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Effects of the Missouri Career Ladder Program on Teacher Mobility

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CHAPTER I

BACKGROUND

A. POLICY PROBLEM AND RESEARCH QUESTION

Public school teachers are usually paid according to two objective criteria: years of experience and educational attainment (certificates, degrees, or coursework). This system, known as the uniform salary schedule, has received criticism for being unfair because it does not reward effort or skill, and for being inefficient because it does not encourage hard work or attract talent (Hanushek 1981).

Education policymakers seeking to reform the way teachers are paid have tried many times, often without success, to tie teacher compensation more closely to the quantity and quality of teachers' work. An influential 1983 report by the National Commission on Excellence in Education, A Nation at Risk, shined a spotlight on the problem and spurred a wave of reforms during the mid- to late 1980s. Many of these included career ladders for teachers, which allowed them to advance in salary based on factors other than seniority such as demonstrated skills or performance. However, most of the reforms enacted in the late 1980s did not last very long (Glazerman 2004). This study focuses on one important exception, a teacher career ladder program that the state of Missouri started in 1986 and continues to operate more or less unchanged to this day.

One goal of Missouri's Career Ladder program (CL) is to help school districts that have difficulty retaining teachers, particularly those that are small and rural, by offering their teachers opportunities to earn extra pay for extra work and professional development. Eligibility for these opportunities is based on a combination of seniority and subjective performance evaluation. The policymakers who established the program hoped that the incentives created by these opportunities would make teaching in their district more attractive and consequently boost recruitment and retention.

This paper seeks to estimate the effect that CL has had on teachers' career decisions, specifically their decisions to stay in a specific school district or to remain in the teaching field.

To date, there has not been much evidence on the effectiveness of teacher incentive programs in general. Reviews by Glazerman (2004), Glazerman et al. (2006), Goldhaber and Anthony (2007), and Podgursky and Springer (2007) indicate that attempts to study teacher incentive programs rigorously are frequently thwarted by the early termination of the very programs being studied. Arizona is the only state besides Missouri to have a career ladder program that has lasted since the 1980s. Dowling et al. (2007) studied the effects of Arizona's Career Ladder Program on student achievement. Their study design compared student performance in participating districts with performance in a matched set of comparison districts over a two-year period. They found positive impacts on test scores in math, reading, and writing. It is worth noting, however, that unlike the Missouri program, the Arizona career ladder allows student achievement to be considered in determining teacher pay.

B. Overview of the Missouri Career Ladder Program

As background, we describe the program as it operates, based on available program documents and published literature, and to a lesser extent how it operates in practice. More detailed information on program rules and operations can be found in Silman and Glazerman (2009).

Program Structure and Operation. Through the CL program, teachers who meet statewide and district-level performance criteria are eligible to receive supplementary pay for meeting CL responsibilities, which can be extra teaching work or participation in professional development. The program does not replace the regular salary schedule. CL responsibilities must be academic in nature and directly related to the improvement of programs and services for students.

A teacher moves up the career ladder in three stages. Teachers are assessed at each stage through periodic observations and evaluations of documentation. Each successive stage offers the opportunity to receive more supplementary pay for CL responsibilities: up to $1,500 for Stage I, $3,000 for Stage II, and $5,000 for Stage III. Out of more than 65,000 teachers in 524 districts in Missouri, over 17,000 teachers (26 percent) from 333 districts (64 percent) participated in the CL program during the 2005-06 school year.

Teacher Eligibility and Qualifications for a Bonus. To enroll in the CL and qualify for bonuses, each teacher must develop a Career Development Plan (associating each CL responsibility with either a designated plan or some other instructional improvement). A district committee must then approve the teacher's plan. Through scheduled and unscheduled observations, as well as reviews of their career development plan and other documentation such as lesson plans, the teacher must show evidence of performance at or above the expected level on 20 criteria listed in the district's Performance-Based Teacher Evaluation (PBTE) instrument. The criteria span six areas: (1) engaging students in class, (2) assessing students correctly, (3) exhibiting content knowledge, (4) showing professionalism in the school, (5) participating in professional development, and (6) adhering to the district's education mission. There are also specific qualification criteria for each stage of CL, as shown in Table 1.

Table 1. Qualifications for Missouri Career Ladder by Stage

Qualification	Stage I	Stage II	Stage III
Minimum experience to qualify (years)	5	7	10
Percent of PBTE criteria at "expected" level	100	100	100
Percent of PBTE criteria "above expected" level	0	10	15
Minimum number of responsibilities	2	3	4
Minimum hours	60	90	120
Maximum bonus	$1,500	$3,000	$5,000
Implied maximum hourly rate	$25	$33	$42

Note: PBTE = Performance Based Teacher Evaluation

To receive a salary supplement, teachers must spend a specified amount of time on a certain number of responsibilities or professional development outside of their contracted time (amounts depend on the stage). Examples of the extra responsibilities that CL teachers undertake include providing students with opportunities for enhanced learning experiences, remedial assistance, and various extended day/year activities. Professional development could include taking college classes, attending workshops, and participating in professional organizations.[1]

In the 2005-06 school year, an average of 79 hours were spent by Stage I participants, 111 hours by Stage II teachers, and 144 hours by Stage III teachers. These hours translate to supplementary pay of about $19, $27, and $35 per hour, respectively, for Stages I, II, and III, somewhat lower than the nominal hourly rates that would be earned by doing the minimum requirement: $25, $33, and $42 per hour. The bonus amounts have never been increased or adjusted for inflation since the program was established in 1985.

District Participation. Missouri's program is available statewide but individual school districts must decide if they will participate and, if so, provide matching funds. The matching rate varies based on district characteristics. Because the matching rate is so critical to understanding why a district participates, it is important to understand how they are determined.

The matching rate formula in effect from the program's inception through the 1995–1996 school year was based entirely on the district's assessed property value per pupil. Districts were ranked on this measure from lowest to highest and divided into 12 groups. Districts with the lowest per pupil value received 90 percent state funding for program

[1] The Missouri Department of Elementary and Secondary Education (DESE) recommends that teachers should not spend more than one-third of CL hours on college classes and workshops.

expenses. For each successive group of districts, the state funding share declined by 5 percentage points, with the highest group receiving 35 percent state funding.

In 1996 the formula changed, making the distribution narrower with fewer distinct matching rates; it also added total enrollment as a ranking factor. This current formula involves an initial sorting of districts by assessed property values per pupil, with the top 25 percent (which we call "high wealth") receiving a 40 percent match. Among the low wealth districts, the largest one-third of districts in terms of student enrollment are eligible for a 50 percent match, and the bottom two-thirds (low wealth, low enrollment) are eligible for a 60 percent match.

District participation in the CL program has grown steadily since it started, although it grew most rapidly in the early years of the program, Table 2 shows the history of participation by district and teachers and the cost to the state. During the first six years, the program grew from 63 districts to 204 by 1992-93. After 1995-96 growth slowed, with a total of 333 districts participating in 2005-06—an increase of 47 districts over a 10-year period. Similar patterns hold for growth over time in the number of teachers participating and in total state payments made for the program.

In general, once a district begins participating in CL, it rarely withdraws from the program. Over the first 21 years of the program, 361 districts have participated and 23 (six percent) have withdrawn.

The remainder of this paper discusses the methods, data, and findings of an analysis used to estimate impacts of CL on teacher mobility. The paper concludes with a summary and discussion of findings.

Table 2. Participation in and Cost of the Missouri Career Ladder Program

Year	Number of Districts Participating	Number of Teachers Participating	Total State Payment
1986-87	63	2,400	$2,624,025
1987-88	121	5,074	$7,182,975
1988-89	147	5,811	$10,484,500
1989-90	177	6,803	$13,839,075
1990-91	192	7,580	$16,688,675
1991-92	199	8,322	$18,902,575
1992-93	204	8,536	$20,362,750
1993-94	229	10,696	$24,426,950
1994-95	269	13,021	$29,300,325
1995-96	286	14,107	$33,358,250
1996-97	278	13,741	$34,312,899
1997-98	288	14,098	$35,799,849
1998-99	299	14,707	$37,333,522
1999-00	309	15,827	$37,687,074
2000-01	322	16,688	$37,993,100
2001-02	330	17,101	$38,253,625
2002-03	338	17,412	$38,599,500
2003-04	332	16,982	$37,103,360
2004-05	328	16,919	$36,465,400
2005-06	333	17,378	$36,986,803

Source: This table contains data from the Missouri Career Ladder program's 2005-06 annual report, produced by the Missouri Department of Elementary and Secondary Education.

CHAPTER II

METHODS AND DATA

A. ANALYTIC GOAL AND CHALLENGES

The goal of the analysis in this paper is to estimate the relationship between eligibility for the CL program and teachers' career decisions. If CL induces teachers to remain in their districts and thus stay in the profession, it may reduce costs to districts (by reducing replacement costs) and minimize the potential disruption to students and schools caused by teacher turnover.

An extensive longitudinal database on teachers throughout the state of Missouri provides a unique opportunity to estimate this relationship between CL and teacher mobility, but there are several complicating factors that must be carefully accounted for in the analysis and interpretation of the analytic results.

First, not all mobility is the same. We do not have the data to measure whether mobility is raising or lowering the overall quality of the teaching force (through attrition of weaker teachers or stronger teachers), but we can measure whether the CL affects teachers at different stages of their career. Furthermore, some movement of teachers out of the classroom may be good if those individuals have been promoted to productive positions in administration such as principalships. Mobility findings should therefore be interpreted with this in mind.

Second, there are many factors that affect teachers' career decisions, of which teachers' eligibility for CL payments is just one. If compensation and working conditions in general are the primary determinants, then CL eligibility is one small component of this package. Compensation and labor market conditions can vary across districts and within districts and they can vary over time, so identifying the unique effect of the CL program amongst the many other changes observed in the data is a challenge. This paper aims to isolate the CL effect by using a large dataset covering several years, and employing statistical controls as much as possible.

Third, the effects of CL eligibility may not be uniform across all teachers. While we focus on the effect of being eligible for the program, the effects of the program may be

different at different stages of a teacher's career. For novice teachers, the program's incentives are of value for their future benefits. For mid-career teachers, the possibility of receiving more pay is more immediate. For veteran teachers with more than 20 years of experience, the effect of behavior on retirement benefits may overshadow any role played by pay supplements like CL that do not count toward calculation of the pension benefit amount. Therefore, we examined subgroups defined by teacher experience and estimated models with the interaction of experience and CL status.

Finally, there is a risk that the observed relationship between CL and teacher mobility may be spurious, reflecting the types of districts that choose to participate in the program and the factors associated with the timing of that choice more than the true impact of the program. For example, if a participating district is hard to staff, then simple comparisons of retention rates between teachers in CL districts and observationally similar teachers in non-CL districts could understate the true impact of the program. Methods are needed to allow us to isolate the effect of the program from unobserved determinants of teacher mobility and that also explain district participation. This analysis attempts to address this through statistical controls (for measured variables) and instrumental variables (for unmeasured factors).

B. MODEL AND ESTIMATION

To examine the relationship between district CL participation and teacher mobility while addressing the issues discussed above, we used a flexible statistical model that is well suited to studying the duration of employment spells and has been used routinely to model teacher behavior (Stinebrickner 1998; Podgursky et al. 2004). This model, the Cox proportional hazard regression, has the following basic form:

$$h(t) = h_0(t)e^{b_1X_1+\ldots+b_kX_k}$$

where $h(t)$ is the probability of exit (defined alternatively as leaving teaching or leaving the school district) for those reach year t, and $h_0(t)$ is the baseline hazard function (defined below). X_1 through X_k are the control variables, including the district's CL status, and b_1 through b_k are used to compute the estimated hazard ratios, measuring the change exit probability associated with a one-unit change in the corresponding variable X_1 through X_k. A hazard ratio of greater than one indicates that greater values of that variable are associated with a higher exit probability. We estimate this model for a dataset that includes one observation per teacher-district spell.

The baseline hazard function represents the percentage of teachers who experience a transition in year t given that they are still employed (in the district) in year $(t-1)$. These can be thought of as year-by-year exit rates. The Cox model assumes that the time path of these exit rates is some function that shifts up or down based on the factors such as CL status, which we hypothesize make a difference.

We first define the outcome to study. In doing so, we differentiate among four types of teacher transitions, as follows:

- ***Transitory moves.*** Teachers often leave teaching for one or two years and then return to teaching in the same district. This type of "churning" mobility is common and may reflect sabbaticals to raise a child. We treat transitory movers as if they were stayers.

- ***Promotions.*** Teachers often leave teaching to take a different job within the same district. Job categories included in this group were central office administrator, principal or assistant principal, librarian, or guidance counselor. We treat promotions as censored data, meaning that the exit status (stayer/mover/leaver) is unknown as of the time of the promotion.

- ***Changing districts.*** We categorize teachers who move to a full-time position in a different Missouri school district as "movers."

- ***Leaving the data.*** Teachers no longer observed in Missouri employee data (for reasons other than censoring due to the final year of our data) we categorize as "leavers." It is likely that these teachers have either retired, left the profession, taken a job at a private school, or moved out of the state.

The empirical analysis focuses on the last two categories, movers and leavers, and the relationship between district CL participation and the decision to either move to a different district or leave teaching in the state of Missouri.

There are several explanatory variables we would want to include in this model, but specifying the CL status variable is an especially important step. The main parameter of interest in this study is the coefficient on this variable and the corresponding hazard ratio, which ratio represents the relative probability of a transition for two groups (e.g., CL and non-CL). A hazard ratio of 1.0 means that teachers in the two groups are equally likely to leave (their district or the state public education system) at any given time. A hazard ratio of less than 1.0 means that CL-eligible teachers are less likely to leave teaching and a ratio of greater than 1.0 means the opposite. For instance, a hazard ratio of 0.50 on the district CL participation indicator would imply that teachers in participating districts are half as likely as teachers in non-participating districts to exit, holding all else equal.

Our main approach was to construct the district CL participation variable as an indicator for the district participating in the CL program within five years following the start of a given teacher's spell in the district (the spell is the time period during which that teacher taught in that district).[2] However, another plausible model would suggest that the CL indicator should only specify whether a district participated within a shorter or longer time frame (2 or 10 years, for example) of the start of the teacher's spell. The appropriate time

[2] We define district CL participation from the beginning of the teacher's spell in that district in order to treat teachers that move equivalently to teachers that stay. On average, teachers that stay have longer district spells.

horizon depends on how well we believed teachers anticipated future district policies in formulating their decisions.

We also included district characteristics in the model that are likely to be associated with differences in teacher mobility. Time-varying control variables include the log of district enrollment, district percent of African-American and Hispanic students, district percent of economically disadvantaged students (as measured by eligibility for free or reduced price lunch), log of district average full-time teacher salary (in constant 2007 dollars), and cohort indicators based on the year the teacher started teaching.

Time-invariant control variables include the district percentage of households with no college education, district percentage of households that are poor, log of median district household income, an indicator for the district being in a large or mid-sized city, and an indicator for the district being in a large or small town.

The critical step for addressing selection bias is the use of instrumental variables. We included a first stage regression that predicts the probability of a district participating in the program using variables that are believed to be unrelated to teacher mobility. We used the CL matching rate based on the 1986 property value per pupil as indicators for the district being in the top 25 percent property value per pupil, the top 33 percent for enrollment in the state, and the interaction of the top wealth and enrollment categories. These variables are tied closely to the arbitrary jumps in matching rates that we believe influenced the likelihood of participating, but are not highly correlated with the mobility outcomes of interest.

In addition to the benchmark model, we also performed several sensitivity checks to ensure that the results are robust. We re-estimated the model using a Weibull hazard function instead of the Cox model, to see how sensitive the results are to the model specification.

We also estimated the model omitting teachers in non-participating districts with observable characteristics that were markedly different from any participating districts. We estimated the model omitting teachers in 38 non-CL districts with propensity scores for district participation that were lower than those of any participating district.[3]

Another check was to estimate the model only including the first observed teacher-district spell for each teacher, to test whether over-representation of highly mobile teachers is affecting the results.

Finally, we estimated the model excluding the two largest school districts in Missouri, Kansas City and St. Louis. Unlike the rest of the state, these two districts have retirement systems separate from the state system, creating some unusual inter-district mobility disincentives (Costrell and Podgursky 2009) that threaten to mask CL effects.

[3] See Booker and Glazerman (2008) for details on the estimation of the propensity score measure.

Because teacher CL eligibility varies with years of experience (at least five years of experience to be eligible for Stage I, and at least 10 years for Stage III), mobility effects of district participation are likely to differ by how long the teacher has been in the district. We estimate separate effects for different ranges of teacher experience, defining the ranges as one-5 years of experience in the district, 6-10 years, 11-20 years, and 21+ years. We split the teachers eligible for Stage III awards into two groups in order to differentiate teacher retirement effects (likely most pronounced in the 21+ years group) from other teacher mobility effects.

All estimates account for the clustering of teachers within districts. Ignoring this would produce biased standard errors and invalid hypothesis tests. Therefore, we used the sandwich estimator for clustering at the district level.

C. DATA DESCRIPTION

The data for this paper come from the Missouri Department of Elementary and Secondary Education (DESE) and includes teacher-level information on all Missouri public school teachers and other public school employees for the 18 school years 1989-90 through 2006-07. DESE also provided district-level data on student demographics, finances, and employment.

The teacher-level dataset contains one observation for each employee-school-year combination, including the district number and a unique teacher identification number, so we could follow teachers throughout the state if they switched districts during the school year and from year to year. Each employee has a job status code, which allowed us to identify teachers who switch to another job within the public school system, such as principal or librarian. Each observation includes a measure of the number of full-time equivalent units the teacher worked that year at that school, allowing us to identify and restrict our analysis to full-time teachers. In addition, each teacher observation includes their years of experience, both in Missouri and in a specific district (which eliminates the problem of left-censoring), the teacher's CL award status, annual salary, and highest degree attained.

Districts that choose to participate in the CL program are on average observationally different from districts that choose not to participate. Table 3 summarizes the characteristics of participating and non-participating districts in 1997-98, the midpoint of the analysis period. On average, districts that participate in the CL are smaller than non-participating districts, with average enrollment of 1,108 students, compared to 2,411 for non-participating districts. Participating districts are also less urban and more rural, with a smaller percentage of African-American students and higher percentage of white students, and have lower median household incomes than non-participating districts.

Table 3. Characteristics of Participating and Non-Participating Districts in 1997-98

Characteristic	Participating Districts	Non-participating Districts
Enrollment (number of students)	1,108	2,411
Race/ethnicity of students		
Percent white	96.7%	91.1%
Percent African-American	2.0%	7.6%
Percent Hispanic	0.7%	0.7%
Percent economically disadvantaged	43.5%	38.4%
Teacher annual salary	$27,939	$28,511
Teacher experience level (years)	12.1	12.4
Student-teacher ratio	13.1	13.2
Urbanicity		
Large or mid-size city	8.0%	19.9%
Large or small town	17.5%	18.2%
Rural area	74.5%	61.9%
County characteristics from Census data		
Percent urban	15.5%	31.8%
Percent of adults with no college degree	65.4%	61.5%
Percent poor	14.4%	12.4%
Median household income	$31,945	$36,039
Propensity score	0.665	0.363
Number of districts	286	236

Because participating and non-participating districts are so different in their observable characteristics, and because those characteristics may be associated with differences in teacher mobility and retention that have nothing to do with the CL program, it is important to control as much as possible when examining teacher mobility. One measure of the average difference between participating and non-participating districts is the propensity score measure in Table 3, which measures the predicted probability of the district participating in the CL program in that year, based on the observable characteristics of the district. Participating districts have an average predicted participation probability of 66.5 percent, more than 30 percentage points higher than non-participating districts. This means that we were able to explain and predict CL participation using the observable variables.

Table 4 summarizes the average district and teacher characteristics of participating and non-participating districts, weighted by the number of unique full-time teachers observed at least once in that district during the analysis period. The teacher-weighted percentage of African-American students is lower in participating districts (9.1 percent) than non-participating (21.3 percent). Average teacher salary is also lower in participating districts ($33,240) than non-participating districts ($40,907). Teachers in participating districts are in districts with higher state funding matching rates, lower median household income, and lower percent large or mid-sized city than teachers in non-participating districts.

Table 4. Description of Analysis Sample, Teacher Level

Characteristic	All Teachers	Teachers in Participating Districts	Teachers in Non-participating Districts
District and Census Data			
Enrollment (number of students)	9,470	5,489	12,124
Percent African-American students	16.4%	9.1%	21.3%
Percent Hispanic students	1.3%	1.6%	1.0%
Percent economically disadvantaged students	38.0%	40.9%	36.1%
Teacher salary (2007 dollars)	$37,840	$33,240	$40,907
Percent urban	63.7%	45.6%	75.7%
State funding matching rate under pre-1996 rules	58.0%	67.5%	51.9%
Percent of adults with no college degree	53.2%	58.7%	49.5%
Poverty rate	12.3%	13.9%	11.3%
Median household income	$39,025	$34,162	$42,267
Percent in a large or mid-size city	52.1%	33.4%	64.5%
Percent in a large or small town	20.4%	23.8%	18.2%
Teacher Outcomes			
Average teaching spell duration	5.1 years	5.2 years	5.0 years
Promoted within district	18.0%	18.3%	17.9%
Moved to different MO district	15.1%	16.2%	14.3%
Left teaching or MO data	38.0%	34.8%	40.2%
Number of teachers	146,308	58,514	87,794

Table 4 also shows the outcome variables of interest and how they vary by CL status. The percentage of teachers whose teaching spell in the district ends with promotion within-district is slightly higher for teachers in participating districts (18.3 percent) than non-participating districts (17.9 percent), but teachers in participating districts moved to a different district in Missouri at a higher rate (16.2 versus 14.3 percent) and left teaching (or left the Missouri data) at a lower rate (34.8 versus 40.2 percent). The next chapter presents findings from different versions of the Cox regression model to determine whether they are likely the results of CL itself.

CHAPTER III

RESULTS

Here we present analysis results focusing separately on the questions of retention in the district and retention in the profession. As discussed in Chapter II, we consider those who change districts but remain in a teaching position in a Missouri public school to be "movers" and those who are no longer on the payroll of a Missouri public school to be "leavers." This chapter presents findings from the preferred, benchmark model, the subgroup findings, and then discusses the sensitivity of the findings to different assumptions.

A. RETENTION IN THE DISTRICT

We first analyzed the effects of CL participation on teacher retention in the district. From Table 4 we see that a larger percentage of teachers in CL districts are observed moving to a different Missouri district, with 16.2 percent of teachers in CL districts moving, compared to 14.3 percent of teachers in non-CL districts. This is not evidence of a causal relationship between CL and teacher retention in the district, as CL districts tend to be different from non-CL districts in a number of ways including wealth, size, and urbanicity, which could also explain differences in teacher retention. The regression model (discussed in Chapter II) controls for these effects, yielding an estimated impact of district CL participation holding other district characteristics equal.

Controlling for other factors potentially related to teacher mobility (listed in Table 5), we found that teachers in CL districts were less likely to leave the district than those in non-CL districts. Table 5 shows the estimated effects on teacher retention in the district (the opposite of "exit by moving") from our benchmark model, using a two-stage instrumental variable (IV) approach to control for district selection into CL participation. The estimated hazard ratio of 0.85 for district CL participation, which is statistically significant at the 0.01 level, implies that teachers in participating districts are 0.85 times as likely as those in non-participating districts to move to a different district, all else equal. Table 5 also shows the estimated effects of the control variables in the model, with a lower district enrollment, higher percentage African-American students, lower percent Hispanic students, and lower district average teacher salary all significantly associated with a higher probability of teachers leaving the district.

Table 5. Results of Cox Proportional Hazard Model, Benchmark Estimates (Hazard Ratios)

Explanatory Variable	Exit by Moving	Exit by Leaving	Exit by Moving or Leaving
District participates in CL	.852**	.899*	.853**
Log of district enrollment	.814**	.972*	.921**
Percent African-American	1.005**	.999	1.001
Percent Hispanic	.981*	1.041**	1.026**
Percent economically disadvantaged	1.000	1.002	1.002*
Log of district average teacher salary (2007 dollars)	.588**	.787**	.666**
Percent urban	.999	1.000	1.000
Percent with no college	1.359	.453**	.592**
Percent poor	.871	1.492	1.208
Log of median household income	1.087	.872	.952
Large or mid-size city	.904	.974	.960
Large or small town	.926	1.031	.984
Number of exits	22,042	55,645	77,687
Number of teachers	146,308	146,308	146,308

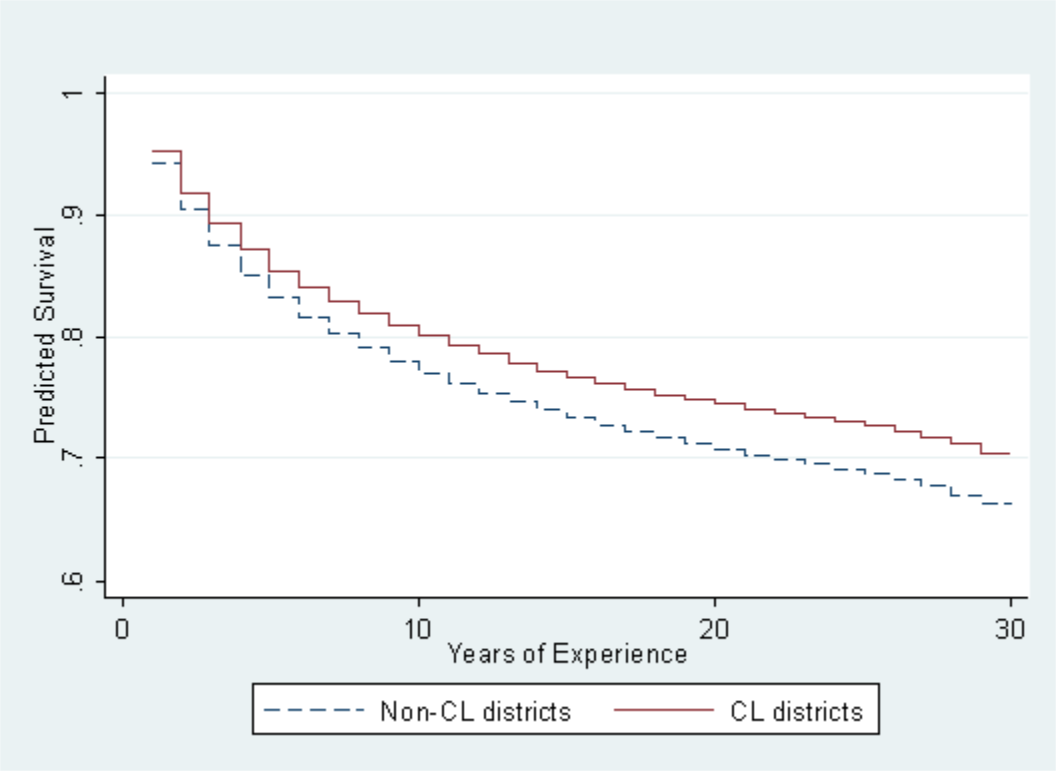
* Indicates significance at 5%; ** at 1%.

Figure 1 illustrates the predicted survival functions for teachers in CL and non-CL districts. The height of the survival function is the predicted proportion of those still in teaching who remain in their original district, and the slope is the predicted probability of moving. Teachers are generally more mobile early in their career, which is reflected by the higher exit probability early in their tenure in the district. The higher survival and lower estimated exit rate for teachers in CL districts are reflected by the higher position of the survival curve and its more gradual slope for CL districts, compared to that for non-CL districts. For example, after ten years, the model predicts that 81 percent of teachers will remain in CL districts versus 77 percent in non-CL districts. After 20 years, the model predicts that 75 percent of teachers remain in CL districts versus 70 percent in non-CL districts.

We also examined CL effects separately for different levels of teacher experience. The Cox model assumes that the CL effect is constant over the course of the teacher's career. It would be reasonable to relax this assumption on the basis that eligibility for the incentives provided by the CL program depend in part on the teacher's experience level. Eligibility for and potential size of the bonuses is tied to stages in the program, which itself is tied to minimum years of service (5, 7, and 10 years, respectively, for the three stages). For example, one might assume that the expected present value of future benefits would be a weaker incentive to reduce early career attrition than the bonuses being paid in current years

for teachers in their fifth to fifteenth year of teaching, when teacher participation is at its highest.

Figure 1. Predicted Survival Until Moving, Using Benchmark Model



The first column of Table 6 shows the estimated effect of district CL participation for teachers in different experience ranges. The first row is the overall effect from Table 5. The second row is the estimated effect on the probability of teachers leaving within their first five years in the district. The estimated effect of 0.89 is not statistically significant at the 0.05 level, indicating that there is insufficient data to conclude that district CL participation is associated with a lower probability of teachers moving during their first five years in the district. Similarly, the third row shows the estimated hazard ratio for leaving during years 6–10 in the district, estimated only from the sample of teachers that lasted at least 6 years in the district. The estimates of CL effects for more experienced teachers are necessarily less precise because the estimate for each experience range relies on a smaller and smaller sample. For example, nearly all teachers are observed in the first through fifth years of teaching, but a smaller number "survive" to more than 10 or more than 20 years of service.

The only teacher experience range where the estimated hazard ratio that is statistically significant is for teachers with 11–20 years of experience. For these teachers the hazard ratio estimate is 0.56, implying that, for teachers with at least 11 years of experience in a CL district, the likelihood of their moving to a different district before they reach 21 years of experience is slightly greater than half what it would be in a non-CL district. This is the group of teachers that are eligible for the largest CL bonuses and who have the most to lose

by leaving the participating district. For teachers with at least 21 years of experience the estimated hazard ratio is also less than one, but not statistically significant, as we observe few teachers switching districts this late in their careers.

Table 6. Results of Cox Proportional Hazard Model by Teacher Experience

	Outcome	
Risk period	Exit by Moving	Exit by Leaving
Overall	.852** 22,042 exits 146,308 teachers	.899* 55,645 exits 146,308 teachers
Exit within 1–5 years of starting teaching	.888 16,140 exits 146,308 teachers	.873** 30,432 exits 146,308 teachers
Exit within 6–10 years of starting teaching	.862 3,296 exits 71,680 teachers	.786** 5,965 exits 71,680 teachers
Exit within 11–20 years of starting teaching	.564** 2,139 exits 48,751 teachers	.912 6,055 exits 48,751 teachers
Exit within 21+ years of starting teaching	.708 467 exits 23,160 teachers	1.126* 13,193 exits 23,160 teachers

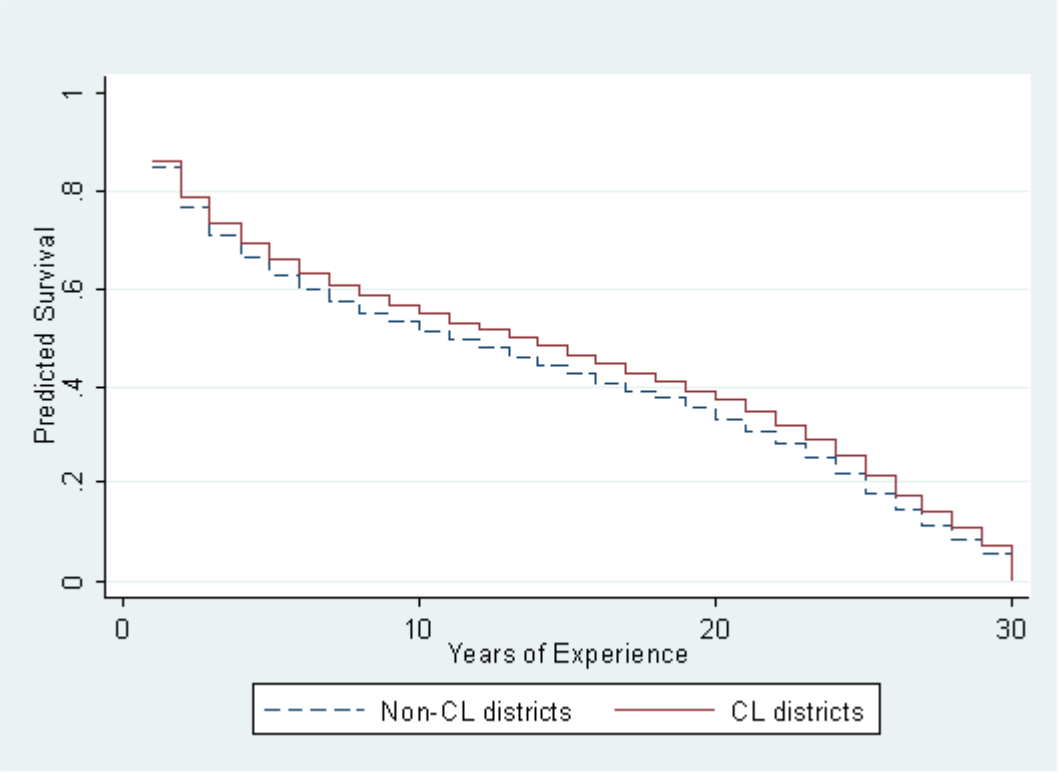
* Indicates significance at 5%; ** at 1%

B. RETENTION IN THE PROFESSION

We repeated the analysis for retention of teachers in the profession as defined above. The raw differences in retention rates (Table 3) suggest that teachers in CL districts stay in teaching at higher rates (34.8 percent) than those in non-CL districts (40.2 percent). After controlling for district characteristics with the Cox model, the estimated hazard coefficient for the CL effect on leaving teaching is 0.9 and statistically significant at the 0.05 level (see Table 5, second column). This implies that teachers in CL districts are less likely (90 percent as likely) to leave teaching as those in non-CL districts, all else equal.

This difference is illustrated graphically in Figure 2, showing the predicted survival functions for CL and non-CL districts. This figure shows how the likelihood of a teacher leaving the profession is highest for teachers in their first few years of teaching, and for teachers nearing retirement, with more than 20 years of experience. The model predicts that all else equal, 55 percent of teachers in CL districts will still be teaching there after 10 years, versus 51 percent of teachers in non-CL districts. For teachers with more than 20 years of experience the survival functions converge, reflecting a higher probability of leaving teaching for teachers in CL districts over this experience range (where all teachers approach retirement age).

Figure 2. Predicted Survival Until Leaving, Using Benchmark Model



The second column of Table 6 shows separate CL effects on teacher retention in the profession for those at different experience levels. Unlike the effects on teacher retention in the district, here the largest and most significant effects are found in the lower experience ranges, with estimated hazard ratios of 0.87 for teachers in years 1–5 in the district, and 0.79 for teachers in years 6–10. Years 6-10 are when teachers typically become eligible for CL awards, which combined with the potential for higher bonuses later in their career could explain why the retention effect in the profession is largest for this experience range. The estimated effect for teachers with 21 or more years of experience is actually 1.13, indicating that these teachers have a greater chance of leaving the profession if they are in a CL district. However, as we see in our sensitivity tests, this result is not robust to alternative specifications.

C. ROBUSTNESS OF THE FINDINGS

The findings reported above were robust to several possible alternative assumptions and model specifications.

For the analysis of retention in the district we treated leavers and promoted teachers as censored observations; for the analysis of retention in the profession we treated promoted teachers as censored observations. The findings were robust, however, to alternative specifications of the failure condition. For example, we repeated the analysis with mover or leaver as the failure condition and obtained a hazard coefficient estimate for CL districts that

lay between the two estimates for movers and leavers respectively (see Table 5, third column).

Table 7 shows the results of some of the sensitivity tests, both overall and for different teacher experience categories. The first two columns estimate the model using a Weibull hazard function instead of a Cox hazard function. The Weibull distribution is typically used when hazard rates either increase or decrease exponentially with time. The results from this model are similar to those from the Cox proportional hazard model.

Columns 3 and 4 of Table 7 use the standard Cox model, but omit teachers in districts that fall outside the region of common support, based on estimated propensity scores for district participation. This omits teachers in 38 non-CL districts that have propensity scores that are lower than those for any participating districts. These districts look quite different from others in the sample, being primarily wealthy urban districts with high property values per pupil. When these districts are omitted, the effect on retention in the profession for teachers with 21+ years of experience becomes insignificant, implying that that effect is being driven by those few unusual districts. Otherwise, the results look similar to those from the benchmark specification.

The third set of sensitivity tests in Table 7 omits the two largest school districts, Kansas City and St. Louis, from the estimation sample. These two districts have their own pension systems, which could lead to different impacts on teacher retention. None of the results change significantly when these two districts are omitted.

In addition to these checks, we also estimated the benchmark model using different time horizons, measured in years since the teacher began teaching in the district, for defining district CL participation. The benchmark model considers the district as a CL participant if it participated within five years of the teacher's first year in the district (regardless of whether the teacher remained in the district during that time). We estimated the model using a 2-year horizon, a 10-year horizon, and the maximum observed value over the entire time period in our data. For each of these methods the results were very similar to the benchmark results shown in Table 5.

Table 7. Results of Cox Proportional Hazard Model, Alternate Specification

	Non-Cox Parametric Survival Curve Model (Weibull Distribution)		Sample Restricted to Region of Common Support Using Propensity Score		Kansas City and St. Louis School Districts Omitted	
Hazard Coefficient	Exit by Moving	Exit by Leaving	Exit by Moving	Exit by Leaving	Exit by Moving	Exit by Leaving
Overall	.811** 22,042 exits 146,308 tchrs	.868** 55,645 exits 146,308 tchrs	.825** 17,467 exits 103,352 tchrs	.861** 37,204 exits 103,352 tchrs	.846** 20,613 exits 130,745 tchrs	.907* 48,521 exits 130,745 tchrs
Exit within 1–5 years of starting teaching	.831** 16,140 exits 146,308 tchrs	.823** 30,432 exits 146,308 tchrs	.875 12,998 exits 103,352 tchrs	.817** 21,913 exits 103,352 tchrs	.879 15,276 exits 130,745 tchrs	.876* 26,793 exits 130,745 tchrs
Exit within 6–10 years of starting teaching	.807* 3,296 exits 71,680 tchrs	.747** 5,965 exits 71,680 tchrs	.768* 2,536 exits 47,933 tchrs	.789** 3,876 exits 47,933 tchrs	.846 3,011 exits 63,417 tchrs	.793** 5,063 exits 63,417 tchrs
Exit within 11–20 years of starting teaching	.548** 2,139 exits 48,751 tchrs	.904 6,055 exits 48,751 tchrs	.548** 1,623 exits 31,640 tchrs	.909 3,981 exits 31,640 tchrs	.572** 1,945 exits 42,938 tchrs	.919 5,269 exits 42,938 tchrs
Exit within 21+ years of starting teaching	.717 467 exits 23,160 tchrs	1.126* 13,193 exits 23,160 tchrs	.728 310 exits 14,048 tchrs	1.042 7,434 exits 14,048 tchrs	.769 392 exits 20,236 tchrs	1.111* 11,406 exits 20,236 tchrs

* Indicates significance at 5%; ** at 1%

CHAPTER IV

CONCLUSION

A. SUMMARY AND POLICY IMPLICATIONS

This paper presented evidence suggesting that a school district's participation in the Missouri Career Ladder Program would tend to increase retention in the district and the profession, especially for mid-career teachers.

The results reported here are especially useful when combined with other findings on this program. Previously reported analyses using 10 years of district-level test score data failed to find evidence for an impact on test scores (Booker and Glazerman 2009). However, focus groups and interviews conducted by Silman and colleagues (Silman and Glazerman 2009) suggest that the program is popular with participating teachers and is run almost entirely by teachers themselves. Thus, when considering the benefits, there was no measurable test score effect, but a positive effect on retention and possibly a positive effect on teacher well-being generated by increasing their incomes by an amount that likely exceeds their hourly rate for the extra work completed.

These findings have several implications for the teaching profession. First, they suggest that small bonuses can affect behavior. Some evidence suggests that incentive payments probably need to exceed 25 percent of teacher salary in order to neutralize the effects of turnover in hard to staff urban schools (Hanushek et al. 2004). If the Missouri CL program can reduce turnover with a bonus on the order of 10 to 20 percent of average teacher salary, even if by a modest amount, then it suggests that there may be more scope for policymakers to make a difference, even with limited budgets, than was previously believed.

Second, the magnitudes of the effect estimates remind us that one should not expect *large* effects from small bonuses. The maximum payout of $5,000 has never been increased or adjusted for inflation. Consequently its purchasing power has eroded in value by almost 60 percent.

Third, the findings suggest that a bonus program that is *not* tied to student performance but offers additional pay for more work for mid-career teachers can make teachers feel better off even if it does not improve their teaching in an easily measurable way.

B. LIMITATIONS OF THE STUDY

It is important to recognize the strengths and limitations of this research. The first caveat is that this study used econometric methods to address the selection bias that arises from unobserved differences between districts that did and did not choose to participate in CL. We believe this approach was well suited to this situation, but such methods do not provide the level of certainty that we would have from a well-run randomized controlled experiment. In an experimental setting, the researcher would randomly determine which districts would or would not implement CL, and the differences between the two groups could only be attributed to the program. In this case, there may still be unobserved determinants of CL status that could be confounded with our estimates of the program effects.

Second, it is important to interpret the findings with a firm understanding of the program itself. The Missouri program was evaluated as an intact policy package. We assume the possibility to earn teacher bonuses was a chief motivating force, but the program also had elements of teacher empowerment, allowing teachers to run the program themselves and to design their own work plan by which they could earn bonuses. There was an evaluation system in place, even if it may not have been implemented uniformly. Therefore, readers should use caution in applying these findings to other programs that use differently structured incentives. To gain a more in-depth perspective on the Missouri program, see Silman and Glazerman (2009).

A final thought to keep in mind when interpreting the results of our analysis is that we have no measure of what non-participating districts were doing instead of participating in CL. These districts could be using those funds to supplement teacher salary generally, but it was not possible to measure all the possible teacher retention strategies in place in CL and non-CL districts. Thus we estimate an overall effect of CL participation relative to all non-participating districts, regardless of the programs those districts may have implemented.

In the future, Missouri will have more detailed test score data, including scores from consecutive years and consecutive grades, which was not available for this study. It may also be possible to measure more of the factors that determine participation and that describe what districts do in the absence of CL. Combining this newly emerging data with more detailed information on the spatial distribution of school districts presents a promising avenue for more policy-relevant research that can build on the current findings and thus drive good decision-making.

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