indicators of union strength in affecting the outcomes of interests; the four legal environment groups (High-CB, Med-CB, Low-CB, and No-CB group), three contractual status (collective bargaining, meet-and-confer, and no agreement), different levels of union density of school districts, and union membership of individual teachers. The various measures of unionization also allow me to assess the relationship between union density/membership with outcomes of interests across and within different legal environments and different contractual status that surpass previous analyses of the effect of union density/membership in studies of private sector unionism (Freeman and Medoff, 1984; DiNardo and Lee, 2004).

[25] In the private sector, unionism is co-terminus with collective bargaining, and a single labor law, the 1936 National Labor Relations Act (amended several times), regulates the labor relations throughout the country.

3.4 The District-Teacher Matched Data

I use data from the 2007-2008 Schools and Staffing Survey (SASS) administered by National Center for Education Statistics (NCES).[26] The SASS provides information on teachers' pay, benefits, and working conditions as well as districts' contractual status and teachers' union membership.[27] I also examine the 2003-2004 wave of the SASS. Since there was little change in a school district having a collective bargaining agreement between 2003 and 2007, I use the 2003 data for a sensitivity analysis on my 2007 results rather than pooling it with the 2007 data to exploit changes over time in panel data.[28]

I focus on public schools, excluding the small number of charter schools. I use three questionnaires from the SASS: the School, the Teacher, and the School District Questionnaires. The Teacher Questionnaire asks if a respondent is a member of teachers unions (or association similar to unions), so I compute the union density by district and use it as an additional measure for teacher unionization. The School District Questionnaire asks about the contractual status between districts and teachers unions (i.e. if a school district has collective bargaining agreement, meet-and-confer agreement, or no agreement at all with the unions).

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[26] The SASS uses a stratified probability sample design to make sure that the samples have sufficient numbers for reliable estimates. Once the schools are stratified and sampled, teachers within the schools are also stratified and sampled based on their characteristics.

[27] Many studies use the Current Population Survey (CPS) Merged Outgoing Rotation Group to analyze the effect of teachers unions on salaries but such analyses face a major problem due to the way the CPS asks workers about collective bargaining status. The CPS asks whether the person is covered by collective bargaining only if a person is not a union member. Thus, when researchers calculate the collective bargaining coverage from CPS, they implicitly assume that all the union members are covered by collective bargaining. This works well for the private sector but distorts the reality in the public sector (See Han, January 2012).

[28] The 2007-08 SASS also obtained data not available in the 2003-2004 survey on topics such as teacher dismissals, Adequate Yearly Progress, teacher quality, length of school days for students, and class organization.

I combine the information on teachers, schools, and districts to form a multilevel dataset. Thus, teachers are grouped within their schools, and the schools are grouped within their districts. In this multilevel dataset, 38,240 teachers are nested in 7,570 schools, and those schools are nested within 4,600 districts. The multilevel dataset allows me to utilize three different measures of teachers unionization; union membership status of teachers, contractual status and union density of school districts. The dataset covers about a third of the U.S. public school districts.

The *School Districts Finance Survey* (SDFS) from Education Finance Statistics Center (EDFIN) of NCES has detailed annual fiscal data on public elementary and secondary education for every school district in the U.S. I merge information from the SDFS with the multilevel dataset from the SASS to create an employer-employee (district-teacher) matched dataset that allows me to examine the union/non-union differentials among employers with similar financial status that was impossible to do in other dataset, which lack any employer identifying information.[29] To the extent that employment and compensation of employees depend on the economic situation of the public sector employers, it is critical to consider the financial status of the local school districts in the analysis of the union effects. The districts' financial data is also useful to examine the claim that public sector unions adversely affect local governments' budgetary balance.

Finally, some of the debates over the effects of teachers unions on pay and benefits have compared earnings of public school teachers with those of other college graduates (Hirsch et al, 2011; Han, 2012). For such comparisons, I use the Comparable Wage Index

[29] Eberts & Stone (1985) emphasized the importance of using employers' information. They obtained the public school districts data from New York Department of Education for the school years 1972-1973 and 1976-1977.

(CWI) from the NCES.[30] The CWI, developed by Taylor and Fowler (2006), measures the regional variations in the salaries of college graduates in non-educational sector. The CWI measures the salaries of occupations that are comparable to teaching in the local labor market using baseline estimates from the 2000 U.S. census and annual data from the Bureau of Labor Statistics' Occupational Employment Survey. The CWI is available at school district level, so it provides the mean for geographically appropriate comparisons for locality differences in cost of living and other labor market conditions that can otherwise contaminate comparisons due to unobservable factors in the local labor market. The CWI is also an appropriate measure of the opportunity cost of being a teacher over finding a non-teaching career in teachers' school district.

Table 3.1 provides some key statistics from the dataset grouped by the legal environment for teachers unions. It shows that in High-CB states about 90% of teachers are members of teachers unions. Smaller proportions of teachers are union members as the legal environments become less favorable to teachers unions. Nevertheless, there is a big surprise in the data: a substantial proportion of teachers, slightly less than 50% of teachers, are unionized in No-CB group.

High-CB group has the highest percentage of teachers with master's degree or above. The fraction of teachers who enter teaching through an alternative certification program is the highest in No-CB group. Majority of teachers earn additional compensation from extracurricular activities (such as coaching, student activity sponsorship, etc.) or from

[30] The basic idea is that all workers will ask for higher wages in areas with a higher cost of living or with lack of amenities. If non-teachers have similar age, educational background, and preference for amenities, the CWI can be used to measure the uncontrollable component of variations in the wages paid to educators. The CWI predicts that Atlanta teachers in metro areas should also be paid 5 percent more than the national average teacher wage, if accountants in the Atlanta metro areas are paid 5 percent more than the national average accountant wage, for example.

Table 3.1: Descriptive Statistics by Group, SASS 2007-2008

	High-CB	Med-CB	Low-CB	No-CB
Teachers				
% of teachers unionized	88.2	64	62.2	45.5
% of teachers who enter teaching through alternative certification programs	11.3	9.7	13.6	23.3
Base teaching salary for 2007-2008 ($)	50,720 (15,680)	39,590 (10,610)	42,200 (10,330)	42,430 (10,200)
Days in the normal contract year	186.49 (26.38)	188.76 (26.41)	190.35 (28.11)	193.96 (30.1)
% of teachers with master's degree or above	55.6	41.1	50.1	43.6
% of teachers who earn additional compensation from extracurricular activities (coaching, evening class, etc.) or outside schools during the school year	56.6	60.4	54.7	49.8
% of teachers who worked during the summer in 2007	43.8	46	38.2	38.2
Fraction of Hispanic teachers	.048 (.214)	.027 (.161)	.018 (.133)	.067 (.251)
Fraction of Black teachers	.043 (.201)	.034 (.182)	.072 (.258)	.143 (.349)
Fraction of Asian and other teachers	.027 (.163)	.007 (.085)	.006 (.074)	.009 (.099)
N	16,430	9,410	6,760	5,640
Schools				
The enrollment of grades K-12	810 (666)	779 (706)	734 (497)	937 (693)
Pupil-teacher ratio	14.15 (5.1)	13.84(4.5)	14.52(4.8)	14.41(4.4)
Fraction of students with free or reduced lunch	.374 (.275)	.397 (.234)	.441 (.235)	.509 (.267)
Fraction of limited-English proficient students	.09 (.154)	.07 (.112)	.042 (.084)	.074 (.129)
Fraction of Hispanic students	.131 (.214)	.104 (.164)	.066 (.129)	.167 (.242)
Fraction of Black students	.106 (.204)	.082 (.152)	.165 (.262)	.285 (.284)
Fraction of Asian students	.053 (.128)	.018 (.028)	.013 (.02)	.018 (.029)
Fraction of American Indian and other students	.04 (.144)	.064 (.146)	.012 (.064)	.035 (.149)
N	3,340	1,770	1,330	1,130
Districts				
# of districts with meet-and-confer agreement (MC)	190	150	190	90
# of districts with collective bargaining agreement (CB)	1,790	760	70	0
# of districts with no agreement (NA)	150	150	440	620
Union density	0.892	0.646	0.63	0.465
% of districts with state or district assessment requirement for high school graduation	58.7	40.7	34.8	95.2
% of districts offering defined-contribution retirement plan to teachers	67.7	67.2	73.03	69.85
% of districts paying funds into this retirement plan	36.1	50.54	47.21	36
% of districts that reward excellence in teaching	5.15	8.15	6.46	20.48
Log (Comparable Wage Index)	.168 (.14)	.02 (.087)	.06 (.095)	.12 (.112)
N	2,130	1,060	700	710

Note: Standard deviations are reported in parentheses

working in jobs outside the school system during the school year, and many teachers have worked during the summer of 2007. The fraction of students eligible for free or reduced-price lunch program is the highest in No-CB group, but the fraction of students who have limited-English proficiency is the highest in High-CB group. The majority of districts in High-CB group and Med-CB group are covered by collective bargaining agreements, but more districts are covered by meet-and confer agreements or no-agreement than by collective bargaining agreements in Low-CB group and No-CB group. More than 95% of the districts require a state or district assessment for high school graduation in No-CB group. The fraction of districts rewarding teachers for excellence in teaching is much higher in No-CB group than in High-CB group. The CWI is the highest in High-CB group and the lowest in Med-CB group.

Table 3.2 presents the unionization and the financial status of each state within the four legal environment groups. Most states in High-CB group have high union density and large collective bargaining coverage. Collective bargaining coverage in Med-CB group is as high as in High-CB group, but the union density of Med-CB group is significantly lower than that of High-CB group, which suggests that the absence of agency fee produces many free riders. The union density of Low-CB group is still quite high with a wide variation in collective bargaining coverage across states. The financial status of each state, measured by the average of school districts' budget (total revenue of districts–total expense of districts) divided by total revenue of districts, shows larger deficits in Low-CB group and No-CB group than in High-CB group and Med-CB group.

Figure 3.1 through Figure 3.4 highlight the findings in the descriptive statistics that contradict some widely held views about public sector unionism. The first misconception is the view that collective bargaining contracts or laws favorable to collective bargaining are

Table 3.2: The Unionization by State

By Group based on the Legal Environment towards Teachers Unions

SASS 2007-2008

States	Percent of teachers unionized	Percent of teachers covered by CB	Percent of teachers covered by MC	Average ratio of revenue-expense/ revenue of districts
1. High-CB group: States that have CB laws and allow agency fees.				
Alaska	84.9	89.86	6.19	-0.036
California	88.83	91.42	6.22	-0.026
Connecticut	98.88	92.39	5.02	0.008
Delaware	90.91	97.08	0	-0.028
Hawaii	96.77	100	0	0.118
Illinois	93.89	96.18	2.55	-0.022
Maine	74.93	88.45	11.55	0.003
Maryland	81.86	97.72	1.66	0.013
Massachusetts	93.89	91.36	5.08	0.004
Michigan	89.61	85.32	5.87	0.013
Minnesota	94.47	66.52	29.17	-0.017
Montana	85	82.83	11.14	0.022
New Hampshire	85.48	98.74	1.26	0.017
New Jersey	95.12	89.37	6.29	-0.022
New Mexico	36.08	44.22	9.17	-0.006
New York	95.59	92.45	4.03	-0.036
Ohio	87.31	85.27	5.33	0.024
Oregon	93.93	96.6	2.78	-0.066
Pennsylvania	91.93	87.14	7.35	0.006
Rhode Island	97.25	79.48	16.76	0.004
Vermont	82.39	94.76	5.24	0.115
Washington	96.31	93.44	6.27	-0.061
Wisconsin	97.44	88.93	10.32	0.015
Group Average	88.27	87.29	7.91	-0.003
2. Med-CB group: States that have CB laws but prohibit agency fees.				
Florida	52.57	95.88	3.91	-0.043
Idaho	60.39	88.8	7.89	0.056
Indiana	72.22	87.99	10.6	0.035
Iowa	72.51	94.49	5.51	0.033
Kansas	53.98	78.3	19.44	0.034
Nebraska	85.89	88.79	10.81	0.016
Nevada	72.8	100	0	-0.095
North Dakota	74.14	78.55	13.11	0.022
Oklahoma	57.07	55.51	11.51	0.012
South Dakota	52.63	73.91	21.87	0.021
Tennessee	60.37	84.65	8.21	-0.053
Group Average	64.02	81.58	10.39	0.006

Table 3.2: The Unionization by State (Cont.)

States	Percent of teachers unionized	Percent of teachers covered by CB	Percent of teachers covered by MC	Average ratio of revenue-expense/ revenue of districts
3. Low-CB group: States that do not have CB laws but allow CB.				
Alabama	86.47	0	50.99	-0.018
Arkansas	34.61	11.08	12.36	-0.025
Colorado	61.26	68.05	13	-0.075
Kentucky	59.49	19.48	15.41	-0.013
Louisiana	55.09	14.17	10.24	0.018
Missouri	73.08	4.38	55.64	-0.065
Utah	59.94	76.83	14.31	-0.063
West Virginia	67.87	0	15.36	-0.038
Wyoming	52.26	3.2	52.78	0.046
Group Average	62.23	18.55	28.47	-0.028
4. No-CB group: States that ban CB of public school teachers.				
Arizona	43.43	3.98	61.23	-0.028
Georgia	55.93	0	0.56	-0.034
Mississippi	37.22	1.02	0	0.014
North Carolina	42.71	0.49	10.84	0.013
South Carolina	27.84	1.78	5.21	-0.047
Texas	58.81	0	11.52	-0.075
Virginia	50.92	0	30.96	-0.028
Group Average	45.56	1	17.16	-0.028

necessary for workers to join the unions. Figure 3.1 shows that even where there is no agreement between districts and teachers unions, half of teachers join the unions. Figure 3.2 shows that in No-CB group, which prohibits collective bargaining of teachers, slightly less than 50% of teachers still join the unions. Furthermore, in Low-CB group, where there are no collective bargaining laws, the average union density is as high as the average union density in Med-CB group, where there exist collective bargaining laws.

The second misconception is that collective bargaining is the only way for public sector workers to come to an agreement with their employers. Before the enactment of public sector labor laws permitting or encouraging collective bargaining of workers in the 1960s and

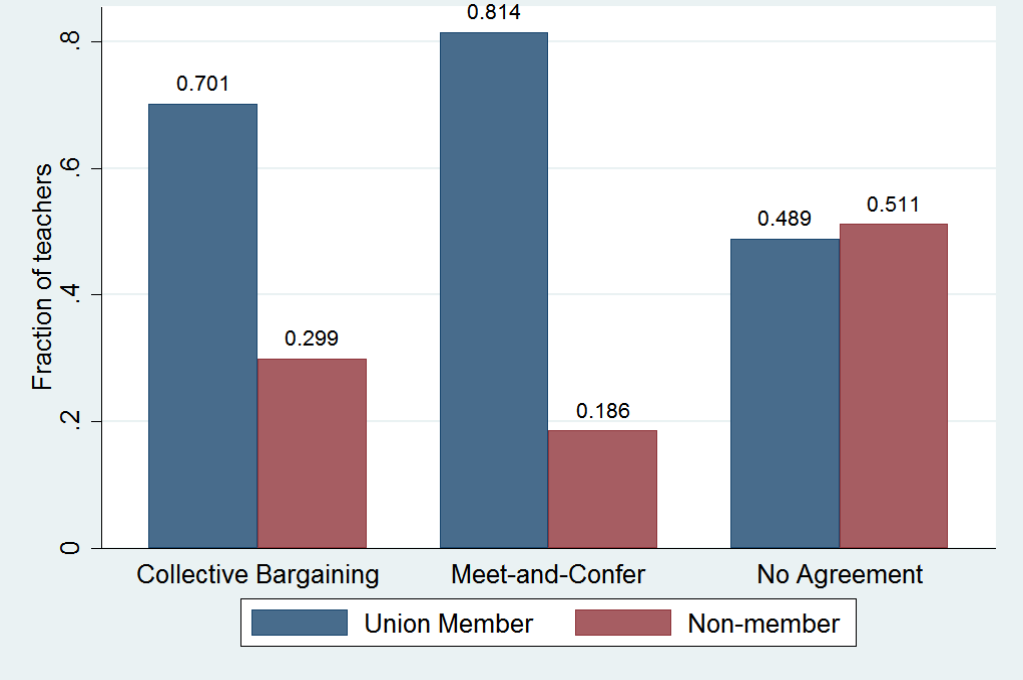

Figure 3.1: Union Membership Status by Agreement Type
Source: SASS 2007-2008

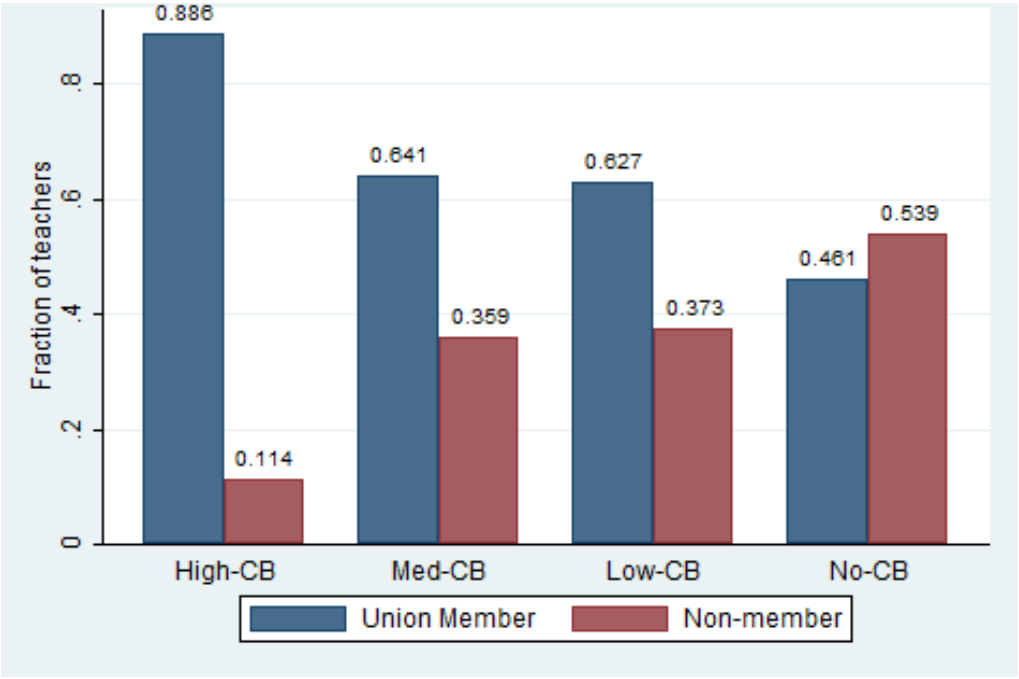

Figure 3.2: Union Membership Status by Legal Environment
Source: SASS 2007-2008

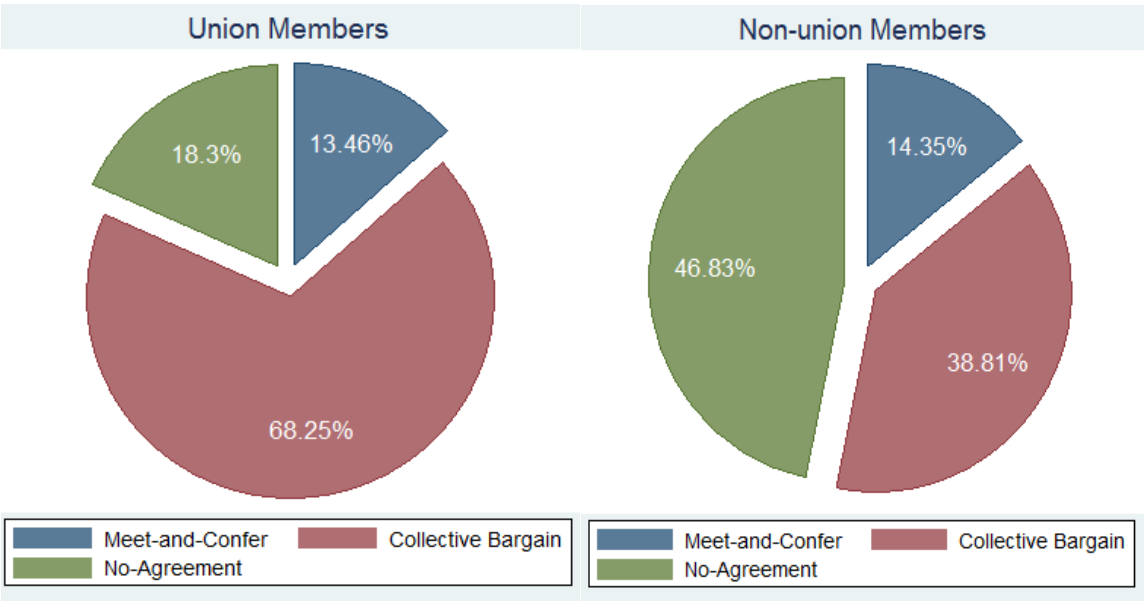

Figure 3.3: Contractual Coverage by Union Membership Status
Source: SASS 2007-2008

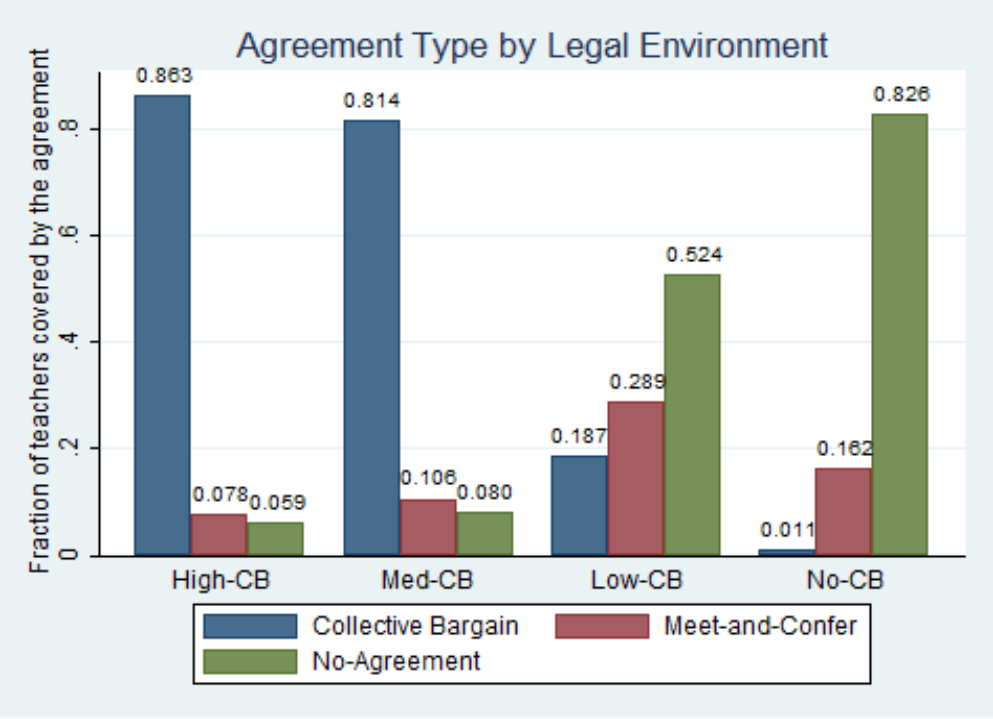

Figure 3.4: Agreement Type by Legal Environment
Source: SASS 2007-2008

1970s, it was common for unions and employers to have meet-and-confer agreements. Figure 3.3 shows that the meet-and-confer agreement is not an obsolete institution. They still exist and quite popular in 2007; approximately 13% of union members and 14% of non-members are covered by these agreements. Approximately 40% of non-members are covered by collective bargaining, and these are the free-riders. Figure 3.4 shows that in Low-CB group about 30% of teachers are covered by meet-and-confer agreement while 20% of teachers are covered by collective bargaining agreements. In No-CB group, where a collective bargaining agreement is not allowed, 16 % of teachers have meet-and-confer agreements with their districts. Therefore, in Low-CB group and No-CB group, meet-and-confer is the main form of agreement between teachers unions and their school districts.

3.5 Empirical Strategies to Correct for Endogeneity Problem of Unionization

I organize my analysis using various measures of unionism around groups of states that have similar legal environment towards teachers unions based on the notion that it is the legal environments rather than the state per se that affects how teachers unions operate. As the legal environments are determined years ago, it is reasonable to view then as exogenous determinants of decisions by teachers to unionize or by school districts to have any contractual agreement with the unions.

I start with a general analysis using all 50 states. To examine the relationship between the legal environment towards collective bargaining of teachers unions and teacher salaries, I estimate the following OLS regression for teacher salaries;

$$Log\ (Salary)_{ijk} = \beta_0 + \beta_1 HighCB_{ijk} + \beta_2 MedCB_{ijk} + \beta_3 LowCB_{ijk} + \beta_4 Union_{ijk} + \beta_5 X_{ijk} + \varepsilon_{ijk} \quad (1)$$

where i, j, and k indicates teachers, schools, and districts respectively, $Log(Salary)_{ijk}$ is the log of the base salary of a teacher i of j^{th} school in k^{th} district. $HighCB_{ikj}$, $MedCB_{ijk}$, and $LowCB_{ijk}$ are the binary variable indicating if a teacher i of j^{th} school in k^{th} district belongs to High-CB group, Med-CB group or Low-CB group respectively. No-CB group is the reference group in the analysis. For $Union_{ijk}$, I use either a binary variable for union membership of individual teacher ($Member_{ijk}$) or the districts' union density ($Density_k$) measured on a scale of 0 to 1.

X is a vector of control variables at teacher level, school level, and district level. I have a rich set of teacher level variables: gender, ethnicity, race, status for full-time/part-time, a dummy for teachers who teach at secondary schools (grades 7^{th} -12^{th}), teaching experience, experience^2, interaction between experience and gender, interaction between experience^2 and gender, education level, and teaching subject. It also includes school characteristics such as school program types, log (number of days in the school year), log (students enrollment of grade K-12), fraction of students eligible for free or reduced-price lunch program, students' ethnicity and race. My measures of district characteristics are log (CWI) and the urban-centric locality of districts where schools are located in. The OLS regressions are weighted by each teacher's final sample weight (w_{ijk}) that is provided in the SASS.

I also examine the relationship between contractual status of school districts with teachers unions and teacher salaries for all states using the model:

$$Log\ (Salary)_{ijk} =$$

$$\beta_0 + \beta_1 CB_{ijk} + \beta_2 MC_{ijk} + \beta_3 Union_{ijk} + \beta_4 (CB * Union)_{ijk} + \beta_5 (MC * Union)_{ijk} + \beta_6 X_{ijk} + \varepsilon_{ijk} \quad (2)$$

where CB_{ijk} and MC_{ijk} are binary variables indicating if k^{th} district of teacher i of school j has collective bargaining or meet-and-confer agreement with teachers unions, respectively. No-agreement districts form the reference group. $Union_{ijk}$ is measured either by $Member_{ijk}$ or $Density_{k}$. $(CB*Union)_{ijk}$ and $(MC*Union)_{ijk}$ are the interaction between CB and union measures and interaction between MC and union measures, respectively. X is the vector for the same control variables that I use in model (1), but state dummies and districts' financial status measured by school districts' total revenue are also added.

The array of measures of unionization creates a challenge in defining the right comparison group for the analysis. Consider, for instance, the question of whether or not to include dummy variables for states in a regression of teacher level outcomes on districts' contractual status or union density. States differ in their levels of collective bargaining coverage and union density. Thus, an analysis that excludes state dummies would be comparing union members or union density in Massachusetts, for example, to non-members or union density in Alabama with the risk of being contaminated by unmeasured differences between the states. However, an analysis that includes states dummies would be comparing the 95% of union members or districts with collective bargaining agreements to the potentially highly selected 5% of teachers who are non-members or districts without bargaining agreements in Massachusetts, and it would also be comparing the potentially highly selected few unionized teachers or districts with bargaining agreements to the majority of teachers who are non-members or districts without bargaining agreements in Alabama.

To deal with this issue, I perform a separate analysis for each of my four groups categorized based on states' legal environments towards the unions: High-CB, Med-CB, Low-CB, and No-CB group. I compare teachers/districts within each group of states that share the

same legal environments so that I find comparable teachers/districts without restricting too much as in the analysis for a single state or a single district. This method also allows me to examine if the relationship between the unions and teachers' work lives differ by legal environment.

However, the unionization poses the endogeneity problem,[31] within a given legal environment. The comparisons of teachers and schools by the union status or bargaining status within the same legal environments may be subject to omitted variable bias and/or selection bias, as some factors that I do not measure may cause differences in union/bargaining status and also affect the outcomes. I employ two statistical methods to mitigate these biases within each group: a multilevel (hierarchical) linear regression model and propensity score matching.

In the multilevel dataset, teachers within the same school may share common characteristics and experience that are unobservable, which may also affect the outcomes. When this commonality is large, teachers within the same school do not behave independently. They have the same value of the school-level residual, and the error terms in OLS regressions are not independent. If so, the standard OLS estimates will suffer from the omitted variable bias. A proper way to deal with this problem is to employ a multilevel linear model that separates the total variance into within-group and between-group components. For detailed explanation of multilevel mixed-effects linear regression models, see Appendix I.

For High-CB group, Med-CB group, and Low-CB group, I estimate the following equation for a multilevel mixed-effect model:

[31] Several studies tried to solve the endogeneity problems in measuring the causal effect of teachers unions by using longitudinal data, difference-in-difference estimators, IV regression, or a combination of these. (Hoxby, 1996; Hirsch et al., 2011).

$Log\ (Salary)_{ijk} =$

$$(\beta_0 + u_{jk}) + \beta_1 CB_{ijk} + \beta_2 MC_{ijk} + \beta_3 Union_{ijk} + \beta_4 (CB * Union)_{ijk} + \beta_5 (MC * Union)_{ijk} + \beta_6 X_{ijk} + \beta_7 Z_{jk} + \varepsilon_{ijk} \quad (3)$$

where X is the vector of control variables at the teacher level, and Z is the vector of control variable at the school level. For $Union_{ijk}$, I use either union membership status ($Member_{ijk}$) or districts' union density ($Density_k$). The model estimates a single coefficient for each independent variable (fixed effects), so the effect of teachers unions is assumed to be the same for all schools within each group. However, the model allows a school-specific intercept, u_{jk}, for each school (random effects). This model is called mixed-effect because it has both fixed effects component and random effects component.[32] As the statistical strategy for estimating variance components and fitting the multilevel model, I use maximum likelihood (ML) estimation. For No-CB group, meet-and-confer is the only available contractual option, so terms including CB are omitted from model (3).

Selection bias may also distort the causal inference of the analysis. Under the same legal environments, some districts choose to have collective bargaining agreements with teachers unions while others choose meet-and-confer agreements. In the same school districts, some teachers choose to join the union while others do not. Thus, I use propensity score matching to minimize the selection bias and to refine my comparisons of teachers or schools within the group of states with the same legal environment.

[32] The likelihood ratio test showed that the random slope was unnecessary once I focus on each group of states with the same legal environment towards teachers unions. Thus, I treat the effect of teachers unions the same for all schools, and the regression estimates a single regression line representing the population average while the school-specific intercept acts as a shifting factor of this regression line up or down depending on schools. See Appendix I for more details.

Considering union membership as a treatment, I view unionized teachers as the treated unit. Using propensity score matching, I define the non-treated unit as teachers who have not joined a union but have a similar probability of joining the union with unionized teacher within the same group of states. The treated units receive the treatment while non-treated units do not. Then, when I contrast treated units and non-treated units, the entire difference in base salary between the two groups is due to the union membership status. Assuming the treatment decision is random conditional on observable pre-treatment characteristics *X* (selection on observables or conditional independence), I specify the propensity score (*p*) of receiving a treatment for teacher i of school j in district k as a function of *X* that determine the selection into treatment such that $p_{ijk}(x) = \Pr(D_{ijk} = 1 \mid X_{ijk} = x)$, where *D* indicates if the teacher receives the treatment. In addition to analyzing union membership as a treatment at the teacher level, I also analyze collective bargaining and meet-and-confer agreements at school district level as additional treatments. Appendix II provides the details of propensity score matching.

I use logit regression to estimate the propensity score for each treatment variable, and the propensity score is the predicted value of *D* that I get from this regression. *X* can include higher order terms of covariates and interactions between the covariates. Since each group is different, the covariates vary a little by group. For example, the estimation of the propensity score for union membership in High-CB group uses about 30 covariates including 6 quadratic terms and 2 interaction terms. Appendix II provides a complete list of covariates used to estimate propensity scores for all treatment variables.

To diagnose the quality of the matching, I carried out a series of tests. I calculated the percent of bias for each covariate that is used to estimate the propensity score[33]. For all treatment variables, the percent of bias for most covariates within each group was less than 5% as required, which suggested that most covariates were well balanced in all groups. I performed a t-test for each covariate and calculated the mean difference between the treated group and the non-treated group. Both tests confirmed that the difference between the two groups was insignificant for most covariates. In sum, I obtained the balancing property of propensity score for all treatment variables in all four groups.[34] Figure 3.5 displays the histogram of propensity scores for union membership by treatment status and by group. In each group of states, the treatment group and non-treated group have a very similar distribution, and their histograms are symmetrical. Therefore, I conclude that the matching has constructed good control units for the treated units on the observables in each group of states, and the results from the propensity score matching will be based on highly comparable groups.

For a matching algorithm, I use the nearest neighbor (*NN*) matching based on propensity score. *NN* matching takes each treated unit and searches for the control unit with the closet propensity score, so all treated units find a match. To avoid bad matches and to keep the potential bias low, I apply "with replacement" option. Thus, a control unit can be the best match for more than one treated unit. I impose the common support restriction to

[33] Percent of bias is the percent difference of the sample means in the treated and non-treated group, and it is calculated as a percentage of the square root of the average of the sample variances in the treated and non-treated groups (formulae from Rosenbaum and Rubin.1985).

[34] Among those with the same predicted probability of treatment (propensity score), the treatment group and non-treated group differ only on their error term in the propensity score equation. But this error term is approximately independent of the pre-treatment characteristics (X). Thus, the treatment assignment D is independent of Y, given the strata created by X's. See Appendix II for a detailed explanation.

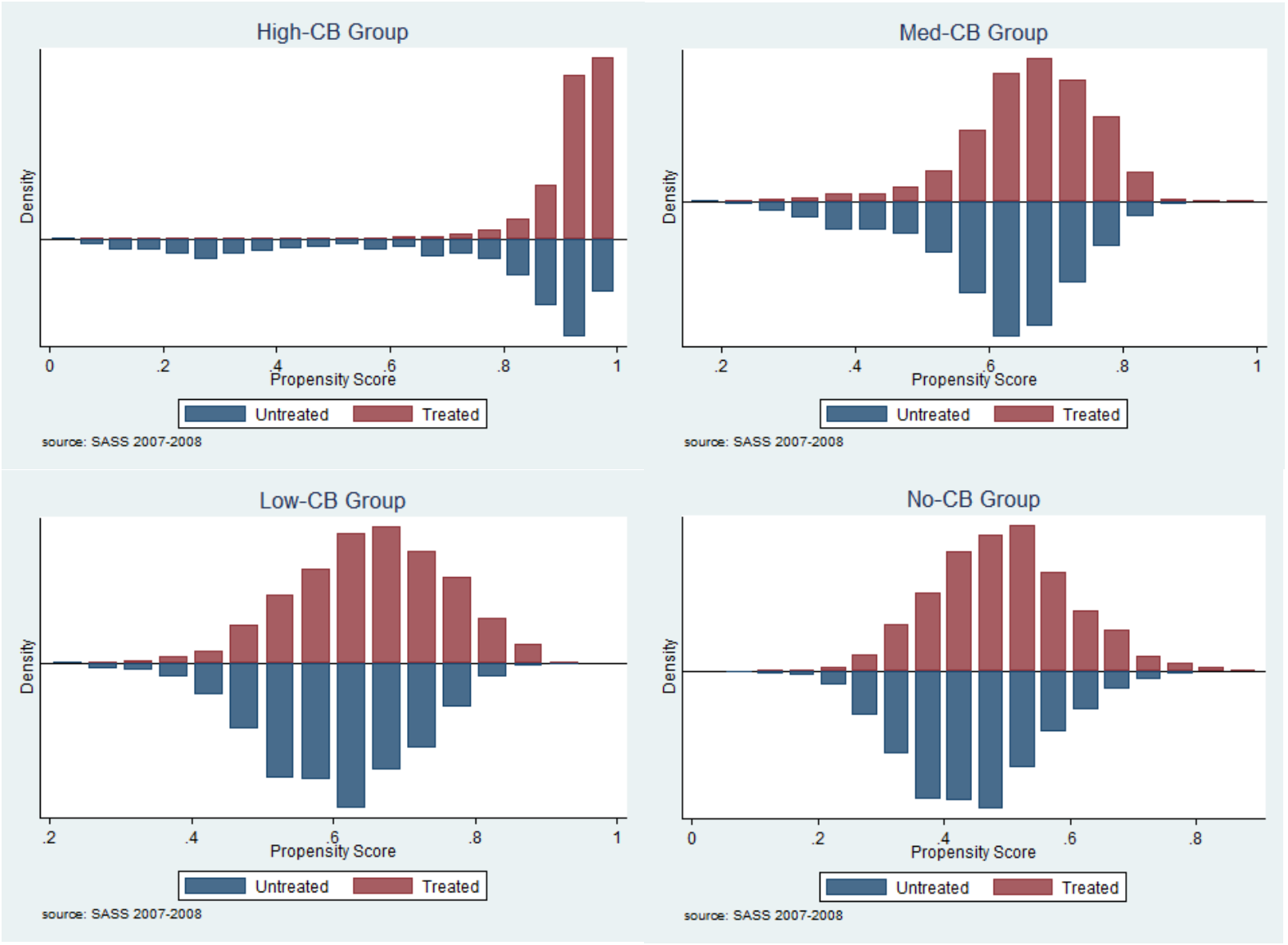

Figure 3.5: Histogram of Propensity Score for Union Membership by Group

Table 3.3: Balanced Distribution of Propensity Score for Union Membership, by Group

SASS 2007-2008, District-Teacher Matched Dataset

Stratum	Control			Treatment			Mean Difference
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	
High-CB group							
1	84	10.466	0.432	26	10.541	0.281	0.074
2	185	10.557	0.259	73	10.619	0.295	0.062
3	103	10.636	0.330	104	10.615	0.300	0.021
4	79	10.638	0.394	116	10.678	0.401	0.040
5	105	10.532	0.400	331	10.562	0.406	0.030
6	110	10.415	0.436	489	10.594	0.387	0.178***
7	197	10.478	0.650	1364	10.633	0.355	0.155***
8	146	10.664	0.306	1,443	10.722	0.307	0.0576**
9	142	10.674	0.309	2,657	10.675	0.309	0.101**
10	156	10.877	0.309	4,144	10.929	0.271	0.052**
Med-CB group							
1	254	10.367	0.363	136	10.382	0.235	0.014
2	277	10.438	0.354	200	10.426	0.322	0.012
3	655	10.424	0.365	847	10.436	0.333	0.013
4	1178	10.514	0.256	2,213	10.518	0.258	0.003
5	567	10.658	0.242	1,700	10.684	0.263	0.027**
6	73	10.787	0.219	278	10.801	0.294	0.013
Low-CB group							
1	69	10.373	0.311	54	10.412	0.415	0.039
2	278	10.479	0.312	252	10.489	0.293	0.01
3	661	10.535	0.292	809	10.543	0.346	0.008
4	413	10.608	0.251	651	10.617	0.227	0.009
5	306	10.639	0.244	681	0.649	0.269	0.011
6	242	10.672	0.228	561	10.703	0.213	0.03*
7	91	10.742	0.281	233	10.744	0.204	0.002
8	34	10.687	0.198	200	10.755	0.0207	0.068*
9	50	10.755	0.244	326	10.777	0.216	0.022
No-CB group							
1	18	10.516	0.183	4	10.585	0.135	-0.068
2	187	10.438	0.196	61	10.483	0.217	0.045*
3	655	10.485	0.212	345	10.517	0.194	0.024**
4	826	10.607	0.256	717	10.638	0.219	0.042**
5	473	10.742	0.211	610	10.726	0.234	0.015
6	229	10.752	0.234	369	10.808	0.204	0.057**
7	1	10.714		18	10.809	10.818	

improve the quality of the matches, so only the observations whose propensity score belongs to the intersection of the regions of the propensity score of the treated and the control units are considered in the analysis. Once each treated unit is matched with a control unit, I compute the mean difference between log (base salary) of the treated units and control units.

Table 3.3 presents the mean differences by group, and the significance of the mean difference for each stratum of propensity score is marked using the T-test. The average treatment effect on the treated (ATT) is then obtained by taking the weighted average of these mean differences. To estimate the variance of the estimator for ATT, I use bootstrapping.

I next investigate the relationship between teachers unions and working condition, which I measure with the log of the number of contract days. The equation I use for each group of states is:

$$Log\ (Contract\ Day)_{ijk} =$$

$$(\beta_0 + u_{jk}) + \beta_1 CB_{ijk} + \beta_2 MC_{ijk} + \beta_3 Union_{ijk} + \beta_4 (CB * Union)_{ijk} + \beta_5 (MC * Union)_{ijk} + \beta_6 X_{ijk} + \beta_7 Z_{jk} + \varepsilon_{ijk} \quad (4)$$

I also examine if there exist compensating differentials between teachers' earnings and working condition by adding teachers' base salary as an additional regressor to model (4).

My dataset has two binary variables indicating if a district offers a defined-contribution retirement plan to teachers and if employers pay any funds into the retirement plan. Using these two variables, I investigate the relationship between teachers unions and non-wage benefits in each group. The two variables are only available at school district level, so I utilize the district level dataset. The equation I estimate is:

Non-wage Benefit$_k$ =

$$\beta_0 + \beta_1 CB_k + \beta_2 MC_k + \beta_3 Density_k + \beta_4 (CB * Density)_k + \beta_5 (MC * Density)_k + \beta_6 X_k + \varepsilon_k \qquad (5)$$

where k indicates districts. *Density*$_k$ measures the union density of kth district. *CB*$_k$ and *MC*$_k$ are binary variables indicating if kth district has collective bargaining or meet-and-confer agreement with teachers unions, respectively. *X* represents the vector of control variables at school district level.[35] The OLS regressions are weighted by each school district's final sample weight (w_k). The log of base salary is added as an additional regressor to model (5) to examine the existence of compensating differentials between salaries and non-wage benefits.

3.6 Results

Table 3.4 summarizes the effect of legal environments towards teachers unions on teachers' base salaries. The results from the SASS show that the base salaries in High-CB group are the highest among all groups. Compared to teachers in No-CB group, which bans collective bargaining, teachers in High-CB group earn 10-14 percent more on average. Surprisingly, however, teachers in Med-CB group, which also has collective bargaining laws, are not paid more than teachers in No-CB group. This may be due to the free rider problem as

[35] These include log (CWI), log (average number of days in the school year), log (student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program within the district, a dummy for districts that offer classes for secondary grades (grades 7th -12th), students' ethnicity and race, teachers' ethnicity and race, a dummy indicating if a district requires high school students to pass a state or district assessment to earn high school diploma, log (total revenue), and 2000 decennial census locale code of districts.

Table 3.4: The Effect of Legal Environment towards Teachers Unions on Teachers' Earnings

SASS Teachers Level Dataset

Weighted OLS Regression

Dependent Variable: Log (Base Salary)

VARIABLES	SASS 2007-2008			SASS 2003-2004		
	(1)	(2)	(3)	(4)	(5)	(6)
High-CB	0.141***	0.131***	0.120***	0.142***	0.126***	0.109***
	(0.0231)	(0.0232)	(0.0247)	(0.0221)	(0.0217)	(0.0226)
Med-CB	-0.0095	-0.0117	-0.0142	-0.0246	-0.0306	-0.0368*
	(0.020)	(0.0199)	(0.0195)	(0.0209)	(0.0202)	(0.0196)
Low-CB	0.0191	0.0162	0.0127	-0.0168	-0.0223	-0.0283
	(0.0240)	(0.0240)	(0.0242)	(0.0175)	(0.0173)	(0.0179)
Union member		0.0258***			0.0435***	
		(0.0076)			(0.0071)	
Union density			0.0549***			0.0882***
			(0.0205)			(0.0169)
Observations	33,500	33,500	33,500	32,500	32,500	32,500
Adjusted R^2	0.533	0.533	0.534	0.592	0.595	0.595

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1

Control variables for SASS Teacher level Dataset for 2003-2004 and 2007-2008: gender, ethnicity, race, a dummy for full-time teachers, a dummy for secondary schools (grades 7th -12th) teachers, experience, experience^2, interaction between experience and gender and between experience^2 and gender, education level, teaching subjects, school program types, log (number of days in the school year), log (total students enrollment of grades K-12), fraction of students eligible for free or reduced-price lunch program, students' ethnicity and race, log (CWI), and 11 urban-centric locality code of the districts that schools are located in.

Table 3.5: The Effect of Teachers Unions on Teacher Salaries
SASS 2007-2008, District-Teacher Matched Dataset, Weighted OLS Regression
Dependent Variable: Log (Base Salary)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(8)	(6)	(7)	(9)	(10)
High-CB	0.145***	0.135***	0.124***							
	(0.0219)	(0.0219)	(0.0234)							
Med-CB	-0.0170	-0.0193	-0.0218							
	(0.020)	(0.0196)	(0.0190)							
Low-CB	0.0158	0.0127	0.0093							
	(0.0237)	(0.0236)	(0.0238)							
CB				0.0259**		0.0215**	-0.0026		0.0181*	-0.0412**
				(0.0107)		(0.0108)	(0.0134)		(0.011)	(0.0188)
MC				0.0180**		0.0149*	0.0154		0.0122	0.0167
				(0.0083)		(0.0084)	(0.0121)		(0.0084)	(0.0172)
Union member		0.0262***			0.0220***	0.0205***	0.0065			
		(0.0075)			(0.0049)	(0.0051)	(0.0071)			
Union density			0.0553***					0.0437***	0.0362***	0.0130
			(0.0205)					(0.0121)	(0.0125)	(0.0172)
Member x CB							0.0338***			
							(0.0112)			
Member x MC							0.0032			
							(0.0129)			
Density x CB										0.0791***
										(0.0246)
Density x MC										0.0009
										(0.0258)
Log(revenue)	0.0108***	0.0109***	0.0109***	0.0116***	0.0104***	0.0114***	0.0116***	0.0100***	0.0111***	0.0115***
	(0.0022)	(0.0022)	(0.0021)	(0.0038)	(0.0037)	(0.0037)	(0.0038)	(0.0037)	(0.0037)	(0.0038)
State dummies				Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	33,420	33,420	33,420	31,330	33,420	31,330	31,330	33,420	31,330	31,330
Adjusted R^2	0.534	0.535	0.535	0.568	0.572	0.568	0.569	0.572	0.568	0.569

Note: Errors are clustered within states for column (1)-(3) and within districts for column (4)-(10) (presented in parentheses).
*** p<0.01, ** p<0.05, * p<0.1. Control variables: same as in Table 4 for SASS Teachers level Dataset

these unions cannot negotiate agency fees and thus may have fewer resources to support their activities.[36]

As seen in Table 3.1, teachers in Med-CB group take on more second jobs than teachers in other groups both during the school year and during the summer. This suggests that more teachers in Med-CB group may be forced to take multiple jobs to make ends meet. It is also possible that teachers unions in the Med-CB may use their bargaining power on other outcomes that would substitute for salaries. Thus, having pro-bargaining laws is not a sufficient condition to affect teachers' base salaries. Initially, I expected that the union effects on pay would be proportional to the strength of the legal framework for unionization; highest in the High-CB group and declining uniformly to Med-CB, Low-CB, and No-CB group. Yet, Table 3.4 shows that the estimated union effects do not differ between Med-CB, Low-CB, and No-CB groups, although High-CB group has the strongest union effects on base salaries. Turning to my two other measures of unionization, union membership and union density are still positively associated with base salaries after controlling for the difference in legal environment. In the SASS 2007-2008 of Table 3.4, column (2) shows that union members earn 2.6 percent more than non-members on average regardless of the legal environment towards teachers unions. The SASS 2003-2004 dataset also shows similar pattern with the results from SASS 2007-2008. In sum, the legal environment is important, but it does not explain all of the union effects.

Table 3.5 adds two additional factors to the regressions of teachers pay on the indicators of unionism: state dummies and district's financial status measured by log (district's total revenue). Most previous analyses of the union effects on pay have not included

[36] Farber (1984) argues that right-to-work (RTW) results in a free-rider problem for private sector unions, which diminish their bargaining power. Gyourko and Tracy (1991) did not find this effect in public sector unions.

measures of school district financial condition due to the data limitation that does not allow researchers to identify the school district in which teachers work. In my study, I find that log (district's total revenue) has a significant relationship with teachers' base salaries. As we initially anticipated, the school districts with better financial status pay their teachers more.

In column (1) through (3) of Table 3.5, adding districts' financial information slightly reduces the coefficients of group dummies and measures of unionization compared to the results for the SASS 2007-2008 in Table 3.4. This implies that the estimates of the union effects on pay have suffered from omitted variable bias by ignoring the financial status of districts. Since the sign of the omitted variable bias is positive, the correlation between unionization and district's revenue must be positive, which I confirm later in the analysis of the relation between teachers unions and districts' budget. There are two possible interpretations of this result; it reflects the selectivity in the districts that unions are able to organize, or union activities improve school finances, possibly through teachers' campaigning in local elections and lobbying local governments on issues relating to school budgets.

The addition of the state dummies considerably reduces the strength of the association between unionization and teacher pay.[37] In column (4) through (10) of Table 3.5, compared to no-agreement districts, teachers in collective bargaining districts earn 2.6 percent more and teachers in meet-and-confer districts earn 1.8 percent more. Regardless of contract status, union members earn 2.2 percent more than non-members, and increasing the district's density by 10 percent is associated with 0.44 percent higher base salaries. The interaction terms between collective bargaining and union membership and between collective bargaining and

[37] See Table 3A in Appendix III for the comparison between the results with and without state dummies. Without state dummies, union effects turn out to be much larger. The effect on base salaries of collective bargaining agreement is about 8 percent, membership effect is 7 percent, and density effect is almost 17 percent.

union density are significantly positive, suggesting that association between union density or union membership and teacher pay is stronger in collective bargaining districts than in no-agreement districts.

The substantial difference in the estimated union effects on teacher pay between the results with and without state dummies displays the complexity of the union effects on teacher pay. While it is possible that the OLS model with state dummies gives more valid estimates of the union impacts than the model without state dummies, it may focus too much on within-state variation in which selection bias may be large and in which there may be a substantial within-state spillover of pay rate from districts that are unionized to districts that are not unionized. Some researchers have examined the spillover effect (or threat effect) of unionization on wages within and across industries (Rosen, 1969; Martin and Rence; 1984). The models of spillover effect have not been particularly successful, so I do not try to differentiate between these two explanations for the impact of state dummies on the analysis.

I next examine the union effects within different legal environments regarding collective bargaining using the variation of unionization in each group. Within each group, I use four model specifications: OLS regression, OLS regression with state dummies, multilevel mixed-effect models, and propensity score matching. The last two models are preferred to OLS regression models as they minimize the bias due to the endogeineity of unionism within the same legal environment.

The results from multilevel model (3) for each group are reported in Table 3.B-1 through 3B-4 in Appendix III. The multilevel model estimates the between-school variance component (σ_u^2) to be 0.104 and within-school variance component (σ_ε^2) to be 0.221 in High-CB group, so the intra-class correlation (ρ) is 0.333. This value is quite large, implying that

teachers within the same school do not behave independently of one another, and that there are unobservable omitted factors in the error term. In all groups, the intra-class correlation is sizeable, ranging between 0.25 and 0.33.[38] Therefore, the estimates from the standard OLS regressions will be biased, and the multilevel models that separately estimate the variance within and between districts are preferred. The propensity score matching corrects for selection bias by finding matches of treated and non-treated units that have the similar probability of getting the treatment. Moreover, as seen Table 3.3, more matches are found in the higher propensity score strata in High-CB group for example, so it will be appropriate to give more weights to these observations, which is done in estimating ATT from propensity score matching. Thus, the propensity score matching is also preferred to OLS regression.

Table 3.6 reports the summary of union wage effects by group and by model specification, using four different measures of unionism. The multilevel mixed-effect model and propensity score matching present very similar results. The results from the OLS regression with state dummies show that both collective bargaining and meet-and-confer agreements are positively associated with base salaries in High-CB group, but the results from both multilevel model and propensity score matching show that neither collective bargaining nor meet-and-confer agreements has positive association with teachers' base salaries in any group. The multilevel models and propensity score matching show that union membership has a positive association with base salaries in High-CB group and No-CB group, and the estimated coefficients from both models are almost the same. The multilevel models show that union density is also significantly related with teachers' base salaries in the High-CB and No-CB group. In those groups, the greater the union density is, the higher the teachers' base

[38] The Intra-class correlation (ρ) is 0.259 for Med-CB group, 0.253 for Low-CB group, and 0.292 for No-CB group.

Table 3.6: The Summary of The Effect of Teachers Unions on Base Salary, by Group and by Model
SASS 2007-2008, Districts -Teachers Matched Dataset
Dependent Variables: Log(Base Salary)

Group	Weighted OLS model	Weighted OLS model with state dummies	Multilevel Mixed-effect Model	ATT from Propensity Score Matching
		The Effect of Collective Bargaining		
High-CB	0.058*	0.075*	0.032	0.023
Med-CB	-0.007	-0.049*	-0.019	-0.018
Low-CB	-0.015	-0.019	-0.018	-0.016
No-CB	NA	NA	NA	NA
		The Effect of Meet-and-Confer		
High-CB	0.051	0.067*	0.036	0.011
Med-CB	-0.006	-0.053*	-0.005	0.012
Low-CB	0.015	0.015	0.014	0.014
No-CB	-0.016	0.008	-0.025*	0.023
		The Effect of Union Membership		
High-CB	0.082***	0.071***	0.064***	0.065**
Med-CB	0.007	0.006	0.008	0.014
Low-CB	0.012	0.019*	0.011	0.005
No-CB	0.022**	0.016**	0.016**	0.019**
		The Effect of Union Density		
High-CB	0.125***	0.100**	0.104***	NA
Med-CB	0.006	0.006	-0.007	NA
Low-CB	-0.008	0.03	-0.011	NA
No-CB	0.041	0.015	0.037**	NA

Note: Errors are clustered within states for OLS models and clustered within schools for multilevel model. *** p<0.01, ** p<0.05, * p<0.1
Control variables: same as in Table 4 for SASS Teachers level Dataset for both OLS models and multilevel models.
Covariates to estimate propensity score for union membership, collective bargaining, and meet-and-confer: see Appendix II.

salaries are. In Med-CB group and Low-CB group, however, no wage gains are found from union activity.[39]

Taking the results from multilevel mixed-effect models and propensity score matching at face value, contractual status has no association with teacher salaries. Spillover effects of unionization may explain this. Once the legal settings towards teachers unions are firmly established, it may be difficult for no-agreement districts to deviate much from the salary level of collective bargaining districts. If they deviate too much during this period, there will be more pressure from teachers unions to push for collective bargaining agreements in the next period. For the same reason, in the No-CB group, no-agreement districts may feel pressure to set their base salary comparable to the salary level of meet-and-confer districts. A school district that pays below the pay in the contracts from nearby school districts may be unable to attract the teachers it wants, and thus matches the pay in the districts with contracts. If this interpretation is correct, the mechanism that underlies the results is the classical market force and the pressure for a single wage for comparable workers in a local labor market. Thus, the spill-over effects of contractual status would be stronger within the group than across the groups.

Even when there are no collective bargaining agreements between teachers unions and districts, teachers still act collectively through political actions such as campaigning and lobbying. Teachers unions can provide more efficient ways to form a collective voice for teachers, and having many members in the unions will be critical to achieve their goals. In No-CB group, about 50% of teachers still join teachers unions, and the unions have a small but significantly positive effect on base salary. Teachers unions possess the power to benefit

[39] Lovenheim (2009) also found that teachers unions had no impact on teacher salaries using the Census/Survey of Government data from three Midwestern states, Iowa, Indiana, and Minnesota.

their members if they can obtain a high enough density even though the labor law does not allow collective bargaining.

An alternative interpretation concerning the surprising absence of the effect of contractual agreements on teacher pay in the Med-CB group and Low-CB group is that the unions may provide advantages for their members on issues beyond the base salaries. For instance, working conditions and non-wage benefits are also part of the compensation packet, and teachers unions surely work hard to improve them. Table 3.7 summarizes the results of my analysis of the union effect on these outcome variables by group and by model.

The columns of Table 3.7 represent the dependent variables for teachers' compensations. The first and the second column shows teachers' earnings and working condition measured by teacher level variables, log (base salaries) and log (number of contract days), respectively. The results for teachers' base salaries are also shown in Table 3.5 and Table 3.6. The non-wage benefits are measured by two district level variables; a dummy indicating if a district offers defined-contribution retirement plan and a dummy indicating if a district pays funds into the defined-contribution retirement plan. The first and the second panel of Table 3.7 present the effect of union membership and the effect of union density on outcome variables, respectively, by group. The third panel shows the effect of contractual status, collective bargaining (CB) and meet-and-confer (MC), on outcome variables by group. I use multilevel mixed-effect models for earnings and working condition, [40] but use OLS regressions with state dummies for non-wage benefits because they are only available at district level where neither the multilevel model nor propensity score matching is applicable.

[40] I record the estimates from multilevel model for group analysis mainly because propensity score matching does not allow me to utilize union density measure as it is not a binary treatment variable. As both methods produce similar estimates, this would not affect main results.

For the general analysis using all 50 states on all dependent variables, I use OLS regressions with state dummies.

The general analysis in Table 3.7 shows that unionism is positively associated teachers' compensation, which is represented by the significantly positive coefficients of all measures of unionism in each panel. When I disaggregate the data by group, however, I find that teachers unions have different effects in different legal settings. The mechanisms through which unions influence teachers' compensations greatly differ such that there is no universal union effect that can be applied to all legal environments.

Table 3.7: The Summary of the Effect of Union Membership, Union Density, Collective Bargaining, and Meet-and-Confer on Teacher Compensation, by Group

SASS 2007-2008

Dependent Variables: Log(Base Salary), Log(Contract Days), Dummy for Districts providing DC retirement plan, and a dummy for Districts contributing funds to DC retirement plan

Group	**Teacher level dependent variable^{T}**		**District level dependent variable^{D}**	
	ln(base salary)	ln(contract days)	Districts has DC retirement plan	Districts contributes funds
Panel 1. Effect of Union Membership by Group				
All States	.022(.005)***	.001(.004)		
High-CB group	.064(.017)***	-.003(.013)		
Med-CB group	.008(.006)	-.004(.005)		
Low-CB group	.011(.007)	-.001(.008)		
No-CB group	.016(.007)***	.001(.007)		
Panel 2. Effect of Union Density by Group				
All States	.044(.012)***	-.014(.009)	.03(.043)	.047(.04)
High-CB group	.104(.034)***	-.01(.015)	.092(.094)	-.04(.07)
Med-CB group	-.007(.016)	-.03(.012)**	.008(.039)	.074(.058)
Low-CB group	-.013(.018)	-.008(.014)	-.047(.082)	.129(.006)**
No-CB group	.037(.016)**	-.02(.011)*	.003(.133)	.046(.074)

Table 3.7: The Summary of Effect of Union Membership, Union Density, Collective Bargaining, and Meet-and-Confer on Teacher Compensation, by Group (Cont.)

Group	Teacher level dependent variable[T]		District level dependent variable[D]	
	ln(base salary)	ln(contract days)	Districts has DC retirement plan	Districts contributes funds
Panel 3: Effects of Collective Bargaining (CB) and Meet-and-Confer (MC) by Group				
All States				
CB	.026(.011)**	-.017(.006)***	.068(.04)*	.081(.042)*
MC	.018(.008)**	-.001(.006)	.006(.034)	.073(.039)*
High-CB group				
CB	.032(.045)	-.024(.014)*	.156(.093)	.126(.074)
MC	.036(.048)	-.009(.014)	.06(.120)	.217(.073)***
Med-CB group				
CB	-.019(.015)	.003(.011)	.019(.052)	.119(.074)
MC	-.005(.018)	.007(.011)	.028(.069)	.147(.04)***
Low-CB group				
CB	-.018(.015)	-.038(.016)*	-.034(.11)	.242(.162)
MC	.014(.011)	.006(.008)	-.028(.034)	.023(.067)
No-CB group				
CB	NA	NA	NA	NA
MC	-.025(.011)	-.02(.012)	.126(.052)**	-.061(.129)

Note: Errors are clustered within states for OLS models and clustered within schools for multilevel model. *** p<0.01, ** p<0.05, * p<0.1

[T]For teacher level dependent variables, SASS district-teacher matched dataset is used.

Analysis for All states: Weighted OLS regressions with state dummies.

Analysis for High-CB, Med-CB, Low-CB, and No-CB: Multilevel mixed effect models are used.

Control variables for SASS district-teacher matched dataset: gender, ethnicity, race, a dummy for full-time teachers, a dummy for secondary schools (grades 7th -12th) teachers, experience, experience^2, interaction between experience and gender and between experience^2 and gender, education level, teaching subjects, school program types, log (number of days in the school year), log (total students enrollment of grades K-12), fraction of students eligible for free or reduced-price lunch program, students' ethnicity and race, log (revenue), log (CWI), and 11 urban-centric locality codes of school districts.

[D]For district level dependent variables, SASS district level dataset is used. Weighted OLS regressions with state dummies are used.

Control variables for SASS district level dataset: log (revenue), log (CWI), a dummy variable indicating if a district requires high school students to pass a state or district assessment to earn high school diploma, log (total student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program, log (number of school days), a dummy for district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes.

Panel 1 summarizes the estimates of union membership premium in teachers' earnings and working condition by group. In the first column, the estimate of coefficient and standard errors for all states shows that union membership status has a significantly positive relationship with teachers' base salaries. On average, union members earn higher earnings than non-members by 2.2 percent. The High-CB group shows the strongest association between union membership and teachers' earnings, and the union membership premium is 6.4%. The No-CB group also shows small but significantly positive association between the two. In the Med-CB and Low-CB group, there is no union membership premium. The second column shows that union membership status has no association with the number of contract days, regardless of the group.

The panel 2 presents the effects of union density on teachers' compensations. For teachers' base salaries, union density premium shows similar pattern with union membership premium. Union density is positively associated with base salaries in the High-CB and the Low-CB group, and the magnitude of the association is about three times greater in the High-CB than in the No-CB group. Union density is associated with the reduction of the number of contract days in the Med-CB and the No-CB group by 2-3 percent. The average contract days are 180 days per year, so this is equivalent to 4-5 days of reduction in contract days or 4-6 percent increase in salaries per working day. Although union density has no relation with the probability of districts providing defined-contribution retirement plan in any group, it is strongly associated with the probability of districts with paying funds into the retirement plan in the Low-CB group. It suggests that in the Low-CB group, unions care more about how the defined-contribution retirement plan is funded by the employers than teachers' base salaries.

The effects of contractual status on teachers' compensation are presented in the panel 3 of Table 3.7. As shown in Table 3.5, there exist a CB premium and a MC premium in teachers' base salaries if we focus on the estimates from the general analysis. Compared to no-agreement districts, teachers in collective bargaining districts earn 2.6 percent more and teachers in meet-and-confer districts earn 1.8 percent more. However, no such premium exists in each group. For other types of teachers' compensation, the story is rather complex. There is a CB premium in the number of contract days, and it is the largest in the Low-CB group. In the Low-CB group, teachers covered by CB have 4% less contract days or equivalently 7 days compared to teachers covered by no agreement.

The general analysis for two dummy variables representing non-wage benefits show that CB provides an important channel to affect the probability that districts engage in teachers' defined-contribution retirement plan. However, the group analysis reveals that MC plays more significant role than CB. In the No-CB group, districts that are covered by MC have higher probability to provide defined-contribution retirement plan to their teachers compared to districts covered by no agreement by 12.6 percentage points. In the High-CB and Med-CB group, the probability that districts pay funds into a defined-contribution retirement plan is significantly higher in MC districts compared to no-agreement districts by 22 and 15 percentage points, respectively. Therefore, it seems that MC is the key mechanism through which unions influence teachers' non-wage benefits. This result explains why some school districts may go for MC agreements rather than CB agreement in states that also allows CB of teachers.

I show that teachers unions have multiple potential pathways for improving teachers' well-being beyond teacher salaries. If they do not raise salaries, they increase working

Table 3.8: The Compensating Differentials between Earnings and Working Conditions
SASS 2007-2008 District-Teacher Matched Dataset
Multilevel Mixed-Effect Model
Dependent Variable: Log (Number of Contract Days)

	High-CB group					Med-CB group				
VARIABLES	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Log(base salary)	0.0667**	0.0696***	0.0701***	0.0666**	0.0672***	0.113*	0.111*	0.110*	0.113*	0.113*
	(0.0261)	(0.0245)	(0.0246)	(0.0261)	(0.0261)	(0.0676)	(0.0655)	(0.0655)	(0.0675)	(0.0675)
CB	-0.0301**			-0.0310*	-0.0225	0.0015			0.0033	0.0124
	(0.0140)			(0.0174)	(0.0178)	(0.0107)			(0.0111)	(0.0118)
MC	-0.0148			-0.0157	-0.007	0.0054			0.0071	0.0152
	(0.0144)			(0.0177)	(0.0181)	(0.0114)			(0.0116)	(0.0125)
Union member		-0.0094		0.0016			-0.0048		-0.0058	
		(0.0136)		(0.0171)			(0.0046)		(0.0049)	
Union density			-0.0207		-0.0137			-0.0292**		-0.033***
			(0.0148)		(0.0190)			(0.0115)		(0.0128)
Observations	12,430	13,720	13,720	12,430	12,430	8,370	8,610	8,610	8,370	8,370
#of schools	2,550	2,830	2,830	2,550	2,550	1,620	1,670	1,670	1,620	1,620

	Low-CB group					No-CB group				
VARIABLES	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Log(base salary)	0.139**	0.135**	0.135**	0.139**	0.138**	0.0382	0.0398	0.0380	0.0424	0.0407
	(0.0642)	(0.0615)	(0.0615)	(0.0642)	(0.0642)	(0.0260)	(0.0260)	(0.0264)	(0.0262)	(0.0264)
CB	-0.0390**			-0.0386**	-0.0382**					
	(0.0155)			(0.0152)	(0.0155)					
MC	0.0039			0.0044	0.0049	-0.0176		-0.0176		-0.0168
	(0.0083)			(0.008)	(0.0083)	(0.0115)		(0.0116)		(0.0114)
Union member		-0.0028		-0.004			0.001	0.0014		
		(0.0077)		(0.0079)			(0.0071)	(0.0074)		
Union density			-0.0077		-0.0079				-0.0215*	-0.0216*
			(0.0136)		(0.0140)				(0.0121)	(0.0122)
Observations	5,910	6,180	6,180	5,910	5,910	4,520	4,820	4,520	4,820	4,520
# of schools	1,150	1,210	1,210	1,150	1,150	930	980	930	980	930

Note: Errors are clustered within schools (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1. Control variables: same as in Table 4 for SASS

conditions and/or non-wage benefits. Union membership and union density are more important mechanisms for unions influencing teachers' earnings than the contractual status. For working conditions and non-wage benefits, union density and contractual status is more relevant channel for union effects. Especially, I find that MC has stronger associations with teachers' non-wage benefits than CB does.

Table 3.8 examines the existence of compensating differentials between teachers' earnings and working condition by group. Teachers who earn more in base salaries work for longer contract days. For example, in High-CB group, increasing the base salaries by 10 percent is associated with 0.7 percent longer contract days, which is equivalent to approximately 1.3 days. Teachers in High-CB group face more favorable trade-offs than teachers in Low-CB group as a 10-percent-increase in base salaries is associated with a 2.5 day-increase in contract days in the Low-CB group. Teachers in No-CB group face no trade-offs between salaries and working conditions, perhaps because the relationship between teachers unions and both earnings and working conditions are quite small. The trade-offs are also found between base salaries and non-wage benefits. Districts that pay higher base salaries have a lower probability of offering defined-contribution retirement plans to teachers than the districts that pay lower base salaries.

In sum, collective bargaining is neither a necessary nor a sufficient condition for teachers unions to affect teachers' working lives. Teachers unionize even where collective bargaining is prohibited, and they gain modest wage premium for members. Teachers in the districts with collective bargaining agreements do not necessarily earn higher salaries than teachers in districts with no agreement. The union effects on outcome variables vary in different legal settings, and the mechanisms through which teachers unions influence

outcomes also differ by group, which shows that it is precarious to generalize the relation between the unions and outcomes in one legal setting to another.[41]

3.7 Conclusion

One of the big challenges in studying public sector unionism is to obtain measures of collective bargaining status and the strength of a union in or out of collective bargaining. I used the School and Staffing Survey (SASS) to construct a multilevel dataset of school districts, schools, and teachers. I combined this dataset with the Comparable Wage Index (CWI) data, which allowed me to control for geographic variation in cost of living, amenity/disamenity, and other unobservable labor market characteristics. By merging the data of districts' financial status from the School Districts Finance Survey to the SASS multilevel dataset and the CWI, I created a district-teacher matched dataset for U.S. public schools.

Some of my findings run counter to the standard story of labor unions. The surprising findings that have emerged from my empirical analysis are that: i) about half of teachers joined teachers unions in even districts where collective bargaining was not allowed, and union members gained a modest wage premium in those districts, ii) a meet-and-confer agreement, which many viewed as a relic of the past, had continued to play an important role for teachers unions and had positive association especially with teachers' non-wage benefits, iii) teachers in districts with collective bargaining agreements did not invariably receive

[41] This result also implies that the external validity of an experimental study for union effects in one legal environment may be weak.

higher base salaries than teachers in the districts that have no agreement with teachers unions[42].

Using multilevel mixed-effect models and propensity score matching, I found that teachers unions behaved in different ways in different legal settings. Whereas the contractual status between school districts and teachers unions had no association with teachers' base salaries within each group, union membership and density had a positive association with base salaries in High-CB group and No-CB group. In Med-CB group and Low-CB group, teachers unions did not bring any wage gain from union activities. In all groups, however, teachers unions are associated with better working conditions (smaller number of contract days) and/or greater non-wage benefits (higher probability that districts offer defined-contribution retirement plans to teachers or with the probability that employer pay funds into the retirement plans). Finally, I found the trade-offs between teacher salaries and other kinds of compensations. The trade-offs between the salaries and other types of compensations was more favorable for teachers in High-CB group than in Low-CB group as teachers in Low-CB group were required to forgo larger salaries to enjoy the same working conditions as teachers in High-CB group.

In the debate over the collective bargaining of public sector workers, both the pro-collective bargaining and the anti-collective bargaining forces seem to believe that the bargaining is the be-all and end-all for public sector unions. My analysis rejects this proposition. The legal environments and contractual status are important for teachers unions to influence teachers' lives, but unions organize with or without bargaining power as the "freedom of assembly" asserts. Furthermore, teachers unions manage to find ways to affect

[42] Underpinning this result was the finding that teachers unions in districts with collective bargaining laws but without agency fees failed to have any significant wage effect.

teachers' well-being even under the most hostile legal environments. Therefore, broadening the perspective towards unionism beyond collective bargaining is essential to fully understand how unions behave and operate in the public sector.

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Chapter 4: Reevaluation of the Role of Teachers Unions on Teacher Pay Structure and School Districts' Financial Status

This paper reevaluates the role of teachers unions on teachers' pay structure and school districts' financial status, using dataset based on the School and Staffing Survey (SASS) and School Districts Finance Survey for 2007-2008. In contrasts to previous findings on unionism, I find that the variance of teachers' earnings is higher in more unionized settings. The positive association between earning variance and unionism is mainly because the increased variance from more credentials-based pay structure dominates the reduced variance from less merit-based pay. Moreover, I find that teachers unions play a larger role in raising more revenue than increasing expenditure of school districts. Therefore, unlike common beliefs that teachers unions weaken financial soundness of school districts, my study shows that the financial status of school districts with teachers unions is stronger than that of districts without the unions.

Key words: collective bargaining, meet-and-confer, agency fees, income inequality, performance pay system, budget deficit

4.1 Introduction

Labor unions have been the subject of debate and dispute for a long time. Ever since the publication of Richard Freeman and James Medoff's *What Do Unions Do?* in 1984, the issues in the book have been greatly discussed in the labor economics. Although most studies agree that the purpose of unions to improve workers' well-being, how union affect workers compensation and other working conditions or whether the union effects are good or bad for social outcomes still remain controversial. In the meantime, some topics are being overlooked because many believe the role of unions in those fields is well understood or the lack of reliable data makes it difficult to study union effects in those topics. In this study, I focus on two of these subjects; the role of unions on the employees' pay structure and employers' financial status.

Unions historically reduce inequality in the distribution of earnings (Freeman and Medoff, 1984; Hirsch and Addison, 1986; Dinardo and Lemieux, 1997). According to these studies, unions have diminished the individual variation in wages by standardizing the pay rate among workers with similar levels of work experience, seniority, and skill. Studies using the panel data for individuals or cross-countries showed that the unionism reduced the income inequality in the public sector (Dinardo, Fortin, and Lemieux, 1996; Lemieux, 1992; Riddell, 1992). Using the CPS data between 1973, 1974, and 1993, Card (2001) also found that increased unionism substantially reduced the wage inequality for both male and female workers within the public sector. According to his estimation, the wage variance would have risen by 30-40 percent in the absence of unions in the public sector.

Wage inequality is closely related to performance-based pay system, and it is commonly believed that unions dislike performance pay system. Teachers unions, for example, often oppose bonus payments system on the basis of the academic performance of students. (Uzell 1983; Brandt 1990). Gregg and Machin (1988) found that, on average, the performance linked pay schemes are less likely to be present if an establishment has a strong union rather than a weak one. Lemieux, Macleod, and Parent (2009) showed that incidence of performance pay has been growing more among nonunion workers than among union workers. However, Ballou and Podgursky (1994, 1997) challenged the widely held belief that most teachers are against performance pay system. For example, Ballou and Podgursky found that Black and Hispanic teachers tend to support pay for performance (1994), and most teachers favor additional pay based on performance as an opportunity to speed up the promotion (1997). Therefore, whether the preference of unions towards performance pay system is actually translated into the pay structure remains controversial.

Many critics of public sector unions have claimed that collective bargaining added to government's budget deficits by asking for higher compensations for employees, which caused or worsened the financial crisis of government. However, the empirical evidence on this issue is equivocal. Freeman and Ichniowski (1988) suggested that public sector collective bargaining could have some adverse effects on state or local budgets. Card, Lemieux, and Riddell (2004) showed that unions reduce wage inequality among male workers, but not among female workers. Allegretto et al. (2011) showed that the increase in budgetary problem after financial crisis was not due to the collective bargaining of public sector employees but mainly due to the fall in the housing prices. Freeman and Han (2012) found that states with more favorable legal environments towards collective bargaining of public sector employees

had slightly larger budget deficits than states that do not allow collective bargaining, but the results were sensitive to model specifications. They also found that some states that forbid collective bargaining of public sector employees were among those with the largest budget deficits.

Building on these studies, my research evaluates common beliefs about the unions in the public sector. Using the dataset in the educational sector, the School and Staffing Survey (SASS) for 2003-2004 and 2007-2008, I investigate whether teachers unions reduce income inequality, whether they result in low rate of implementation of performance pay system, and whether they worsen the financial condition of their employers. Motivated from Han (2012), which showed that the absence of financial information of school districts resulted in the omitted variable bias in the estimated union effects, this study uses a unique dataset that merges different sources of data to utilize the information on school districts' economic status in addition to general characteristics of school districts.

In contrast to the findings of previous literature on unions, my study shows that teachers unions are associated with higher variance of teacher salaries as the salary structures is based more on objective credentials, which tend to raise the income variance, and less on performance pay system, which tends to lower the income variance. Moreover, my data on financial information of school districts rejects the conventional wisdom that public sector unions deteriorate employers' financial status. Rather, I show that unionism is associated with stronger financial standing of school districts, measured by district's total budget. I find that teachers unions play a greater role in raising districts' total revenue per student than raising districts' total expenditure per student.

4.2 Legal Settings for Teachers Unions

The legal environments for public school teachers differ greatly by state. Followed by Han (2012), I categorize states into four groups by two legal criteria: the legal status of collective bargaining and of the agency shop for public school teachers. Table 4.1 shows the group classification of 50 states using these legal criteria. The "High-CB" group contains 23 states that have compulsory collective bargaining laws and allows unions and employers to negotiate mandatory agency fees for workers who do not join the unions.[43] The "Med-CB" group contains 11 states that have compulsory collective bargaining laws but bans mandatory agency fees. Thus, non-members in the Med-CB group do not pay the unions dues even though they are covered by collective bargaining. The "Low-CB" group consists of 9 states that allow collective bargaining to happen but does not require employers to bargain with unions. The "No-CB" group consists of 7 states that outlaw collective bargaining by public sector workers. The group categorization reflects the strength of the legal settings towards unions in a descending order, ranging from the most favorable (the High-CB group) to the most hostile (the No-CB group) legal environment for collective bargaining of public sector unions.

All unions and school districts, except in the No-CB group, can sign collective bargaining agreements (CB). These agreements determine teacher pay and conditions of work environment, and the outcomes are legally binding. In all states, including the No-CB group, districts and unions can choose the alternative option to collective bargaining, called "meet-and-confer (MC)". During meet-and-confer, teachers unions and school districts exchange

[43] The 'compulsory' bargaining laws do not imply that laws automatically establish the bargaining agreement between employers and employees in the public sector, regardless of workers' preferences. The collective bargaining is mandated only when the majority of employees favor it.

information, opinions, and proposals to reach a resolution on matters within the scope of representation prior to the adoption by the districts of its final budget for the ensuing year. However, unlike the collective bargaining agreements that produce legally binding contracts at the end of the meeting, the outcomes of meet-and-confer agreements are generally legally unenforceable.

In some school districts, even in the High-CB and the Med-CB group that have mandatory collective bargaining laws, there is no agreement between teachers unions and school districts. In this case, teachers are covered by neither collective bargaining nor meet-and-confer agreement. In the No-CB group, the majority of school districts have no agreement with teachers unions, and meet-and-confer is the only available agreement option between teachers unions and districts.

Table 4.1: Legal Environments for Collective Bargaining of Public School Teachers

Group	Definition	States
High-CB	States that have compulsory CB laws and allow agency fees	Alaska, California, Connecticut, Delaware, Hawaii, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Hampshire, New Jersey, New Mexico, New York, Ohio, Oregon, Pennsylvania, Rhode Island, Vermont, Washington, Wisconsin
Med-CB	States that have CB laws but prohibit agency fees	Florida, Idaho, Indiana, Iowa, Kansas, Nebraska, Nevada, North Dakota, Oklahoma, South Dakota, Tennessee
Low-CB	States that do not have CB laws but allow CB	Alabama, Arkansas, Colorado, Kentucky, Louisiana, Missouri, Utah, West Virginia, Wyoming
No-CB	States that ban CB of public sector workers	Arizona, Georgia, Mississippi, North Carolina, South Carolina, Texas, Virginia

Source: "Teacher Monopoly, Bargaining, and Compulsory Unionism, and Deduction Revocation Table", National Right to Work Foundation (2010)

4.3 Data

The primary data source I use is from the 2007-2008 *Schools and Staffing Survey* (SASS) administered by National Center for Education Statistics (NCES).[44] The SASS data is multilevel; the information is obtained from the questionnaires at teacher, school, and school district level. The school district questionnaire asks about the contractual status between districts and teachers unions (i.e. if a school district has collective bargaining agreement, meet-and-confer agreement, or no agreement at all with the unions). The teacher questionnaire asks if a respondent is a member of teachers unions (or association similar to unions). I compute the union density by district using this information on union membership status of individual teacher and utilize it as an additional measure for unionization of teachers. In the SASS district data, there are about 4,600 school districts which covers a third of the U.S. public school districts.

I also use the Comparable Wage Index (CWI) from the NCES. The CWI, developed by Taylor and Fowler (2006), measures the regional variations in the salaries of college graduates in non-educational sector. The CWI measures the salaries of occupations that are comparable to teaching in the local labor market using baseline estimates from the 2000 U.S. census and annual data from the Bureau of Labor Statistics' Occupational Employment Survey. The CWI is available at school district level, so it provides the mean for geographically appropriate comparisons for locality differences in cost of living and other labor market conditions that can otherwise contaminate comparisons due to unobservable

[44] I also examine the 2003-2004 wave of the SASS. Since there was little change in the collective bargaining status of school districts between 2003-2004 and 2007-2008, I use the 2003-2004 data for a sensitivity analysis for my 2007-2008 results rather than pooling it with the 2007 data to exploit changes over time in panel data.

factors in the local labor market. The CWI is also an appropriate measure of the opportunity cost of being a teacher over finding a non-teaching career in teachers' school district.[45]

The final data source is the *School Districts Finance Survey* (SDFS) from Education Finance Statistics Center (EDFIN) of NCES. SDFS has detailed annual fiscal data on public elementary and secondary education for every school district in the U.S. This data provides valuable information on both the revenue and the expenditure of each school district. I merge information from the SDFS and CWI with the SASS district data to create the master dataset of school districts for 2007-2008. After the merge, the sample in my master dataset includes about 3,800 school districts. For the sensitivity analysis, I also utilize another dataset which merged 2003-2004 SASS with 2003 CWI and 2003 SDFS in the same way I used to create the master dataset for 2007-2008.

Table 4.2 provides some key statistics from the dataset grouped by the legal environment for teachers unions. The majority of school districts in the High-CB group and the Med-CB group are covered by collective bargaining agreements. In the Low-CB group, collective bargaining of teachers unions is allowed, but more school districts have meet-and-confer with teachers unions than collective bargaining. In the No-CB group, most school districts have no agreement with the unions, but many districts are covered by meet-and-confer agreements. Union density of each state is calculated using teachers' union membership status from the SASS teacher level data. Approximately 90 % of teachers are unionized in the High-CB group. The union density in the Med-CB group and Low-CB group

[45] The basic idea is that all workers will ask for higher wages in areas with a higher cost of living or with lack of amenities. If non-teachers have similar age, educational background, and preference for amenities, the CWI can be used to measure the uncontrollable component of variations in the wages paid to educators. The CWI predicts that Atlanta teachers in metro areas should also be paid 5 percent more than the national average teacher wage, if accountants in the Atlanta metro areas are paid 5 percent more than the national average accountant wage, for example.

is very similar even though the former group has mandatory collective bargaining laws and the latter group does not. More than 60% of teachers are unionized in both groups, but more than 80% of teachers are covered by collective bargaining in the Med-CB group. This implies that there are many free-riders, mainly due to the fact that agency fees are not allowed in this group. In the No-CB group, collective bargaining is banned, but about half of teachers still join the unions.

Most school districts require a state or district assessment for high school graduation in the No-CB group. The number of instruction in major subjects required for high school graduation is also the greatest in the No-CB group. This suggests that the No-CB group set stricter standard for high school graduation compared to other groups do. The number of days in the normal contract year is the smallest but the salary schedule is the highest for teachers in the High-CB group. The fraction of districts rewarding teachers for excellence in teaching is much higher in the No-CB group than in the High-CB group. More school districts offer group life insurance and retirement plan in the Low-CB and the No-CB group than in the High-CB group. Percent of Hispanic or Black students are the highest in the No-CB group. Percent of students with reduced or free-lunch program is also the highest in the No-CB group. The CWI, which reflects the cost of living of a school district, is the highest in the High-CB group and the lowest in the Med-CB group. I measure the financial status of each state by the average of school districts' budget (total revenue – total expense of school districts) divided by the total revenue of school districts. On average, there exist greater budget deficits in the Low-CB group and the No-CB group than in the High-CB group and the Med-CB group.

Table 4.2: Descriptive Statistics by Group
SASS School District Data, 2007-2008

	High-CB	Med-CB	Low-CB	No-CB
# of districts with meet-and-confer agreement (MC)	190	150	190	90
# of districts with collective bargaining agreement (CB)	1,790	760	70	0
# of districts with no agreement (NA)	150	150	440	620
Union density	0.89	0.65	0.63	0.47
% of districts with state or district assessment requirement for high school graduation	58.7	40.7	34.8	95.2
# of years of instruction required for high school graduation for the field of				
English	3.94 (.31)	3.97 (.26)	3.91 (.31)	3.99 (.19)
Mathematics	2.88 (.61)	2.89 (.57)	3.26 (.66)	3.30 (.54)
Computer science	.41 (.57)	.57 (.68)	.50 (.61)	.69 (.65)
Social studies	3.20 (.58)	3.07 (.55)	3.24 (.54)	3.38 (.57)
Physical or biological science	2.59 (.65)	2.65 (.65)	2.99 (.72)	2.89 (.62)
Foreign language	.46 (.77)	.38 (.74)	.40 (.73)	.81 (.94)
Days in the normal contract year for a teacher	187 (26)	189 (26)	190 (28)	194 (30)
Yearly base salary schedule ($) for teachers with				
BA with no teaching experience	35,540 (5,630)	30,650 (3,110)	33,090 (3,840)	33,590 (4,200)
BA with 10 years of teaching experience	47,780 (9,230)	36,728 (4,106)	39,670 (4,920)	40,180 (4,200)
MA with no teaching experience	39,200 (6,080)	33,180 (3,190)	36,550 (4,420)	36,170 (4,350)
MA and 10 years of teaching experience	53,740 (10,100)	40,960 (4,910)	44,000 (5,830)	43,650 (4,830)
% of districts rewarding excellence in teaching	5.15	8.15	6.46	20.48
% of districts offering				
general medical Insurance	99.16	98.48	97.85	98.74
dental insurance	91.57	79.81	84.36	88.92
group life insurance	84.50	80.47	91.54	93.13
defined-benefit (DB) retirement plan	85.77	84.55	93.11	90.04
defined-contribution (DC) retirement plan	67.7	67.2	73.03	69.85
% of districts paying funds into DC plan	36.1	50.54	47.21	36.0
% of Hispanic students	13.11	10.45	6.63	16.66
% of Black students	10.58	8.25	16.46	28.49
% of Asian students	5.32	1.76	1.27	1.84

Table 4.2: Descriptive Statistics by Group (Cont.)

	High-CB	Med-CB	Low-CB	No-CB
% of students with free or reduced lunch	37.40	39.71	44.05	50.91
% of large/mid-size city and urban fringe	57.12	26.07	32.16	40.8
Log (Comparable Wage Index)	.17 (.14)	.02 (.09)	.06 (.10)	.12 (.11)
Average ratio of (district's revenue-district's expense)/ district's revenue	-0.003	0.006	-0.028	-0.028
N	2,130	1,060	700	710

Note: Standard deviations are reported in parentheses

4.4 Empirical Strategies

I employ weighted OLS regressions to evaluate some of the commonly held beliefs about teachers' unions. The legal environment towards collective bargaining of public sector unions has historically evolved over several decades since 1970s to shape the exogenous perspective on unionism in each state. Thus, I first utilize the dummy variables for four legal groups to measure strength of the unionism to investigate the relationship between legal environments toward collective bargaining and outcomes of interest. I also use additional measures for unionism; the contractual status (collective bargaining or meet-and-confer agreement) between unions an districts and union density of districts. The equations I estimate to evaluate these claims are:

$$Outcome_k = \beta_0 + \beta_1 HighCB_k + \beta_2 MedCB_k + \beta_3 LowCB_k + \beta_4 Density_k + \beta_5 X_k + \varepsilon_k \quad (1)$$

$$Outcome_k =$$

$$\beta_0 + \beta_1 CB_k + \beta_2 MC_k + \beta_3 Density_k + \beta_4 (CB * Density)_k + \beta_5 (MC * Density)_k + \beta_6 X_k + \varepsilon_k \quad (2)$$

where k indicates school district. $HighCB_k$, $MedCB_k$, and $LowCB_k$ are the binary variables indicating if the k^{th} district belongs to the High-CB group, the Med-CB group or the Low-CB group respectively. The No-CB group is the reference group in the analysis. $Density_k$ represents the union density of the k^{th} district measured on a scale of 0 to 1. CB_k and MC_k are binary variables indicating if the k^{th} district has collective bargaining or meet-and-confer agreement with teachers unions, respectively. No-agreement districts form the reference group. *X* represents the vector of control variables at school district level.[46] Each regression is weighted by school districts' final weights. As seen in Table 4.2, each group has some distinctive characteristics that may be related to both unionism and the outcomes of interest. Thus, state dummies are also included in model (2) to reduce omitted variable bias in estimating union effects.

I also run the separate regression analysis for each group using model (2) to examine if the effects of teachers unions vary depending on legal environment towards collective bargaining. The estimated union effects may be smaller within each group than across groups because the spillover effects of unions are more easily transmitted within the same group whose members share the similar legal and cultural view towards unionism.

The first claim I evaluate is that teachers unions, like most private and public sector unions, compress the pay structure and reduce income inequality. To assess this claim, I estimate union wage differentials for the log (minimum teacher salary schedule) and the log (maximum teacher salary schedule). If teachers unions compress the pay scale, the strength of

[46] These include log (CWI), log (average number of days in the school year), log (student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program within the district, a dummy for districts that offer classes for secondary grades (grades 7^{th} -12^{th}), students' ethnicity and race, teachers' ethnicity and race, a dummy indicating if a district requires high school students to pass a state or district assessment to earn high school diploma, log (total revenue), and 2000 decennial census locale code of districts.

the association between the unions and the minimum salary schedule would exceed the strength of association between the unions and the maximum salary schedule. I also examine the relation between unionism and the variance of teachers' base salaries within school districts, which is a widely used measure of pay inequality in literature.[47]

The second assertion is that teachers unions strongly oppose pay for performance, which allows school districts to pay teachers based on some academic performance measures of their students. To investigate if this claim has any empirical ground, I use the binary variable indicating if a district rewards teachers for excellence in teaching. In Table 4.2, the No-CB group has the highest fraction of districts that pay incentives based on their performance, so the unconditional mean supports the common belief that teachers unions are against the performance pay system. One of the important elements to consider examining the role of unions on performance pay system is employers' economic condition. A school district with better financial status would be more likely to compensate high-performing teachers in addition to their base salaries than a school district with financial distress. Since my dataset contains the information on school districts' fiscal standing, I can separate out the effect of the financial situation of districts from the effect of teachers unions on performance pay system.

Lastly, I look into the validity of the claim that public sector unions worsen the financial condition of the employers. Many argue that unions increase the public spending beyond the financial capacity of the employers. To evaluate this assertion, I use three outcome variables; per pupil revenue measured by log (district's total revenue/number of students), per pupil spending measured by log (district's total expenditure/number of students), and district's total budget, measured by (total revenue–total expenditure)/1,000,000. Unlike the

[47] The minimum salary schedule and maximum salary schedule are provided in district level dataset of the 2007-2008 SASS. I calculate the variance of base salaries/10,000 within each district using the teacher level dataset from the 2007-2008 SASS, and merge this information to district level dataset.

common belief, the descriptive statistics reported in Table 4.2 show that the Low-CB group and the No-CB group have larger budget deficits than the High-CB group and the Med-CB group. The regression analysis can confirm if this finding stands even after controlling for other relevant variables.

4.5 Results

Most studies agree that unions tend to reduce income inequality in wage distribution. Initially, I have hypothesized that unions would have larger influence on the minimum salary schedule than on the maximum salary schedule to attain more compressed income distribution. However, I find that teachers unions affect the maximum salary schedule much more than the minimum salary schedule. Moreover, unions are associated with a greater variance in base salaries, thus with a wider pay structure. The first and the second panel of Table 4.3 present the effect of unionism on teachers' minimum and maximum salary schedule respectively. Column (1) shows that the High-CB group has a larger minimum salary schedule by 6.2 percent compared to the No-CB group. Column (4) shows that the High-CB group also has larger maximum salary schedule compared to the No-CB group but by greater magnitude, 16.7 percent, so the gap between the two groups is much greater for the maximum salary schedule. Moreover, both union density and contractual status (CB or MC) are positively associated only with the maximum salary schedule (see column 5). The third panel of Table 4.3 shows that the districts in the High-CB group have larger variance of base salaries of teachers and less compact wage distribution than the districts in the No-CB group

Table 4.3: The Effect of Teachers Unions on the Pay Structure

SASS, 2007-2008 District Level Dataset

Weighted OLS Regression

Dependent Variables: Log(Minimum Salary schedule), Log(Maximum Salary schedule), and Variance(Base Salary/10,000)

VARIABLES	(1) min_sal	(2) min_sal	(3) min_sal	(4) max_sal	(5) max_sal	(6) max_sal	(7) var_sal	(8) var_sal	(9) var_sal
High-CB	0.0620**			0.167***			76.77***		
	(0.031)			(0.0502)			(14.51)		
Med-CB	0.0050			-0.003			13.07		
	(0.0313)			(0.0449)			(9.046)		
Low-CB	0.0341			0.0029			8.458		
	(0.0320)			(0.0498)			(10.34)		
CB		-0.0042			0.0470*			12.66	
		(0.0086)			(0.0249)			(12.21)	
MC		0.0087			0.0316*			20.23	
		(0.0071)			(0.0178)			(20.20)	
Union density			-0.0024			0.0539**			28.10**
			(0.0054)			(0.0217)			(11.76)
Log(revenue)	0.066***	0.038***	0.038***	0.112***	0.086***	0.085***	59.18***	57.39***	55.94***
	(0.0183)	(0.0059)	(0.0058)	(0.0239)	(0.0171)	(0.0167)	(18.04)	(11.38)	(11.30)
State dummies		Yes	Yes		Yes	Yes		Yes	Yes
Observations	3,700	3,700	3,700	3,700	3,700	3,700	3,650	3,650	3,650
Adjusted R^2	0.501	0.763	0.763	0.668	0.780	0.782	0.231	0.276	0.260

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1

Control variables: log (CWI), a dummy variable indicating if a district requires high school students to pass a state or district assessment to earn high school diploma, log (total student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program, log (number of school days), a dummy for district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes

does (see column 7), and that union density is positively linked to the wage variance (see column 9). District's total revenue has positive association with salary schedules suggesting that districts with better financial status are able to pay teachers more.

I repeat the same analysis using SASS 2003-2004 master dataset to check if this story is consistent across different time period. Table 4A in Appendix IV reports the results in the same format with Table 4.3. The magnitudes of the coefficients of union measures are very similar to those from the SASS 2007-2008 master dataset and the signs of the coefficients are the same. The High-CB group compared to the No-CB group is positively linked to the teacher salary schedule, and more so with maximum salary schedule. Contractual status, both CB and MC, lose statistical significance, but union density has larger association with maximum salary schedule than with minimum salary schedule. Therefore, as seen from the SASS 2007-2008, unionism is positively associated with wage variance.

This pattern, however, is not universal across legal environment. I examine the relation between unionism and wage variance by legal group using 2007-2008 SASS master dataset. Table 4.4 presents the estimated coefficients and standard errors for contractual status and union density for each group. For each group, first two columns do not include state dummies and last two columns add state dummies. The last two columns emphasize more in the variation of unionism within the states than the first two columns. Districts covered by collective bargaining agreement have larger wage variance relative to districts with no agreement in both the High-CB group (see column 1 and 3) and the low-CB group (see column 9 and 11). However, in the low-CB group, union density is negatively associated with wage variance (see column 10 and 12), so the total effect of unionism on wage distribution is unclear. Union density is positively associated in all the other groups, although

Table 4.4: The Effect of Teachers Unions on the Pay Structure by Group
SASS, 2007-2008 District Level Dataset
Weighted OLS Regression
Dependent Variables: Variance (Base Salary/10,000)

VARIABLES	High-CB group				Med-CB group			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CB	73.26**		44.86*		-11.20		-9.822	
	(32.61)		(23.23)		(11.52)		(10.87)	
MC	94.87		80.47		-15.08		-10.80	
	(66.17)		(57.33)		(10.12)		(10.97)	
Union density		86.45***		53.08**		8.026		3.213
		(30.01)		(24.79)		(13.16)		(8.946)
State dummies			Yes	Yes			Yes	Yes
Observations	1,600	1,600	1,600	1,600	900	900	900	900
Adjusted R^2	0.134	0.134	0.200	0.198	0.117	0.115	0.177	0.175

VARIABLES	Low-CB group				No-CB group			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
CB	17.26**		10.84*					
	(5.348)		(5.965)					
MC	-5.424		-6.631		-4.421		5.607	
	(6.822)		(7.431)		(7.382)		(7.910)	
Union density		-12.66		-16.87*		5.504		8.604
		(7.607)		(9.024)		(15.40)		(19.10)
State dummies			Yes	Yes			Yes	Yes
Observations	590	590	590	590	560	560	560	560
Adjusted R^2	0.184	0.181	0.190	0.190	0.058	0.059	0.083	0.083

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1
Control variables: log (CWI), log(revenue), a dummy variable indicating if a district requires high school students to pass a state or district assessment to earn high school diploma, log (total student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program, log (number of school days), a dummy for district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes

only the High-CB group shows statistical significance (see column 2 and 4). In sum, as opposed to standard understanding, I do not find the evidence that unionism reduces income inequality in the educational sector.

Table 4.5 presents the evidence that teachers unions are associated with less use of performance pay system. Column (1) shows that the No-CB group among all groups is most likely to reward their teachers for excellence in teaching. Column (2) adds union density to the model, and the coefficients for the High-CB and Med-CB become insignificant. This suggests that union density may be the main mechanism for teacher unions to influence the implementation of performance pay system. According to column (3), the probability of rewarding teachers for excellence in teaching falls by 10 percentage points in the districts with collective bargaining agreements compared to districts without any agreement with the unions. The probability of rewarding teachers for excellence in teaching is about 6 percentage points lower for meet-and-confer districts compared to no-agreement districts. Regardless of the contractual status, a 10-percent-increase in union density is associated with the reduction of the probability of rewarding teachers for excellence in teaching by 1 percent (see column 4). In Table 4.2, the No-CB group has the highest rate of rewarding their teachers for excellence in teaching, on average. To control for this, I include state dummies in the last two model specification only to see the state dummies playing minor role.

Table 4B in the Appendix IV replicates the Table 4.5 using 2003-2004 SASS dataset. The signs of most coefficients for unionism measures, except for meet-and-confer, are still negative, although the statistical significance in many coefficients disappear. In column (2) and (4), union density is still negatively associated with the probability of rewarding teachers

Table 4.5: The Effect of Teachers Unions on Performance Pay System

SASS 2007-2008 District level Dataset

Weighted OLS Regression

Dependent Variable: Binary Variable for Districts Rewarding Teachers for Excellence in Teaching

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
High-CB	-0.0805***	-0.0439				
	(0.0293)	(0.0368)				
Med-CB	-0.0638*	-0.0502				
	(0.0319)	(0.0313)				
Low-CB	-0.0631**	-0.0530*				
	(0.0284)	(0.0280)				
Collective bargain			-0.0931***		-0.104***	
			(0.0232)		(0.0307)	
Meet-and-confer			-0.0581***		-0.0651**	
			(0.0206)		(0.0269)	
Union density		-0.101**		-0.113***		-0.0717**
		(0.0473)		(0.0368)		(0.0320)
State dummies					Yes	Yes
Observations	3,790	3,790	3,790	3,790	3,790	3,790
Adjusted R^2	0.152	0.162	0.222	0.217	0.222	0.217

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1

Control variables: log (CWI), log(total revenue), a dummy variable indicating if a district requires high school students to pass a state/district assessment to earn high school diploma, log (total student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program, log (number of school days), a dummy for district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes.

for excellence in teaching. Adding state dummies in column (6) cut the magnitude of the coefficient in half, but it seems clear that union density is the key channel for teachers unions to affect the performance pay system. Districts with higher union density are less likely to implement pay for performance than districts with lower density.

The group analysis for the effect of unionism on performance pay system is presented in Table 4.6. In the High-CB group, a negative association exists between unionism and performance pay system. In column (1) and (3), districts that have collective bargaining or meet-and-confer agreements with unions have smaller probability of rewarding teachers for excellence in teaching than districts that have no agreement with unions. Column (2) and (4) show that union density is negatively associated with pay for performance in the High-CB group. The association between unionism and performance pay is weak in the Med-CB group and uncertain in the low-CB and the No-CB group. Therefore, districts with stronger unionism tend to reject performance pay system, and this is more common for the states that have favorable legal environment towards collective bargaining of teachers.

Teacher salary schedules are usually determined based on observable credentials such as teaching certification status, education level, and seniority. Pay structure mainly based on teacher qualification or teaching performance tends to increase the variance in income distribution. On the other hand, less use of pay for performance reduces income variance. When the increased income variance due to greater use of credentials for pay structure is more than the offset by the reduced income variance due to less use of performance pay, the income distribution becomes wider. Therefore, teachers unions which object to pay for performance are associated with greater income inequality.

Table 4.6: The Effect of Teachers Unions on Performance Pay System by Group
SASS, 2007-2008 District Level Dataset
Weighted OLS Regression
Dependent Variable: Binary Variable for Districts Rewarding Teachers for Excellence in Teaching

VARIABLES	High-CB group				Med-CB group			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CB	-0.241***		-0.217***		-0.0353		-0.0275	
	(0.0787)		(0.0748)		(0.0276)		(0.0277)	
MC	-0.215***		-0.205***		-0.0448		-0.0336	
	(0.0642)		(0.0573)		(0.0326)		(0.0324)	
Union density		-0.198**		-0.173*		-0.0069		0.0381
		(0.0822)		(0.0840)		(0.0332)		(0.0253)
State dummies			Yes	Yes			Yes	Yes
Observations	1,660	1,660	1,660	1,660	940	940	940	940
Adjusted R^2	0.278	0.261	0.315	0.302	0.087	0.083	0.179	0.180

VARIABLES	Low-CB group				No-CB group			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
CB	0.0894*		0.0386					
	(0.0455)		(0.0812)					
MC	0.0389**		0.0208*		-0.0260		-0.0366	
	(0.0131)		(0.0108)		(0.0834)		(0.0727)	
Union density		-0.0081		-0.0441		0.0240		0.0663
		(0.0294)		(0.0300)		(0.0721)		(0.0681)
State dummies			Yes	Yes			Yes	Yes
Observations	610	610	610	610	590	590	590	590
Adjusted R^2	0.049	0.038	0.093	0.093	0.167	0.167	0.205	0.207

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1
Control variables: log (CWI), log(total revenue), a dummy variable indicating if a district requires high school students to pass a state/district assessment to earn high school diploma, log (total student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program, log (number of school days), a dummy for district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes.

Table 4.7: The Effect of Teachers Unions on District Finance

SASS, 2007-2008 District Level Dataset

Weighted OLS Regression

Dependent Variables: Log(Revenue/Student), Log(Expenditure/Student), and (Total Revenue –Total Expenditure)/1,000,000

VARIABLES	(1) lnrev_kid	(2) lnrev_kid	(3) lnrev_kid	(4) lnexp_kid	(5) lnexp_kid	(6) lexp_kid	(7) budget	(8) budget	(9) budget
High-CB	0.13***			0.108**			1.216		
	(0.043)			(0.047)			(0.884)		
Med-CB	-0.0077			-0.0348			0.957		
	(0.049)			(0.049)			(1.138)		
Low-CB	-0.0233			-0.0016			1.177		
	(0.060)			(0.050)			(1.113)		
CB		0.119***			0.126***			2.650**	
		(0.041)			(0.041)			(1.293)	
MC		0.114***			0.121***			2.519*	
		(0.034)			(0.039)			(1.397)	
Union density			0.143***			0.128**			2.699**
			(0.051)			(0.052)			(1.177)
State dummies		Yes	Yes		Yes	Yes		Yes	Yes
Observations	3,790	3,790	3,790	3,790	3,790	3,790	3,790	3,790	3,790
Adjusted R^2	0.343	0.476	0.477	0.312	0.433	0.432	0.031	0.057	0.056

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1

Control variables: log (CWI), a dummy variable indicating if a district requires high school students to pass a state or district assessment to earn high school diploma, log (total student enrollment grades K-12), log (total number teachers for grade K-12), fraction of students eligible for free or reduced-price lunch program, log of number of school days, a dummy for district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes

Finally, as noted earlier, I find no support in my data that teachers unions are detrimental to financial status of their school districts. Recall that the financial status of states, measured by the average of school districts' budget (total revenue – total expense) divided by total revenue of districts, was lower in the Low-CB group and the No-CB group that do not have collective bargaining laws than in the High-CB group and the Med-CB group that have such laws (See Table 4.2). I utilize three variables to capture the financial status of districts; log (districts' total revenue per student), log (districts' total expenditure per student), and districts' budget/1,000,000. I regress these variables on various union measures using 2007-2008 SASS data, and Table 4.7 presents the results.

I find that there is positive association between unionism and district' revenue, and also between unionism and districts' expenditure. The first and the second panel of Table present the relation between unionism and districts' revenue/expenditure. In column (1), compared to districts in the No-CB group, districts in the High-CB group have larger total revenue per student by 13 percent. Column (4) shows that districts in the High-CB group have larger total expenditure per student than districts in the No-CB group by 10.8 percent. Thus, the positive association is stronger with districts' total revenue per student than with total expenditure per student. Column (2) and (5) show that controlling for state dummies, collective bargaining and meet-and-confer agreement are linked with larger districts' revenue and expenditure by similar amounts (11-12 percent). Union density is positively associated with both total revenue per student and total expenditure per student, but the association is also greater with total revenue per student. The third panel of Table 4.7 reports the estimated coefficients and standard errors for union effects on districts' budget. According to column (8), collective bargaining districts or meet-and-confer districts have higher budgets by $2.6

million compared to no-agreement districts. Union density is positively associated with the size of districts' financial standing to the extent that a 10-percent-increase in union density is linked with about $270,000 increase in districts' budget. This positive association between teachers unions and districts' financial status might be because teachers unions often lobby for larger education revenue so that more resources become available for educators and students.

I repeat the same analysis using 2003-2004 SASS master dataset, and Table 4C in Appendix IV presents the results. As seen in Table 4.7, the positive association is stronger between the unions and log (total revenue per student) than between the unions and log (total expenditure per student). Comparing column (2) and (5), we see that collective bargaining districts or meet-and-confer districts compared to no-agreement districts have both larger revenue and larger expenditure, but more of the revenue than the expenditure. Union density is significantly linked to total revenue per student (see column 3), but not to total expenditure per student (see column 6). In column (8) and (9), both contractual status and union density have positive association with districts' budgets. Collective bargaining has greater association with districts budget than meet-and-confer. The SASS 2007-2008 also shows this pattern, but SASS 2003-2004 shows it more clearly. Therefore, districts' budgets are higher for districts with greater unionism.

Table 4.8: The Effect of Teachers Unions on District Finance by Group
SASS, 2007-2008 District Level Dataset
Weighted OLS Regression
Dependent Variables: (Total Revenue −Total Expenditure)/1,000,000

VARIABLES	High-CB group				Med-CB group			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CB	3.449		4.515		1.641		2.809	
	(2.504)		(2.860)		(1.055)		(2.614)	
MC	4.536		5.563*		1.119		1.636	
	(3.207)		(3.393)		(0.682)		(1.684)	
Union density		1.878		3.281		0.848		0.971
		(1.967)		(2.517)		(0.912)		(1.309)
State dummies			Yes	Yes			Yes	Yes
Observations	1,655	1,655	1,655	1,655	936	936	936	936
Adjusted R^2	0.032	0.031	0.058	0.057	0.108	0.107	0.127	0.125

VARIABLES	Low-CB group				No-CB group			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
CB	-3.069*		-2.615					
	(1.514)		(1.691)					
MC	0.451		0.827		3.166		2.344	
	(0.682)		(0.754)		(2.814)		(2.934)	
Union density		0.548		1.165		1.728		2.441*
		(1.314)		(1.302)		(1.278)		(1.061)
State dummies			Yes	Yes			Yes	Yes
Observations	608	608	608	608	583	583	583	583
Adjusted R^2	0.121	0.117	0.129	0.126	0.157	0.155	0.173	0.173

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1
Control variables: log (CWI), a dummy variable indicating if a district requires high school students to pass a state or district assessment to earn high school diploma, log (total student enrollment grades K-12), log (total number teachers for grade K-12), fraction of students eligible for free or reduced-price lunch program, log of number of school days, a dummy for district offering classes to secondary grades (7^{th} -12^{th}), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes.

Table 4.8 shows the results from the group analysis for the union effects on districts' budgets. As seen in Table 4.7, teachers unions have positive association with school districts' budgets for most groups. In the Low-CB group, this association is not clear as the sign of the coefficient of collective bargaining is opposite to the sign of the coefficient of union density. However, the estimated negative association between collective bargaining and districts' budget loses its statistical significance with the addition of state dummies. This suggests that the negative coefficient for collective bargaining may be simply capturing the variation in the state-specific heterogeneity of districts' budget more than measuring union effects on budgets.

4.6 Conclusion

By combining the Schools and Staffing Survey (SASS) and School Districts Finance Survey data for 2007-2008, I created the unique dataset that contains more sophisticated measures on unionism of public school teachers and financial information of school districts. This dataset allowed me to reevaluate claims being made on teachers unions and their policies for teachers' labor market.

Some of my findings are against conventional wisdom about teachers unions, and sometimes quite the opposite from the standard story regarding labor unions. Unlike the previous studies that showed the negative association between unionism and income inequality, I found that the variance of teachers' earnings were higher in more favorable legal environment than in hostile legal environment for unions. I also found that teachers unions tend to undermine the probability of implementing performance pay system. Because the increased variance from more use of credentials-based pay structure dominated the reduced

variance from less use of merit pay system, unionism were positively associated with variance of earning for teachers.

Teachers unions raised both per pupil revenue and per pupil expenditure of school districts, but they raised the revenue more than the expenditure. Collective bargaining districts or meet-and-confer districts had higher budgets than no-agreement districts. Union density also has positive association with districts' economic situation. This finding rejects the common belief that unions tend to deteriorate employers' financial status by pushing for greater spending beyond the financial capacity of employers. The results from 2007-2008 SASS dataset are consistent with those of 2003-2004 SASS dataset.

My study suggests that the results from previous studies on unions in the public sector may not be applicable in more recent period. When school districts face budgetary problems, financial information of districts is a critical factor to consider examining union effects. Thus, reevaluation of the previous perspectives and understandings towards unionism is an important task to fully understand how unions behave and operate after the financial crisis in 2008. Moreover, it is essential to recognize that collective bargaining is not a necessary condition for public sector unions to affect outcomes of interest. Meet-and-confer agreement also plays an important role for unions to influence the well-being of employees and employers. Union density, regardless of contractual status, is also a significant channel for unions to affect school districts' outcomes. More study is required to comprehend how these non-bargaining mechanisms can affect the outcomes of both employees and employers.

It is noteworthy that the significance of union effects tends to decrease when I focus on each group and run separate analysis within the group of states with the same legal environment. This may be because the spillover effects of unions are stronger within legal

group or each state than across groups or states. Therefore, it is essential to understand how union effects actually spread out beyond their own districts influencing their neighborhood districts, although it seems clear that the workers' voice through the union density plays an important channel.

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Appendix I

Multilevel (Hierarchical) Mixed-Effect Linear Model

To adjust for the unobservable factors that are shared by the teachers within the same school, I use multilevel mixed-effect models that can contain both fixed effects and random effects. The mixed-effect model has the following form in matrix notation,

$$y = X\beta + Zu + \varepsilon \tag{1}$$

where y is the n × 1 vector of outcomes, X is an n × p covariate matrix for the fixed effects β, and Z is the n × q covariate matrix for the random effects u. The n × 1 vector of error terms, ε, is assumed to be multivariate normal with mean zero and variance matrix $\sigma_\varepsilon^2 R$. β is the regression coefficient to be estimated, and $X\beta$ is the linear predictor of the fixed portion in model (1). For the random portion of (1), $Zu+\varepsilon$, u is assumed to have variance–covariance matrix K, and it is orthogonal to ε. The total variance matrix is:

$$Var\begin{bmatrix} u \\ \varepsilon \end{bmatrix} = \begin{bmatrix} K & 0 \\ 0 & \sigma_\varepsilon^2 R \end{bmatrix} \tag{2}$$

The random effects u are not directly estimated but instead they are characterized by the variance components of K. They are estimated along with the overall residual variance (σ_ε^2) and the residual-variance parameters.

Since my data is clustered (i.e. teachers are clustered within schools), I can rewrite equation (1) as

$$y_j = X_j\beta + Z_j u_j + \varepsilon_j \quad (3)$$

where j=1, 2,…, *M* indicate clusters (schools) and j^{th} cluster has n_j observations. These clusters can be considered as *M* independent groups, so the random effect u_j can be thought as *M* realizations of a q× 1 vector that is normally distributed with mean 0 and Var(u_j)= $\sum$, a q × q variance matrix. In two-level model, the observation y_{ij} is for individual i within cluster j, and the individual comprise the first level and clusters comprise the second level of the model.

In the random intercept model, which I mainly use for the analysis, the random effect only works through the intercept and not through the coefficient, so there is only one random effect at school level. The only possible covariance structure is the identity matrix (I) so that $\sum = \sigma_u^2 I$. σ_ε^2 is called "within-school" estimated variance component and σ_u^2 is called "between-school" estimated variance component, and I can use these values to estimate the intra-class correlation (ρ). Intra-class correlation is a summary of the proportion of the outcome variability that is attributable to differences across schools and it is calculated as:

$$\hat{\rho} = \frac{\hat{\sigma}_u^2}{\hat{\sigma}_u^2 + \hat{\sigma}_\varepsilon^2} \quad (4)$$

which ranges between 0 and 1. When the intra-class correlation is large (close to 1), the

within-school variation among teachers is so small that teachers in the same school behave almost the same. When the intra-class correlation is small (close to 0), then the teachers within the same school are almost independent from each other, and simple OLS regression could suffice for the analysis.

Multilevel models using survey data needs to be dealt with caution. In a standard modeling with weights, the sampling weight for teacher i in school j in the two-level sample is $w_{ij} = 1/\pi_{ij}$ where π_{ij} is the probability that $teacher_{ij}$ is selected. However, multilevel modeling of survey data is different from the standard modeling in that weighted sampling occurs at multiple levels in the model, resulting in multiple sampling weights. Therefore, it is not enough to just use the single sampling weight (w_{ij}), because weights enter into the log likelihood at both the school level and the teacher level. I need w_j, the inverse of the probability that group j is selected in the first stage, and $w_{i|j}$, the inverse of the probability that individual i from group j is selected at the second stage conditional on group j already being selected. Thus, I specify two types of weights in both data level (teacher's final weight and school's final weight). Because w_{ij} is unique to group j, the group-to-group magnitudes of these weights need to be standardized (normalized) so that they are constant across groups. I rescale w_{ij} to sum to the cluster size n_j. I also tried other rescaling methods, but the estimates were quite robust to these rescaling methods.

In my multilevel dataset, teachers comprise the first level and schools comprise the second level of the model, ignoring the district for the moment. The equation for multilevel model to measure the effect of union membership on the base salary is:

$$Log(Salary)_{ij} = \beta_0 + \beta_1 Member_{ij} + \beta_2 X_{ij} + \beta_3 Z_j + (u_{0j} + u_{1j} Member_{ij}) + \varepsilon_{ij}$$

$$= (\beta_0 + u_{0j}) + (\beta_1 + u_{1j}) Member_{ij} + \beta_2 X_{ij} + \beta_3 Z_j + \varepsilon_{ij} \quad (5)$$

where $Member_{ij}$ represents if teacher i at school j is a member of teachers unions, X is the vector of control variables that are measured at individual (teacher) level, and Z is the vector of control variable measured at the school level. There are two levels of error terms for each teacher. One is at the individual level (ε_{ij}), and the other is at the school level (u_{0j}). The first error term ε_{ij} is unique to teacher i in school j, assumed to be i.i.d. for all teachers, and $\varepsilon_{ij} \sim N(o,\sigma_{\varepsilon}^2)$. The other error term u_j is unique to school j, and its value is identical for all teachers in the j[th] school to represent the unobserved common experience that all teachers in the j[th] school share. u_j is i.i.d. across schools and also assumed $u_j \sim N(o,\sigma_u^2)$. Since all teachers in the same school have the same value of the school-level error term (u_j), the total error terms ($\varepsilon_{ij} + u_j$) in the model are associated across teachers within the same school.

The model (5) allows random effects through both random slope (u_{1j}) and random intercepts (u_{0j}). The random coefficient assumes that the effect of teachers unions on teacher salary may vary from one school to the other. As the fixed intercept model is nested in random intercept model, I perform a likelihood ratio test to check if adding random intercept of each school improves the fit of the model. In each group of states, the model with random intercept was favored over the model with fixed intercept. Thus, I decide to add a school-specific intercept into the model. After this, I perform another likelihood ratio test to see if adding random slope to random intercept model can make a significant improvement in model fit, as the random intercept model is nested in random slope combined with random intercept model. The model that only has random intercept is favored to the model that has both random slope and random intercept in each group. This implies that the random slope is unnecessary once I focus on each group of states with the same legal environment towards

teachers unions, and I can treat the effect of teachers unions the same for all schools. Thus, model (5) becomes simpler as there is now a single coefficient for union membership:

$$Log(Salary)_{ij} = (\beta_0 + u_j) + \beta_1 Member_{ij} + \beta_2 X_{ij} + \beta_3 Z_j + \varepsilon_{ij} \quad (6)$$

The model now has both fixed effect and random effect component, called mix-effect. The model estimates a school-specific intercept for each school but a single coefficient for each independent variable. The fixed portion of the model, $\beta_0 + \beta_1 Unionism_{ij} + \beta_2 X_{ij} + \beta_3 Z_j$, produces a single regression line representing the population average while the random effect, u_j, is a shifting factor of this regression line up or down depending on schools. For appropriate weighting scheme to deal with survey data, I specify two types of weights in both teacher-level and school-level data, and I also standardize the weight for rescaling. As the statistical strategy for estimating variance components and fitting the multilevel model, I use maximum likelihood (ML) estimation.

It is noteworthy that I have not considered the district, which is a third-level in my dataset. The current weighing and rescaling methods of the statistical analysis with multilevel dataset does not support higher level than two-level model, so there is a chance that the multilevel mixed-effect model in using the three-level dataset may not correctly define the standardized weight. However adding school-specific intercept will still capture the great amount of district-level variation especially when we focus on each group. Then, we can think of the school-level error term (u_j) is replaced by a complex of school and district level error term (u_{jk}), and the total error terms ($\varepsilon_{ij} + u_j$) is by $\varepsilon_{ijk} + u_{jk}$.

Appendix II

Propensity Score Matching Model

To adjust for the selection bias for unionization, I use propensity score matching model. Rosenbaum and Rubin (1983) defined propensity score as the conditional probability of receiving a treatment given pre-treatment characteristics:

$$p(X) = \Pr(D = 1 \mid X) = E(D \mid X) \tag{7}$$

where $D = \{0, 1\}$ is the indicator of exposure to treatment and X is the vector of pretreatment characteristics. Authors show that if the exposure to treatment is random within cells defined by multi-dimensional X, it is also random within cells defined by the values of the propensity score, $p(X)$, which is one-dimensional variable. Two very important assumptions must be addressed for propensity score matching.

Assumption 1 The balancing property of pretreatment covariates given propensity score:

$$D \perp X \mid p(X)$$

Assumption 2 Unconfoundedness given propensity score:

$$\text{If } Y_{1i}, Y_{0i} \perp D \mid X, \text{ then } Y_{1i}, Y_{0i} \perp D \mid p(X)$$

The first assumption implies that observations with the same propensity score must have the same distribution of observable characteristics independently of treatment status. In other words, for a given propensity score, exposure to treatment is random and on average treated and control units should be observationally identical. The second assumption means that if the treatment decision is random conditional on the pretreatment observable characteristics (selection on observables), then all selection biases due to observable covariates can be removed conditional on propensity score.

Let Y_{1i} and Y_{0i} denote the potential outcome of treated unit and untreated unit, respectively. Then, then the Average Treatment effect on the Treated (*ATT*) can be estimated once the propensity is given:

$$ATT = E\{Y_{1i} - Y_{0i} \mid D_i = 1\} = E\left[E\{Y_{1i} - Y_{0i} \mid D_i = 1, p(X_i)\}\right]$$

$$= E\left[E\{Y_{1i} \mid D_i = 1, p(X_i)\} - E\{Y_{0i} \mid D_i = 0, p(X_i)\} \mid D_i = 1\right] \quad (8)$$

Suppose that teacher i of school j in district k has a propensity score of joining the teachers unions (*p*) as a function of the covariates (*X*) such that $p_{ijk}(x) = \Pr(D_{ijk} = 1 \mid X_{ijk} = x)$, where *D* indicates if the teacher joins the unions. I use logit regression to estimate propensity score since the treatment status is a binary variable:

$$Union_{ijk} = \beta_0 + \beta_1 X_{ijk} + \varepsilon_{ijk} \quad (9)$$

where *X* represents the covariates that determine selection into treatment. *X* can include higher order terms of covariates and interactions between the covariates.[48] The propensity score is the predicted value of *Union* that I get from this regression. For a matching algorithm, I use the nearest neighbor (*NN*) matching based on propensity score. *NN* matching takes each treated unit and search for the control unit with the closet propensity score, so all treated units find a match.

Following Becher and Ichino (2002), let *T* be the set of treated units (teachers who are members of teachers unions) and *C* be the set of control units (teachers who are not members of teachers unions), and let Y_i^T and Y_m^C be the base salary of the union-teachers and non-union teachers, respectively. Denote by *C*(*i*) the set of non-union teachers matched to the union-teachers i with the estimated propensity score p_i. Then, *NN* matching has sets that are defined as $C(i) = \min_m \| p_i - p_m \|$.

[48] The covariates to estimate the propensity score for union membership in High-CB group are a dummy for collective bargaining district and meet-and-confer district, gender, ethnicity, race, a dummy for full-time teachers, a dummy for teachers who teach at secondary schools (grades 7^{th}- 12^{th}), teaching experience, experience^2, interaction between experience and gender and between experience^2 and gender, education level, teaching subjects, school program types, log (number of days in the school year), log (CWI), log (total students enrollment of grades K-12), fraction of students eligible for free or reduced-price lunch program and its squared, fraction of Hispanic student in the district and its squared, fraction of black students and its squared, fraction of Asian students and its squared, fraction of other race students and its squared. The covariates to estimate the propensity score for collective bargaining in High-CB group are union density, log (CWI), log (total student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program and its squared, log (number of school days) and its squared, years of instruction required 6 major subjects to obtain a standard diploma, a dummy for a district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, 8 dummies for census district locale codes, and log (revenue). The covariates to estimate the propensity score for meet-and-confer in High-CB group are union density and its squared, log (CWI), log (total student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program, log (number of school days), years of instruction required 6 major subjects to obtain a standard diploma, a dummy for a district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, 8 dummies for census district locale codes. Similar sets of covariates are used for other groups.

Let N_i^T be the number of units in the treated group (number of union-teachers) and N_i^C be the number of units in the control units (number of non-union teachers) matched with union-teacher i. Control units are given an initial weight proportionate to the number of control units that are matched with treated unit, which is then rescaled so that the sum of weights equals the number of matched treated units. In the case of matching with replacement, weights of control units that were reused are summed across all matches in which the control unit was used. Denote $w_{im} = \frac{1}{N_i^C}$ if $m \in C(i)$ and 0 otherwise. Then ATT estimator from *NN* matching is:

$$ATT^{NN} = \frac{1}{N^T}\sum_{i\in T}\left(Y_i^T - \sum_{m\in C(i)} w_{im} Y_m^C\right) = \frac{1}{N^T}\sum_{i\in T} Y_i^T - \frac{1}{N^T}\sum_{m\in C} w_m Y_m^C \tag{10}$$

where $w_m = \sum_i w_{im}$.

Estimating variance for ATT estimator should also include the variance from the estimation of the propensity score, the imputation of the common support, and etc. I use bootstrapping to deal with this problem. Assuming the outcomes across units are independent,

$$Var(ATT^{NN}) = \frac{1}{(N^T)^2}\left(\sum_{i\in T} Var(Y_i^T) + \sum_{m\in C}(w_j)^2 Var(Y_m^C)\right) \tag{11}$$

$$= \frac{1}{(N^T)^2}\left(N^T Var(Y_i^T) + \sum_{m\in C}(w_j)^2 Var(Y_m^C)\right)$$

$$= \frac{1}{N^T} Var(Y_i^T) + \frac{1}{(N^T)^2}\sum_{m\in C}(w_j)^2 Var(Y_m^C).$$

Appendix III

Table 3.A: The Effect of Contractual Status of Teachers Unions on Teacher Salaries
SASS 2007-2008, District-Teacher Matched Dataset
Weighted OLS Regression
Dependent Variable: Log (Base Salary)

VARIABLES	Without state dummies					With state dummies				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CB	0.079***		0.063***		0.037***	0.033***		0.029***		0.0243**
	(0.0073)		(0.007)		(0.008)	(0.0108)		(0.011)		(0.011)
MC	0.0231**		0.0121		-0.0054	0.0206**		0.0174**		0.0142*
	(0.009)		(0.0092)		(0.009)	(0.0082)		(0.008)		(0.008)
Union member		0.074***	0.056***				0.023***	0.021***		
		(0.005)	(0.0056)				(0.005)	(0.0052)		
Union density				0.172***	0.142***				0.048***	0.040***
				(0.011)	(0.013)				(0.0123)	(0.013)
Observations	31,330	33,420	31,330	33,420	31,330	31,330	33,420	31,330	33,420	31,330
R-squared	0.506	0.506	0.510	0.515	0.516	0.567	0.571	0.567	0.571	0.567

Note: Errors are clustered within districts (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1
Control variables gender, ethnicity, race, a dummy for full-time teachers, a dummy for secondary schools (grades 7th -12th) teachers, experience, experience^2, interaction between experience and gender and between experience^2 and gender, education level, teaching subjects, school program types, log (number of days in the school year), log (total students enrollment of grades K-12), fraction of students eligible for free or reduced-price lunch program, students' ethnicity and race, log (CWI), and 11 urban-centric locality code of the districts that schools are located in.

Table 3.B-1: The Effect of Teachers Unions on Base Salaries for Groups that have Collective Bargaining Laws
High-CB Group
SASS 2007-2008, District-Teacher Matched Dataset
Multilevel Mixed-Effect Model: Random Intercept by School
Dependent Variable: Log (Base Salary)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CB	0.0322			-0.0056	-0.0292	-0.0304	-0.108
	(0.0449)			(0.0457)	(0.0464)	(0.0615)	(0.0839)
MC	0.0363			-0.0022	-0.0261	-0.0006	-0.112
	(0.0478)			(0.0482)	(0.0490)	(0.0737)	(0.123)
Union member		0.0664***		0.0694***		0.0199	
		(0.0173)		(0.0187)		(0.0612)	
Union density			0.104***		0.112***		-0.00852
			(0.0343)		(0.0351)		(0.114)
Member x CB						0.0566	
						(0.0655)	
Member x MC						0.0288	
						(0.0783)	
Density x CB							0.158
							(0.125)
Density x MC							0.165
							(0.156)
Log(revenue)	0.0139***	0.0129***	0.0119***	0.0139***	0.0135***	0.0143***	0.0143***
	(0.0039)	(0.0039)	(0.0038)	(0.0039)	(0.0039)	(0.0039)	(0.004)
Observations	12,380	13,670	13,670	12,380	12,380	12,380	12,380
# of schools	2,540	2,820	2,820	2,540	2,540	2,540	2,540

Note: Errors are clustered within schools (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1
Control variables: gender, ethnicity, race, a dummy for full-time teachers, a dummy for teachers who teach at secondary schools (grades 7th-12th), teaching experience, experience2, interaction between the experience and gender, education level, teaching subjects, school program types, log (number of days in the school year), log (CWI), log (total students enrollment of grades K-12), fraction of students eligible for free or reduced-price lunch program, students' ethnicity and race, and 11 urban-centric locality code of the districts that schools are located in.

Table 3.B-2: The Effect of Teachers Unions on Base Salaries for Groups that have Collective Bargaining Laws
Med-CB Group
SASS 2007-2008, District-Teacher Matched Dataset
Multilevel Mixed-Effect Model: Random Intercept by School
Dependent Variable: Log (Base Salary)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CB	-0.019			-0.0221	-0.0182	-0.0207	-0.0112
	(0.015)			(0.0153)	(0.0151)	(0.0189)	(0.0280)
MC	-0.0055			-0.0084	-0.0048	0.0038	0.0458
	(0.0178)			(0.0179)	(0.0174)	(0.0222)	(0.0374)
Union member		0.0085		0.0092		0.0158	
		(0.0064)		(0.0065)		(0.0194)	
Union density			-0.0068		-0.00228		0.0305
			(0.0165)		(0.0169)		(0.0405)
Member x CB						-0.0054	
						(0.0208)	
Member x MC						-0.0219	
						(0.0259)	
Density x CB							-0.0269
							(0.0447)
Density x MC							-0.0942
							(0.0629)
Log(revenue)	0.0348***	0.0322***	0.0320***	0.0351***	0.0347***	0.0351***	0.0348***
	(0.0051)	(0.005)	(0.005)	(0.0052)	(0.0051)	(0.0052)	(0.0051)
Observations	8,340	8,570	8,570	8,340	8,340	8,340	8,340
# of schools	1,610	1,660	1,660	1,610	1,610	1,610	1,610

Note: Errors are clustered within schools (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1
Control variables: gender, ethnicity, race, a dummy for full-time teachers, a dummy for teachers who teach at secondary schools (grades 7th-12th), teaching experience, experience2, interaction between the experience and gender, education level, teaching subjects, school program types, log (number of days in the school year), log (CWI), log (total students enrollment of grades K-12), fraction of students eligible for free or reduced-price lunch program, students' ethnicity and race, and 11 urban-centric locality code of the districts that schools are located in.

Table 3.B-3: The Effect of Teachers Unions on Base Salaries for Groups that have Collective Bargaining Laws
Low-CB Group
SASS 2007-2008, District-Teacher Matched Dataset
Multilevel Mixed-Effect Model: Random Intercept by School
Dependent Variable: Log (Base Salary)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CB	-0.0176			-0.0186	-0.0155	-0.0666***	-0.139***
	(0.0145)			(0.0144)	(0.0144)	(0.0196)	(0.044)
MC	0.0142			0.013	0.0168	0.001	-0.0065
	(0.0107)			(0.0106)	(0.0107)	(0.014)	(0.0303)
Union member		0.0107		0.0091		-0.0098	
		(0.0072)		(0.0071)		(0.0083)	
Union density			-0.0136		-0.0208		-0.0453**
			(0.0179)		(0.0182)		(0.0204)
Member x CB						0.0714***	
						(0.0196)	
Member x MC						0.0197	
						(0.016)	
Density x CB							0.180***
							(0.0589)
Density x MC							0.0361
							(0.0418)
Log(revenue)	0.0365***	0.0346***	0.0346***	0.0364***	0.0366***	0.0366***	0.0373***
	(0.0045)	(0.0045)	(0.0045)	(0.0046)	(0.0046)	(0.0046)	(0.0046)
Observations	5,910	6,170	6,170	5,910	5,910	5,910	5,910
# of schools	1,150	1,210	1,210	1,150	1,150	1,150	1,150

Note: Errors are clustered within schools (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1
Control variables: gender, ethnicity, race, a dummy for full-time teachers, a dummy for teachers who teach at secondary schools (grades 7th-12th), teaching experience, experience2, interaction between the experience and gender, education level, teaching subjects, school program types, log (number of days in the school year), log (CWI), log (total students enrollment of grades K-12), fraction of students eligible for free or reduced-price lunch program, students' ethnicity and race, and 11 urban-centric locality code of the districts that schools are located in.

Table 3.B-4: The Effect of Teachers Unions on Base Salaries for Groups that have Collective Bargaining Laws
No-CB Group
SASS 2007-2008, District-Teacher Matched Dataset
Multilevel Mixed-Effect Model: Random Intercept by School
Dependent Variable: Log (Base Salary)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MC	-0.0252**			-0.0255**	-0.0262**	-0.0264	-0.0046
	(0.0115)			(0.0114)	(0.0113)	(0.0176)	(0.0269)
Union member		0.0157**		0.0159**		0.0156**	
		(0.0073)		(0.0075)		(0.0079)	
Union density			0.0370**		0.0371**		0.0423**
			(0.0163)		(0.0164)		(0.0181)
Member x CB							
Member x MC						0.00172	
						(0.0219)	
Density x CB							
Density x MC							-0.0381
							(0.0472)
Log(revenue)	0.0173***	0.0168***	0.0157***	0.0166***	0.0154***	0.0166***	0.0154***
	(0.0055)	(0.0055)	(0.0054)	(0.0055)	(0.0054)	(0.0055)	(0.005)
Observations	4,520	4,820	4,820	4,520	4,520	4,520	4,520
# of schools	930	980	980	930	930	930	930

Note: Errors are clustered within schools (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1
Control variables: gender, ethnicity, race, a dummy for full-time teachers, a dummy for teachers who teach at secondary schools (grades 7th-12th), teaching experience, experience2, interaction between the experience and gender, education level, teaching subjects, school program types, log (number of days in the school year), log (CWI), log (total students enrollment of grades K-12), fraction of students eligible for free or reduced-price lunch program, students' ethnicity and race, and 11 urban-centric locality code of the districts that schools are located in.

Appendix IV

Table 4.A: The Effect of Teachers Unions on the Pay Structure
SASS 2003-2004 District Level Dataset
Weighted OLS Regression
Dependent Variables: Log(Minimum Salary schedule), Log(Maximum Salary schedule), and Variance(Base Salary/10,000)

VARIABLES	(1) min_sal	(2) min_sal	(3) min_sal	(4) max_sal	(5) max_sal	(6) max_sal	(7) var_sal	(8) var_sal	(9) var_sal
High-CB	0.0946***			0.173***			0.637***		
	(0.0260)			(0.0459)			(0.122)		
Med-CB	0.0126			-0.0136			-0.0848		
	(0.0257)			(0.0445)			(0.204)		
Low-CB	0.0114			-0.0409			-0.138		
	(0.0202)			(0.0471)			(0.159)		
CB		0.0076			0.0308			0.171	
		(0.0169)			(0.0242)			(0.119)	
MC		0.0014			0.0270			-0.140	
		(0.0117)			(0.0216)			(0.149)	
Union density			0.0220*			0.0461***			-0.0540
			(0.0127)			(0.0167)			(0.136)
Log(revenue)	0.0504***	0.0387***	0.0388***	0.0923***	0.0661***	0.0677***	0.445***	0.369***	0.387***
	(0.0088)	(0.0093)	(0.0104)	(0.0162)	(0.0161)	(0.0167)	(0.0741)	(0.0741)	(0.0705)
State dummies		Yes	Yes		Yes	Yes		Yes	Yes
Observations	3,600	3,600	3,600	3,600	3,600	3,600	3,580	3,580	3,580
Adjusted R^2	0.546	0.747	0.748	0.700	0.807	0.808	0.220	0.280	0.278

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1
Control variables: log (CWI), a dummy variable indicating if a district requires high school students to pass a state or district assessment to earn high school diploma, log (total student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program, log (number of school days), a dummy for district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes

Table 4.B: The Effect of Teachers Unions on Performance Pay System

SASS 2003-2004 District level Dataset

Weighted OLS Regression

Dependent Variable: Binary Variable for Districts Rewarding Teachers for Excellence in Teaching

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
High-CB	-0.0791	-0.0466				
	(0.0497)	(0.0476)				
Med-CB	-0.0503	-0.0370				
	(0.0620)	(0.0597)				
Low-CB	-0.0546	-0.0415				
	(0.0526)	(0.0529)				
Collective bargain			-0.0287		-0.00596	
			(0.0222)		(0.0187)	
Meet-and-confer			0.0334		0.0169	
			(0.0268)		(0.0225)	
Union density		-0.0890***		-0.106***		-0.0510**
		(0.0286)		(0.0312)		(0.0214)
State dummies					Yes	Yes
Observations	3,850	3,850	3,850	3,850	3,850	3,850
Adjusted R^2	0.050	0.059	0.045	0.056	0.153	0.162

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1

Control variables: log (CWI), log(total revenue), a dummy variable indicating if a district requires high school students to pass a state/district assessment to earn high school diploma, log (total student enrollment grades K-12), fraction of students eligible for free or reduced-price lunch program, log (number of school days), a dummy for district offering classes to secondary grades (7th -12th), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes.

Table 4.C: The Effect of Teachers Unions on District Finance

SASS 2003-2004 District Level Dataset

Weighted OLS Regression

Dependent Variables: Log(Revenue/Student), Log(Expenditure/Student), and (Total Revenue –Total Expenditure)/1,000,000

VARIABLES	(1) lnrev_kid	(2) lnrev_kid	(3) lnrev_kid	(4) lnexp_kid	(5) lnexp_kid	(6) lexp_kid	(7) budget	(8) budget	(9) budget
High-CB	-0.0206			-0.0395			0.0011		
	(0.0730)			(0.0616)			(0.0014)		
Med-CB	-0.0680			-0.0804			0.0001		
	(0.0657)			(0.0591)			(0.0017)		
Low-CB	-0.0092			0.007			0.0007		
	(0.0734)			(0.0557)			(0.0015)		
CB		0.266***			0.248***			0.002**	
		(0.0882)			(0.0885)			(0.001)	
MC		0.142**			0.132**			0.0016*	
		(0.0576)			(0.0559)			(0.0008)	
Union density			0.0879*			0.0801			0.0019**
			(0.0507)			(0.0537)			(0.0009)
State dummies		Yes	Yes		Yes	Yes		Yes	Yes
Observations	4,150	4,150	4,150	4,150	4,150	4,150	4,150	4,150	4,150
Adjusted R^2	0.219	0.388	0.382	0.210	0.374	0.367	0.030	0.054	0.057

Note: Errors are clustered within states (presented in parentheses). *** p<0.01, ** p<0.05, * p<0.1

Control variables: log (CWI), a dummy variable indicating if a district requires high school students to pass a state or district assessment to earn high school diploma, log (total student enrollment grades K-12), log (total number teachers for grade K-12), fraction of students eligible for free or reduced-price lunch program, log of number of school days, a dummy for district offering classes to secondary grades (7^{th} -12^{th}), students' ethnicity and race, teachers' ethnicity and race, and 7 dummies for census district locale codes.