

WORKING P A P E R

Effect of Teacher Pay on Student Performance

Findings from Illinois

RAND EDUCATION
with contributions from Ann Flanagan and
David W. Grissmer

WR-378-EDU

April 2006

Prepared for the Department of Education

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**EFFECT OF TEACHER PAY ON STUDENT PERFORMANCE: FINDINGS FROM
ILLINOIS**

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PREFACE

There is increasing concern about the performance of students and the quality of the teachers in our nation's schools. Higher teacher pay (linked to accountability) has been put forward as one of the ways of attracting and retaining high-quality teachers, but direct evidence of whether higher teacher pay results in improved student outcomes has been sparse. Illinois offers a unique opportunity to examine the effect of teacher pay on student performance at the district level for two reasons: (a) some districts are split districts encompassing either elementary and middle schools or high schools only; and (b) salaries differ significantly by district type. This paper uses data on Illinois districts from 1995-1998 to explore differences in teacher pay and to examine the effect of teacher pay on district test scores, controlling for other district student and teacher characteristics. The results, while based on exploratory analyses, should be of interest to education researchers and policymakers at the national, state, and local levels who are struggling with issues of teacher quality and improving learning for all students.

Several RAND researchers contributed to this paper. In particular, Catherine Augustine, Richard Buddin, Lionel Galway, Daniel McCaffrey, and Jennifer McCombs reviewed earlier drafts and provided helpful comments on methodology and substance. The paper benefited greatly from their input.

This research was conducted within RAND Education and reflects RAND Education's mission to bring accurate data and careful, objective analysis to the national debate on education policy. Questions about this report should be directed to Sheila Kirby at Sheila_Kirby@rand.org.

I. INTRODUCTION

There is growing concern about our ability to be competitive in the global marketplace fueled by the perceived low levels of student performance both on national and international assessments. The No Child Left Behind Act of 2001 seeks to address these concerns, and it requires states to establish high standards for students, test student mastery of those standards in grades 3-8 and high school, and establish sanctions for schools and districts that fail to meet annual yearly progress goals for students and particular groups of students. However, as of 2005, overall student achievement fell dismally short of meeting standards on the national assessment. For instance, in 2005, the average percentage of eighth grade students meeting or exceeding proficiency standards on the National Assessment of Educational Progress (NAEP) was 31 percent in reading and 30 percent in mathematics (NCES, 2005a, 2005b).

Hand in hand with these reports, there is increasing concern regarding the quality of the teachers in our nation's schools for two major reasons: First, there is a growing body of evidence that teacher quality matters in terms of effects on student achievement (see McCaffrey et al, 2004 for a useful review of this literature).¹ For example, Rivkin, Hanushek, and Kain (2005) analyze data from 3,000 Texas schools and find "large differences among teachers in their impacts of achievement" (2005: 418) and suggest that high quality instruction can help offset disadvantages associated with low socioeconomic background. Second, teacher compensation represents a significant public investment. In 2002, for example, the nation invested \$192 billion in teacher pay and benefits. However, there is considerable controversy over whether, despite this large investment, teacher pay is adequate. As Hess (2004) puts it:

Reformers of all stripes recognize that teacher compensation is a crucial element in hiring the teachers we need and steering them into the schools where they are needed most.

It is in deciding how to tackle the challenge that reformers split.

Superintendents, education school professors, teachers unions, and

¹ While there is considerable consensus that we need "better teachers," identifying the attributes that measure quality of teachers has proven difficult in practice. See Rice (2003) for a good review of this literature. Rivkin, Hanushek, and Kain (2005) also conclude that little of the variation in teacher quality in their study is explained by observable characteristics such as education or experience.

professional associations are united in the conviction that the crucial step is the need to pay teachers more. Today, almost everyone “knows,” in the words of *Washington Post* national columnist Richard Cohen, that “Teachers make lousy money.” There’s one problem with this analysis: It just isn’t true. (http://www.policyreview.org/apr04/hess_print.html)

Hess presents data to show that, if one correctly accounts for benefits and working hours, teachers are not underpaid compared with other professionals. He agrees that good teachers are likely underpaid while mediocre teachers are grossly overpaid and argues for an overhaul of the teacher compensation system.

With all the attention being paid to relative teacher pay and teacher quality, calls for linking teacher compensation to outcomes have become increasingly frequent and some states and districts are experimenting with various forms of performance-based pay. As recently as March 22, 2006, the front page of the *Washington Post* announced a new pay-for-performance program for Florida’s teachers that is set to begin the next academic year. This effort is being hailed as a landmark in the movement to make schools and teachers more accountable for results and the first time that a state “has so closely linked the wages of individual school personnel to their students’ exam results” (Whoriskey, *The Washington Post*, March 22, 2006).

The linkage between teacher pay and teacher quality, however, is ambiguous. Allegretto, Corcoran, and Mishel (2004) point out that the relationship between teacher pay and teacher quality appears to be different depending on the time period being considered. In the short-run, pay increases do not appear to have noticeable effects on the quality of teachers entering teaching (Figlio, 2002; Ballou and Podgursky, 1997; Hanushek, Kain, and Rivkin, 1999). Over the long-run, trends in relative teacher pay seem to be related to trends in teacher quality (Corcoran, Evans, and Schwab, 2004; Bacolod, 2003). For example, Lakdawalla (2001, 2002) finds some support for the hypothesis that higher wages outside teaching have caused districts to substitute quantity of teachers for quality of teachers. Hoxby and Leigh (2004) offer a different explanation for the decline in aptitude of those choosing teaching as a profession, attributing it largely to the pay compression brought about by unionization.

Direct tests of whether higher pay improves student outcomes (because of increases in teacher quality and/or greater effort on the part of teachers) are relatively rare and

generally show little or no relationship, fueling the “money does not matter” debate.² Loeb and Page (2000) and Stoddard (2003) offer a plausible explanation for why most studies fail to find a relationship between teacher salaries and student outcomes. Student quality and other non-pecuniary characteristics are valued by teachers, vary considerably by district, and are likely to be “capitalized” into teacher wages as compensating differentials; thus teachers may be willing to accept lower wages in districts with better working conditions or higher student quality, both of which are likely to be correlated with higher student outcomes. Further, alternative wage opportunities or local amenities may vary. Both studies find a large effect of teacher pay on student outcomes, controlling for job characteristics, local wage opportunities, and/or local amenities.

II. PURPOSE OF CURRENT STUDY

The current study is an extension of a larger project examining the effects of district policies on student achievement in Illinois. In the course of gathering longitudinal data on the 800 school districts that comprise the Illinois school system, we learned that a substantial proportion of Illinois school districts are “split” districts. These districts are separated by school level and encompass *either* elementary and middle schools *or* high schools as opposed to the more traditional districts encompassing all school levels.³ Teachers in the split high school districts earn considerably more while elementary school teachers earn less than their counterparts in the traditional districts. The pay differentiation may be largely attributable to the higher wage alternatives of high school teachers. If wage levels are being driven by high school teachers, it follows that elementary and middle school teachers would benefit—in terms of higher salaries—from the presence of high school teachers in their districts. That is, salaries are set to attract high school teachers and for equity reasons, elementary and middle teachers are paid at similar levels as well. Split elementary school districts without high school teachers would thus have lower pay scales.

This natural experiment in teacher pay offers a unique opportunity to study the effects of pay differentials on the quality of teachers in these districts and on student performance. Our hypothesis is that, other things equal, higher pay should attract

² See, for example, Hanushek, 1986, 1996; Hedges, Laine, and Greenwald 1994; Greenwald, Hedges, and Laine 1996; Krueger 2002.

³ We do not know the origin of the split districts and do not address that in this paper.

higher-quality teachers, so we should see better high school teachers over time self-selecting themselves into split high school districts, while higher-quality elementary and middle school teachers would migrate to the traditional, mixed districts. If this sorting hypothesis is correct, we should find that, controlling for everything else, split high school districts should have higher student performance while the opposite would be true for elementary school districts. However, teachers value working conditions and the quality of students in addition to pay, and if these differ substantially across the two types of districts, then our hypothesis may not be borne out.

This paper focuses on two research questions:

- Are there differences in teacher pay by district type that are not explained by the experience level and educational attainment of teachers in these districts?
- What is the effect of teacher pay and district type on student performance, controlling for other district factors?

We are able to examine the first research question for all three groups of teachers—elementary, middle, and high school teachers. However, we were not able to get 10th grade scores. As a result, our analysis of the effect of teacher pay on student performance was limited to the lower grade levels, in particular 3rd and 8th grade reading and mathematics.

III. DATA

We had data on approximately 800 school districts and schools within those districts in Illinois from 1987 through 1998. We also obtained 3rd and 8th grade scores at the school and district level for both reading and mathematics on the state assessment system. Illinois used the Illinois Goal Assessment Program (IGAP) until 1998 when it switched over to the Illinois Standards Achievement Tests (ISAT) (<http://www.cpre.org/Publications/il.pdf>). The data included a number of student-related characteristics (enrollment, race/ethnicity of the student body, percent of students classified as low-income and limited English proficient, student mobility, average class-size by grade level) and teacher-related characteristics (race/ethnicity, average teaching experience, advanced degrees, and average teacher salaries) at the school, district, and state level. In addition, we obtained teacher salary data at the individual teacher level over the same time period linked to teacher characteristics including teaching experience, educational attainment, and school and district where the

teacher was currently teaching. We also linked data from the 1990 Census to the district records, primarily on demographics and median household income of the district population.

Table 1 provides an overview of the number of schools by district type as of the 1998 school year. Overall, there were about 3,800 schools in our dataset and a total of approximately 800 school districts. Of these, 406 were unitary or traditional districts, 292 were elementary school districts, and about 95 are high school districts. Some districts were missing information and were excluded from the district achievement regressions.

Table 1. Distribution of Schools by District Type

	Elementary Schools	Middle Schools	High Schools
Elementary School Districts (n=292)	971	220	--
High School Districts (n=95)	--	--	152
Traditional Districts (n=406)	1666	354	496
Total number of schools	2637	574	648

IV. METHODS

For the first research question, the level of analysis is the teacher. We analyze teacher salary as a function of several teacher attributes and a dummy variable indicating the type of district. As is usual with wage equations, the dependent variable is the natural log of salary. This allows us to interpret the coefficients as the estimated percentage change in salary when the independent variable increases by one unit. Taking logs narrows the range of the variable and makes estimates less sensitive to outliers.

Models are estimated separately for elementary, middle, and high school teachers. The purpose is to understand whether teacher pay differentials are being driven by traditional factors such as years of experience or educational attainment or whether

salary structure differs by district type. We estimate the model on data from the 1998 school year.⁴ The model is estimated as a simple linear OLS model.

For the second research question, the level of analysis is the district. We use the average district salary (in real 1998 dollars) in a larger model that examines district mathematics and reading scores at the 3rd and 8th grades as a function of student demographics, time, average class size, enrollment, and type of district. We limit the analyses to the years 1995-1998 because the assessment was the same during that time period. In addition, earlier years were missing salary information.

A typical approach for estimating achievement over time in a longitudinal model is given by Equation (1):

$$s_{it} = \mu_i + \gamma C_{it} + \mathbf{x}_{it} \boldsymbol{\beta} + v_{it} \quad (1)$$

where i and t index individual districts and years, respectively; s is test score; μ is an unobserved district-specific factor that does not vary over time; C is a particular variable of interest (for example, type of district); γ is an unobserved parameter reflecting the possible effect of this variable on s ; \mathbf{x} is a $1 \times K$ vector of K observable factors affecting s , $\boldsymbol{\beta}$ is a $K \times 1$ vector of unobserved parameters, and v is a random error term (Zimmer and Buddin, forthcoming). The model includes observed family background characteristics like race/ethnicity and other demographics that are likely to affect student achievement. Obviously, because our model is at the district level, we model district test scores (averaged across schools) as a function of attributes aggregated to the district level.

Two common approaches to estimating a school- or district-level effect over time are a random-effects and a fixed-effects model. The decision to use one or the other approach depends on whether the μ_i are best viewed as parameters to be estimated or as outcomes of a random variable and what we believe about the correlation between μ_i and the observed factors (C and \mathbf{x}). A random-effects model assumes that unobserved permanent factors affecting student achievement (μ_i) are uncorrelated with observed factors (C and \mathbf{x}). This type of model would be appropriate if the vector of district characteristics contains a relatively complete set of observed factors affecting student achievement. Alternatively, the fixed-effects model uses the longitudinal nature of the data to “difference out” the μ_i for observations on the same unit of analysis—in this case

⁴ As a check, we estimated the same model for 1993 and 1995 and found little difference in the coefficients.

the district. In our analysis, we estimated a random effects model but then checked whether the underlying assumptions were valid, using a Hausman test, which examines the correlation between the error term and the regressors.

V. ANALYSES OF TEACHER SALARIES

For this set of analyses, we used data at the individual teacher level to examine differences in pay by district type.

Profile of Teachers by District Type

It is useful to examine the characteristics of public school teachers teaching in Illinois districts, grouped by school level and district type to set the context for the teacher pay regression models. Teachers who were not regular fulltime classroom teachers were omitted from the analysis. Table 2 shows characteristics of (a) elementary school teachers in traditional and split elementary school districts; (b) middle school teachers in traditional and split elementary school districts; and (c) high school teachers in traditional and split high school districts.⁵

- The districts were similar with respect to average age and overall years of teaching experience, although high school teachers appeared to have more years of teaching experience on average, particularly those in high school districts.
- Educational attainment differed among middle and high school teachers by district type. In particular, those in split districts were much more likely to have a master's degree (or higher degree). The difference was particularly marked at the high school level, where about 68 percent of teachers in the high school district had a master's degree or higher compared with 45 percent of teachers in the traditional school district. If we consider educational attainment as a proxy for quality (albeit a weak one), the differences we see here suggest that higher-quality teachers tend to congregate in split districts.
- The distribution of elementary and high school teachers in terms of race-ethnicity also differed by district type. While those teaching in the split districts tended to be overwhelmingly white (93-95 percent), 27 percent of elementary school teachers and 15 percent of high school teachers in the traditional districts were minority, mostly

⁵ The variable indicating whether teachers had teacher certification seemed to be missing for the vast majority of teachers and so is not reported here.

Table 2. Characteristics of Teachers by School Level and District Type

Selected characteristics	Elementary school teachers		Middle school teachers		High school teachers	
	Traditional districts	Elementary school districts	Traditional districts	Elementary school districts	Traditional districts	High school districts
Mean total years of teaching experience	15.0	14.5	15.3	15.4	16.3	17.2
Mean age	42.9	41.7	41.4	41.7	42.8	42.0
Highest educational attainment*						
B.A. degree (%)	59.7	57.7	57.4	50.5	53.7	32.0
M.A. degree or higher (%)	40.0	42.3	42.2	49.4	45.1	67.8
Race-ethnicity						
White, non-Hispanic (%)	72.8	93.4	94.7	95.1	84.5	95.0
African-American (%)	19.5	4.3	4.1	3.6	12.1	3.1
Hispanic (%)	6.5	1.7	1.0	0.8	2.5	1.3
Other (%)	1.2	0.6	0.2	0.5	0.9	0.5
Female (%)	86.2	89.1	62.1	67.4	50.3	47.6

Note: *May not add to 100 percent due to missing data.

African American.⁶ Middle school teachers were similar across district type with respect to race-ethnicity.

- Split elementary school districts at the elementary and middle school levels had a higher percentage of female teachers than traditional districts. Not surprisingly, approximately half of the high school teachers were male, regardless of district type.

We now turn to examining teacher pay across the different district types.

Teacher Salary Differentials by District Type

Teacher pay traditionally differs by experience and education. There was considerable variability across the districts in terms of teacher pay. The average 1998 salary across all districts was about \$35,000 and the 10th and 90th percentiles were \$24,400 and \$46,400 respectively.

- Looking only at beginning teacher salaries, we find that salaries at the 10th and 90th percentiles for those with a bachelor's degree were \$23,800 and \$34,500. Beginning teachers with a master's degree had salaries that averaged between \$4,000-6,000 higher than the ones reported above.
- The pay variability across districts was considerably higher if we selected B.A. graduates with 10 years of teaching experience. The middle 80 percent of the distribution earned between \$29,700 and \$50,500, a very large difference in pay.

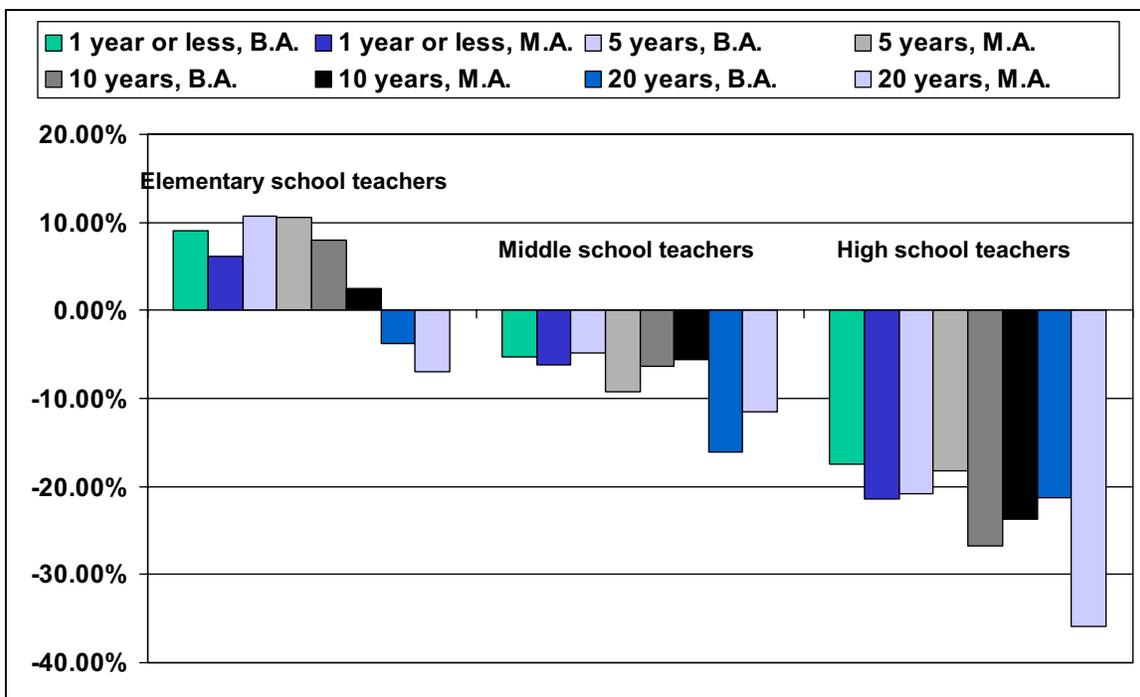
Table 3 shows the average 1998 salaries by district type for teachers with particular attributes in terms of experience (one year, five years, ten years, and twenty years) and whether or not they have a master's degree. Interestingly, the hypothesis we had outlined at the beginning—that teacher salaries should be tied to the presence of high school teachers in the district and as such, should favor traditional districts over elementary districts and high school districts over traditional districts—is borne out at the elementary and high school levels but not the middle school level.

Figure 1 shows the percentage difference in teacher pay for typical teachers calculated using average teacher pay in traditional districts as the base (i.e. for teachers of a given type, $((\text{average pay in traditional districts} - \text{average pay in split districts}) / \text{average pay in traditional districts})$). The largest differences were at the high school level where the pay premium ranged from 18 to 36 percent of the average pay in traditional districts. At the

⁶ It is likely that a higher percentage of the traditional districts are urban districts and this might explain the differences in the minority composition of teachers.

Table 3. Average 1998 Salaries for Teachers with Specific Characteristics, by District Type

Teaching experience and highest educational attainment	Elementary school teachers		Middle school teachers		High school teachers	
	Traditional districts	Elementary school districts	Traditional districts	Elementary school districts	Traditional districts	High school districts
One year or less						
B.A.	\$29,972	\$27,270	\$27,112	\$28,560	\$28,900	\$33,948
M.A.	\$35,063	\$32,908	\$32,032	\$34,022	\$33,585	\$40,801
5 years						
B.A.	\$35,659	\$31,847	\$31,748	\$33,270	\$34,445	\$41,625
M.A.	\$42,110	\$37,681	\$34,980	\$38,229	\$40,935	\$48,414
10 years						
B.A.	\$39,641	\$36,486	\$36,303	\$38,620	\$36,663	\$46,469
M.A.	\$45,442	\$44,335	\$42,965	\$45,331	\$46,238	\$57,223
20 years						
B.A.	\$43,624	\$45,274	\$42,925	\$49,856	\$43,573	\$52,835
M.A.	\$51,303	\$54,890	\$53,731	\$59,932	\$54,446	\$73,951



Note: Percentage difference is calculated as $(\text{pay in traditional districts} - \text{pay in split districts}) / \text{pay in traditional districts}$ for each type of teacher.

Figure 1. Percentage differences in average teacher salaries of typical teachers between traditional districts and split districts, by school level

elementary school level, teachers in elementary school districts earned between 2 and 11 percent less than their counterparts in the traditional districts, with the exception of highly experienced teachers (20 years). These teachers earned 4-7 percent *more* than similar teachers in traditional districts. Middle school teachers in elementary school districts earned between 5 and 9 percent more than their peers in traditional districts. For highly experienced teachers, the pay differential rose to 12-16 percent.

One possibility is that these differences in pay were in the form of “hazard pay.” For example, teachers in central cities working with low-performing students of diverse abilities may earn a wage premium that compensates for difficult working conditions. We looked at differences in the percentage of low-income students, percentage of minority students, student mobility rates, and district size to see if these could explain the systematic differences in salary. A somewhat higher percentage of students in traditional elementary districts were low-income (25 percent) compared with split elementary districts (21 percent) while the percentage of minority students was higher in the elementary district (13 percent) than in the traditional district (7 percent). The

average student mobility rate was about 15 percent in both, but the variance in mobility rates was much higher among split districts than among traditional districts.

Not surprisingly, the one major difference between the two types of districts at the elementary level was district size. For example, the median enrollment in traditional districts was about 990 students and districts at the 5th and 95th percentiles had 300 and 7,500 students respectively. (This includes enrollment at all grade levels). These numbers were considerably higher than enrollment in elementary districts (median=490 students; 5th percentile=100 students; 95th percentile=3,100 students). Thus, one plausible explanation for lower salaries in split elementary districts is the smaller size of the districts—elementary teachers may prefer to work in smaller districts and may be willing to trade some pay for the opportunity to do so. However, the fact that high school districts were quite large *and* paid higher salaries runs counter to this explanation. For example, high school districts had a median enrollment of 1,100 students while the 5th and 95th percentile districts reported enrollments of 100 and 6,600 respectively. High school districts, because they do not encompass other school levels, may be able to target their resources better than traditional districts with competing school levels.

Models of Teacher Pay

In an effort to better understand the wage premiums being offered in the various types of districts, we used the 1998 teacher pay data to estimate a simple model of teacher pay as a function of years of teaching experience, advanced degree, the type of district, and interactions among these. The variables are defined in Table 4, which also provides the means and standard deviations. In addition to the variables shown, we had a dummy variable for district type and interactions between years of teaching experience and the M.A. dummy variable and the district type dummy. Because the dependent variable is in logarithmic form, the coefficients show the estimated percentage change in salary when the independent variables change by one unit.

Table 5 presents the results of the regressions. The simple model did a better job of explaining the variation in salary at the high school and middle school levels (70-71 percent) than at the elementary level (58 percent). The high R-squared was largely due to the fact that most districts' salary schedules are tied to education and years of experience.

The dummy variable indicating whether the teacher was working in a split district was statistically significant and quite large in the elementary and high school models.

Table 4. Analysis Variables: Definitions and Summary Statistics

Definition	Traditional districts		Split districts	
	Mean	Standard Deviation	Mean	Standard Deviation
<i>Elementary school teachers</i>				
Dependent variable:				
Ln (salary)	10.66	0.25	10.64	0.31
1998 teacher salary (\$) ^a	(44165.66)	(11069.61)	(43694.64)	(13580.44)
Independent variables ^b				
Years of teaching experience	15.02	10.15	14.48	9.83
M.A. (=1 if teacher has master's degree, =0 otherwise)	0.39	0.49	0.42	0.49
<i>Middle school teachers</i>				
Dependent variable:				
Ln (salary)	10.62	0.29	10.72	0.32
1998 teacher salary (\$) ^a	(42796.81)	(12924.37)	(47338.86)	(14876.56)
Independent variables ^c				
Years of teaching experience	15.31	10.22	15.36	10.39
M.A. (=1 if teacher has master's degree, =0 otherwise)	0.42	0.49	0.49	0.50
<i>High school teachers</i>				
Dependent variable:				
Ln (salary)	10.68	0.29	11.00	0.34
1998 teacher salary (\$) ^a	(45108.66)	(12890.09)	(63029.01)	(20359.07)
Independent variables ^b				
Years of teaching experience	16.35	10.78	17.17	10.61
M.A. (=1 if teacher has master's degree, =0 otherwise)	0.44	0.50	0.67	0.47

Notes:

^a It is helpful to see the dollar salary values in addition to the log salary values.

^b In addition, the model includes a split district dummy (Split district =1 if teaching in elementary school district, =0 if teaching in traditional district); and interactions between this dummy and education and experience.

^c In addition, this model includes a split district dummy (Split district =1 if teaching in high school district, =0 if teaching in traditional district); and interactions between this dummy and education and experience.

Table 5. Regression Results of Teacher Pay Models

Dependent Variable: Ln(1998 teacher salary)

Independent Variables	Elementary school teachers		Middle school teachers		High school teachers	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Intercept	10.384	--	10.266	--	10.336	--
Split District	-0.131	0.003*	0.029	0.005*	0.170	0.005*
Years of teaching experience	0.014	0.000*	0.017	0.000*	0.016	0.000*
Years of teaching experience*Split District	0.007	0.000*	0.004	0.000*	0.002	0.000*
M.A. degree	0.163	0.002*	0.208	0.004*	0.175	0.003*
M.A.*Split District	0.035	0.003*	-0.023	-0.006*	0.083	0.006*
Adjusted R-squared	0.58		0.71		0.70	
(Number of observations)	(54,770)		(14,259)		(28,699)	

Note: *Statistically significant at .05 level of significance.

The models estimated that beginning elementary teachers without a master's degree teaching in split districts earned about 13 percent less and high school teachers in split districts earned 17 percent more than their counterparts in the traditional districts, holding everything else constant.

Years of teaching experience and having a master's degree were significant in all three models, although the coefficients on the M.A. dummy variable seemed disproportionately large. The interaction variables suggested that there was a wage premium for both experience and education for working in a split district (although not for a master's degree for middle school teachers). Thus, teachers with a master's degree in traditional districts were predicted to earn 16-20 percent more than teachers with only a bachelor's degree, other things equal, while elementary and high school teachers in split districts earned an even greater premium for a master's degree (an additional 4 and 8 percent respectively). Middle school teachers with a master's degree earned about 21 percent more in traditional districts and about 19 percent more in split districts than teachers without a master's degree.

Given the size of the coefficients, the models over-predicted average teacher salaries for teachers with masters' degrees with 5 or 10 years of teaching experience who were working in split districts but did a good job predicting salaries for those with 20 years of experience.

Our purpose here was exploratory—to see whether the trends we had seen in the data were borne out in a regression analysis that controlled for other factors. We found that working in split districts provided a premium at the high school level, controlling for experience and education, while the opposite was true at the elementary level. However, in general, experience and education both had higher rates of return in split districts than in traditional districts.

VI. EFFECTS OF TEACHER SALARIES ON STUDENT PERFORMANCE

In this section, we now turn to student performance in 3rd and 8th grade reading and mathematics over the 1995-1998 time period.⁷ School-level raw scores on the IGAP were aggregated to the district level, so what we analyzed were average district scores.

⁷ Given the marked differences we had seen earlier with respect to educational attainment and salaries at the high school level, it would have been interesting to carry out these same analyses for high school versus traditional districts. Unfortunately, we were unable to get 10th grade scores in a timely fashion.

Trends in Average District Scores

Before turning to the regression results, we examine the trends in average district scores over time by district type. Reading scores were well below the mathematics scores in both district types. Elementary districts outperformed traditional districts at both the 3rd grade and 8th grade levels and in both reading and mathematics over this time period. For example, average 3rd grade reading and mathematics scores were 268 and 305 points in elementary districts compared with 259 and 292 points in traditional districts. This was true at the 8th grade level as well. There was tremendous variability in the performance of districts. For example, at the 3rd grade level, there was a 95-98 point difference in scores of traditional districts at the 5th and 95th percentiles and even larger differences (106-126 points) in scores of elementary districts at the same percentiles.

To see whether and how scores had changed over time, we examined trends in average 3rd and 8th grade raw scores in reading and mathematics (Figures 2 and 3). Reading scores remained fairly stable at the 3rd grade level but fluctuated at the 8th grade level and seemed to be trending downwards in both types of districts. Mathematics scores increased at both grade levels and in both types of districts with one exception (3rd grade scores in elementary districts, where they remained stable from 1996-1998).

Variables Used in the Analyses⁸

Table 6 presents the definitions and means and standard deviations of the analysis variables used in the model. Four models were estimated: 3rd grade reading, 3rd grade mathematics, 8th grade reading, and 8th grade mathematics. The independent variables included a dummy for district type (=1 if the district was a split elementary school district); year dummies; student demographics, including racial-ethnic make-up of the student body, percentage low-income, and percentage of students with limited English proficiency; student mobility rate; and district enrollment.

A little less than a third of our sample consisted of split districts. Overall, a little less than 10 percent of students were minority and about 23 percent of them were low-income students. Surprisingly, the percentage of limited English proficient students was fairly small—1 percent—across all districts. Between 14-15 percent of students moved each year but the mobility rate varied widely across districts. District size varied

⁸Additional variables from the Census (median household income, educational attainment of district populations) were not significant in the model and thus not included in the final regressions.

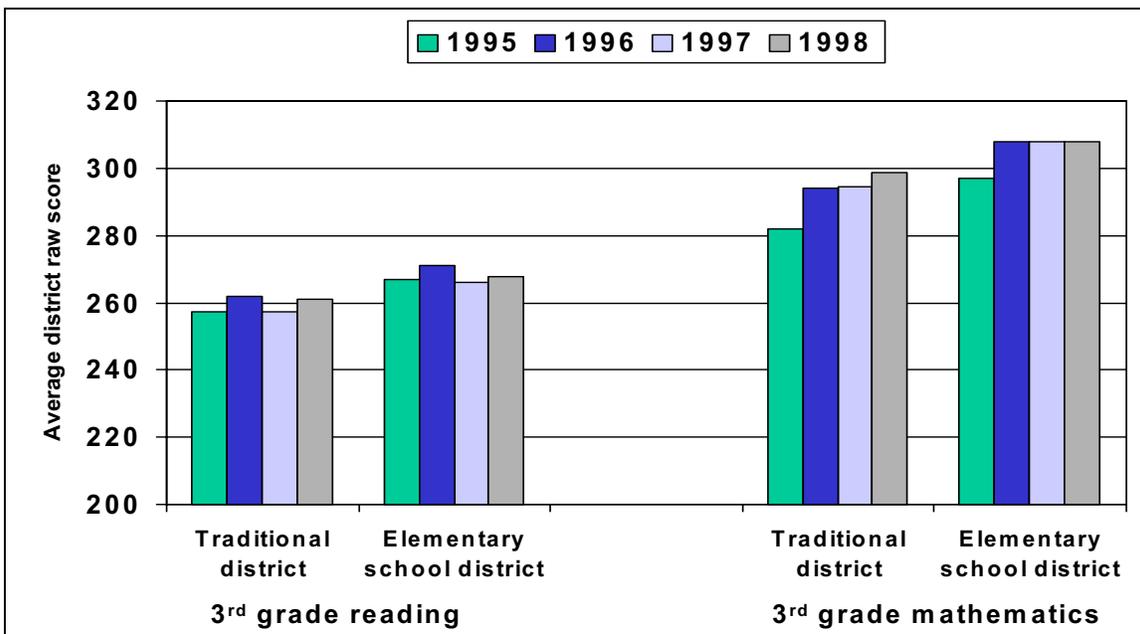


Figure 2. Average district raw scores for 3rd grade reading and mathematics, 1995-1998

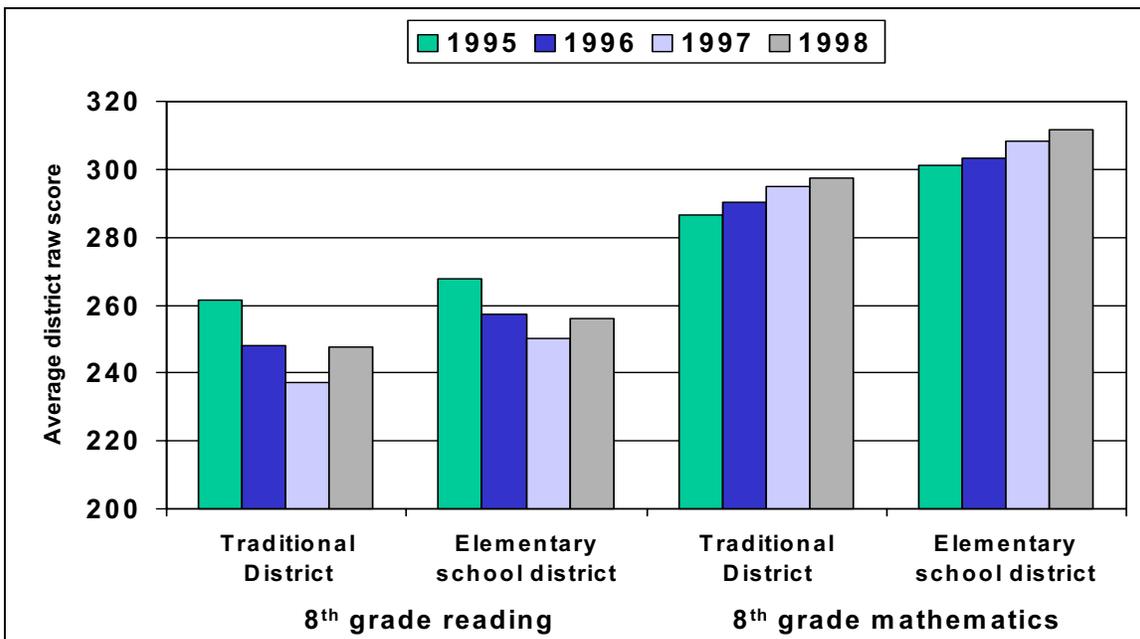


Figure 3. Average district raw scores for 8th grade reading and mathematics, 1995-1998

Table 6. Analysis Variables: Definitions and Summary Statistics

Definition	3 rd grade		8 th grade	
	Mean	Standard Deviation	Mean	Standard Deviation
Dependent variables				
Average district reading raw score	262.96	34.59	252.46	31.48
Average district mathematics raw score	297.82	42.18	298.03	36.34
Independent variables				
1995, 1996, 1997, 1998 year dummies (=0 if no, =1 if yes)	0.25 (each dummy)	0.43	0.25 (each dummy)	0.43
Elementary school district (=0, if traditional district, =1 if elementary school district)	0.31	0.46	0.31	0.46
District student characteristics				
Percentage white, non-Hispanic students	90.47	17.35	90.47	17.35
Percentage black, non-Hispanic students	4.94	10.88	4.94	10.88
Percentage Hispanic students	3.13	6.79	3.13	6.79
Percentage students of other race-ethnicity	2.92	3.57	2.92	3.57
Percentage low-income students	23.06	16.10	23.06	16.10
Percentage limited English proficient students	1.30	3.58	1.30	3.58
Average class-size experienced by students from 1 st to current grade	20.82	3.73	21.57	3.64
Student mobility rate	14.58	7.81	14.58	7.81
District enrollment (000s)	2.14	15.62	2.14	15.62
District teacher characteristics at grade level				
Percentage with M.A. degree	0.32	0.17	0.32	0.16
Average years of teaching experience	14.35	2.26	14.45	2.14
Average teacher salary (1998 \$, 000s)	37.27	7.78	36.66	7.42

considerably—while the mean was about 2100 students with a standard deviation of over 15,000. We also tried a number of different specifications of this variable, including a squared term, but the variable was insignificant in all the models.

We had data by district on average class sizes for the different grade levels from 1987-1998 and thus were able to construct a variable that captures the average class size experienced by 3rd and 8th graders from the time they started school. Thus, for example, most 8th graders in 1995 were in 1st grade in 1988, and we used data from 1988 through 1995 to capture the average class size these students experienced as they progressed through the grades. This assumes they stayed in the same district. It seems plausible to hypothesize that it is the sum of the experiences in school that affect student performance, not simply current conditions. The average class size over the period of schooling was about 20.8 for 3rd graders and about 21.6 for 8th graders.

We also included three district teacher characteristics—percentage of teachers with master’s degrees, average teacher experience, and of course, average teacher salary. A little less than third of the teachers had master’s degrees at each grade level. Teachers had about 14 years of teaching experience on average. The salary variable measures real salary in 1998 dollars, using the CPI.⁹ The average salary was about \$37,000 for 3rd grade teachers and a little lower for 8th grade teachers.

Regression Results: 3rd Grade Model

Table 7 presents the results of the 3rd grade models. These models were estimated as random-effects models because one of our primary interests was the effect of district type, controlling for other factors, on student performance. However, the random-effects model requires rather stringent assumptions and we return to this topic later in this section. The results shown in Table 7 (and in Table 8) should be seen as suggestive and exploratory, rather than definitive.

Overall, the model explained 44 percent of the variation in reading scores and 35 percent of the variation in mathematics scores at the 3rd grade.

The two variables of interest are at the bottom of the table. Controlling for other factors, including teacher salaries and district size, we found that elementary school districts had average scores that were between 5 and 6 points *higher* than those of traditional districts

⁹ We did some work on estimating a cost-of-living index that would adjust for differences in cost of living among districts but the index needs refining and was not used in these analyses.

Table 7. Regression Results of Models of Student Performance, 3rd GradeDependent variables: Average district 3rd grade reading and mathematics raw scores

Independent variables	3 rd grade reading		3 rd grade mathematics	
	Coefficient	Standard error	Coefficient	Standard error
Constant	252.04	7.50*	271.69	10.00*
1996 dummy	4.73	1.13*	11.50	1.26*
1997 dummy	0.25	1.14	12.34	1.28*
1998 dummy	3.51	1.16*	14.92	1.30*
District student characteristics				
Percentage black, non-Hispanic students	-0.59	0.07*	-0.62	0.10*
Percentage Hispanic students	-0.86	0.20*	-0.89	0.26*
Percentage students of other race-ethnicity	0.39	0.28	0.83	0.39*
Percentage low-income students	-0.56	0.07*	-0.55	0.09*
Percentage limited English proficient students	0.22	0.37	0.33	0.46
Average class-size experienced by students from 1 st to current grade	-0.35	0.20	-0.50	0.25*
Student mobility rate	-0.39	0.10*	-0.11	0.11
District enrollment	0.04	0.37	-0.27	0.52
District teacher characteristics				
Percentage with M.A. degree	0.17	0.08*	0.19	0.11
Average years of teaching experience	-0.17	0.39	-0.58	0.51
Average teacher salary	0.95	0.21*	1.25	0.28*
Elementary school district	5.41	1.91*	6.30	2.67*
Observations	2406		2406	
Unique districts	631		631	
R-squared	0.44		0.35	

Note: *Statistically significant at .05 level of significance.

and this effect was significant. This suggests that there were unmeasured characteristics of these districts that fostered higher student achievement. We had seen earlier that these districts tended to be much smaller, on average, than traditional districts. It is possible that the smaller size of these districts allowed for better instructional leadership, greater attention to curriculum, more targeted interventions to assist low-performing students, or more supportive school and district climate, all of which could be correlated with better student outcomes.

Districts with higher salaries, controlling for other factors, appeared to have significantly higher test scores in both reading and mathematics. For example, a district with an average salary level that was \$5,000 higher than that of a similar district was predicted to have an average test score that is about 5 points ($.95 \times 5$) higher in reading and over 6 points (1.25×5) in mathematics. Note that the two effects largely offset each other. Elementary districts with average salaries that are \$5000 lower than those of similar traditional districts would still match traditional districts in terms of average student performance.

Districts with higher percentages of African-American and Hispanic students and low-income students had significantly lower scores than those with lower percentages of such students. Higher average class size experienced over the schooling period had a negative effect on test scores but was significant only in the mathematics model. High mobility rates also lowered reading scores. District size and the percentage of limited English proficient students had little effect on test scores.

Although evidence regarding the effect of advanced degrees on student test scores is mixed at best,¹⁰ we found that districts with higher proportions of teachers with advanced degrees have significantly higher reading test scores. However, the effect is small. For example, increasing the percentage of teachers with advanced degrees by 10 percentage points (a very large increase) raises average test scores by about 2 points on average. The coefficient is positive in the mathematics model but not statistically significant at the .05 level. Average teaching experience appears not to have an effect on test scores in these models, other things equal.

Regression Results: 8th Grade Model

Table 8 presents the results of the 8th grade models.

¹⁰ See Rice (2003) for a review of this literature. More recently, Rivkin, Hanushek, and Kain (2005) find little or no evidence that a master's degree raises the quality of teaching.

Table 8. Regression Results of Models of Student Performance, 8th Grade

Dependent variables: Average district 8th grade reading and mathematics raw scores

Independent variables	8th grade reading		8 th grade mathematics	
	Coefficient	Standard error	Coefficient	Standard error
Constant	271.79	6.93*	283.31	7.98*
1996 dummy	-11.43	1.06*	3.39	0.99*
1997 dummy	-21.74	1.06*	7.79	1.00*
1998 dummy	-12.27	1.07*	11.34	1.00*
Elementary school district	7.81	1.72*	10.94	2.03*
District student characteristics				
Percentage black, non-Hispanic students	-0.58	0.06*	-0.81	0.08*
Percentage Hispanic students	-1.07	0.18*	-1.28	0.20*
Percentage students of other race-ethnicity	0.27	0.25	0.71	0.29*
Percentage low-income students	-0.41	0.06*	-0.41	0.07*
Percentage limited English proficient students	0.13	0.33	0.48	0.35
Average class-size experienced by students from 1 st to current grade	-0.55	0.20*	-0.84	0.21*
Student mobility rate	-0.38	0.09*	-0.46	0.09*
District enrollment	-0.25	0.33	-0.07	0.39
District teacher characteristics				
Proportion with M.A. degree	0.19	0.07*	0.25	0.09*
Average years of teaching experience	-0.81	0.40*	-0.97	0.46*
Average teacher salary (1998 \$)	0.75	0.20*	1.43	0.23*
Observations	2344		2343	
Unique districts	615		615	
R-squared	0.47		0.53	

Note: *Statistically significant at .05 level of significance.

The 8th grade model did better than the 3rd grade model in explaining the variation in district test scores, particularly in mathematics. Overall, the model explained 47 percent of the variation in reading scores and 53 percent of the variation in mathematics scores compared with 44 (reading) and 35 (mathematics) percent in the 3rd grade model.

The effect of being a split district was larger at the 8th grade than at the 3rd grade level. Elementary school districts had significantly higher average scores—8-11 points higher—than traditional districts compared to a 5-6 point differential at the lower grade level. One explanation for this finding may be that this reflects a cumulative effect on student performance i.e. for students who stay in the smaller split districts, the positive impact on performance increased over time. It would be interesting to examine these districts more closely to see whether these districts have maintained their higher test scores over time and to better understand the reasons for the difference in performance through detailed case studies.

Teacher salary was significant and positive in both models. A district with an average salary level that was \$5,000 higher than that of a similar district was predicted to have an average test score that was about 4 points ($.75*5$) higher in reading and over 7 points ($1.43*5$) in mathematics. Because middle school teachers in elementary districts had *higher* salaries, the model predicts that, if salaries were \$5000 higher on average in these districts, 8th grade test scores would be 12-18 points higher in these districts compared with traditional districts—a substantial difference. On the other hand, traditional districts would have to *raise* salaries by \$8,000-10,000 to offset the elementary school district effect.

The results for race-ethnicity and poverty mirror those found in the 3rd grade model--districts with higher percentages of African-American and Hispanic students and low-income students had significantly lower scores than their counterparts with lower percentages of such students.

Higher average class sizes over the schooling period were associated with significantly lower test scores in both reading and mathematics and the effect was larger at the 8th grade level than at the 3rd grade level. High mobility rates lowered scores in both subjects. District size and the percentage of limited English proficient students again had little effect on test scores.

Districts with higher percentages of teachers with advanced degrees had significantly higher test scores, but, as was the case with the 3rd grade analysis, the effect is small. Increasing the percentage of teachers with master's degrees by 10 percentage points is

predicted to raise the average district score by between 2 and 3 points, depending on subject.

Sensitivity Analysis

The models shown above were estimated unweighted so that small and large districts were both given a weight of one. However, it is clear that districts differed widely in enrollment so it is useful to explore whether the models are structurally different if we only examine large versus small districts. We divided the sample into quartiles and reestimated the models for three groups: lowest quartile (smallest districts); middle 50 percent of the districts; and top quartile (largest districts). The models were similar with respect to size and significance of coefficients in the large and middle districts. Both the variables of interest—district type and teacher salary—remained significant. The lowest quartile was dominated by elementary school districts, thus the split district dummy was insignificant as was salary. This sensitivity analysis suggests that the model results were reasonably robust with respect to the question of weighting.

Caveats

As mentioned earlier, the random-effects model requires that the unobserved district-specific effects are uncorrelated with each explanatory variable in all time periods (Wooldridge, 2002), while the fixed-effects model requires far fewer assumptions. One can use the Hausman test, which uses the results of the fixed-effects and random-effects models, to test whether the ideal conditions of the random-effects model are met. In our case, all four models showed volatility in the magnitude and direction of the coefficients and the Hausman test suggested correlation between the error term and the explanatory variables. Thus the coefficients are likely to be suffering from omitted variable bias. In the fixed-effects model, the effect of salary was insignificant and the elementary school district dummy was dropped because it did not vary over time. Thus, as we warned earlier, the findings from the random-effects model, while provocative and interesting, need further validation. Nonetheless, we believe that the analyses are useful as building blocks for future work.

VII. CONCLUSIONS

Our purpose in this paper was to take advantage of a natural experiment in Illinois in which salaries for teachers appeared to differ substantially based on the type of district in which the teacher was teaching. Districts were either traditional districts that encompassed all school levels or split districts that had particular school levels

(elementary school districts that contained only elementary and middle schools or high school districts that contained only high schools). We hypothesized that salary structures would be linked to the presence of high school teachers i.e., high school teachers in high school districts should have higher salaries and elementary and middle school teachers in elementary school districts should have lower salaries on average than counterparts in traditional districts. If higher pay attracts higher-quality teachers, we would expect sorting to occur with higher-quality teachers sorting themselves into higher-paying districts. We also hypothesized that because teacher quality is correlated strongly with student achievement, we should see effects of type of district and teacher salaries on student performance.

The paper focused on two main research questions:

- Were there differences in teacher pay by district type that could not be explained by the experience level and educational attainment of teachers in these districts?
- What was the effect of teacher pay and district type on student performance, controlling for other district factors?

Differences in Teacher Salaries by District Type

To answer the first question, we used teacher salary data at the individual teacher level for 1998 and analyzed the salary structure in traditional and split districts. Comparing teachers with similar levels of education and experience, we found that:

- (a) Elementary teachers in elementary school districts earned 2-11 percent *less* than similar counterparts in traditional mixed districts with the exception of highly experienced teachers.
- (b) Middle school teachers in elementary school districts earned 5-9 percent *more* than their peers in traditional districts and the pay differential was higher for more experienced teachers (which runs counter to what we had expected).
- (c) High school teachers in high school districts earned 18-36 percent *more* than similar teachers in traditional districts.

The simple models of teacher pay confirmed that district type significantly affected teacher salaries for elementary and high school teachers in the expected direction. However, we also found that the payoff for both education and experience was significantly higher in split districts compared with traditional districts.

Effects of District Type and Teacher Salaries on Student Performance

We examined average district test scores at the 3rd and 8th grades in reading and mathematics on the state accountability test from 1995-1998 and estimated random-effects models of average district test scores as a function of district student and teacher characteristics, year dummies, and district type. There was tremendous variability across both types of districts in average test scores but on average, elementary districts appeared to outperform traditional districts in both subjects and both levels. However, because districts varied widely in terms of teacher and student characteristics, we estimated a multivariate model that controlled for these factors. We found that:

- (a) Controlling for other district factors, elementary school districts had higher test scores on average than traditional districts at both grade levels and in both subjects. If we believe average district test scores are linked to teacher quality and higher-quality teachers would be attracted by higher pay, then this finding runs counter to our hypothesis. At the 3rd grade level, achievement was higher in elementary school districts that on average offered *lower* salaries. At the 8th grade level, the hypothesis worked as expected—middle school teachers earned more in elementary districts and these districts had higher achievement. This suggests that unmeasured differences between districts also affected student achievement. The smaller size of elementary school districts may have provided a more supportive climate for student learning.
- (b) Controlling for other district factors (including average education and experience of teachers, district type), higher teacher salaries were associated with higher student performance. On the surface, this runs counter to the finding above, because elementary school districts had a *lower* salary structure than traditional districts. It is important to remember that, in a multivariate analysis, we are controlling for other factors. Thus, regardless of district type, we found that higher salaries appeared to be associated with better average student outcomes. This lends some support to the hypothesis that higher pay attracted more effective teachers.

Implications for Future Work

The analyses presented here offer some interesting and useful information for future work. However, because of the issues with the underlying assumptions and robustness of the models, the findings should be regarded as suggestive rather than definitive. Further, we were limited to using 1995-1998 test score data because the test changed after that time period; as a result, the analyses are somewhat dated. It would be useful

to extend this work to examine: (a) the robustness of the models with respect to different underlying assumptions; and (b) how and why the traditional districts differ from elementary districts in terms of governance, finance, school and district climate, curriculum etc. in order to understand better the reasons for the differences in student performance.

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