

The Effect of
Performance-
Pay in
Little Rock,
Arkansas on
Student
Achievement

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The Effect of Performance-Pay in Little Rock, Arkansas on Student Achievement

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ABSTRACT

This paper examines evidence from a performance-pay program implemented in five Little Rock, Arkansas elementary schools between 2004 and 2007. Using a differences-in-differences approach, the evidence shows that students whose teachers were eligible for performance pay made substantially larger test score gains in math, reading, and language than students taught by untreated teachers. Further, there is a negative relationship between the average performance of a teacher's students the year before treatment began and the additional gains made after treatment. That is, performance-pay in Little Rock appears to have improved student achievement and to have done so more for students of teachers who were previously less effective at producing learning gains.

1) Introduction

In the United States, the majority of public school teachers receive compensation according to a salary schedule that is almost entirely determined by their number of years of service and their highest degree attained. The wisdom of this system, however, has increasingly been questioned by policymakers and researchers in recent years. Several school systems have considered adding a component to the wage structure that directly compensates teachers based upon the academic gains made by the students in a teacher's care, at least partly measured by student scores on standardized tests. Several public school systems including Florida, New York City, Denver, and Nashville have recently adopted such "performance-pay" policies. Recent survey research suggests that nearly half of all Americans support performance-pay for teachers whose students are making academic progress, while about a third of Americans directly oppose such a plan (Howell, West, and Peterson 2007).

This paper examines evidence from a performance-pay program implemented in five Little Rock, Arkansas elementary schools between 2004 and 2007. Using a differences-in-differences approach, the evidence shows that students whose teachers were eligible for performance pay made substantially larger test score gains in math, reading, and language than students taught by untreated teachers. Further, there is a negative relationship between the average performance of a teacher's students the year before treatment began and the additional gains made after treatment. That is, performance-pay in Little Rock appears to have improved student achievement and to have done so more for students of teachers who were previously less effective at producing learning gains.

II) Previous Research

The focus on performance-pay programs recognizes the consensus that teacher quality is one of the most important parts of the education process. Analyses using panel data suggest that the quality of the teacher in a classroom is one of the most important predictors of student achievement (Rivkin, Hanushek and Kain 2005; Harris and Sass 2006; Aaronson, Barrow and Sander 2003; Ballou, Sanders and Wright 2004; Goldhaber and Brewer 1997; Rockoff 2004). Other research has focused on identifying observable characteristics that predict teacher productivity, though these papers have had little success in their search (for a complete review of this literature see Hanushek and Rivkin 2006).

Several researchers have evaluated the impact of performance pay programs on reported teacher satisfaction, classroom practices, and retention (Johns, 1988; Jacobson, 1992; Heneman and Milanowski, 1999; Horan and Lambert, 1994). Some U.S. evidence suggests that programs providing bonuses to entire schools, rather than changing the pay of individual teachers, have a positive impact on student test scores (Clotfelter and Ladd, 1996). However, there is currently very little empirical evidence from the United States suggesting that direct teacher-level performance pay leads to better student outcomes.¹

Figlio and Kenny (2006) independently surveyed the schools that participated in the often-used National Educational Longitudinal Survey (NELS). They then supplemented the NELS dataset with information on whether schools compensated teachers for their performance. They found that test scores were higher in schools that individually rewarded teachers for their classroom performance.

¹ There is also limited evidence on the impact of performance pay in other countries. Lavy (2002) found that a school-based program in Israel increased student performance, and Glewwe, Ilias, and Kremer (2003) found similar results from a program in Kenya.

Eberts, Hollenbeck, and Stone (2000) used a differences-in-differences approach to evaluate the impact of a performance incentive for teachers in an alternative high school in Michigan. They found that the program had no effect on grade point averages or attendance rates and actually increased the percentage of students who failed the program. However, the study was unable to provide a direct evaluation of student achievement (i.e. test scores). Further, the study's focus on an alternative dropout recovery school produces difficult estimation problems and could limit its use in the discussion of traditional public K-12 education.

Finally, Keys and Dee (2005) evaluated an incentive improving career ladder program in Tennessee. They took advantage of the fact that this program operated at the same time as the notable Tennessee STAR program, a random assignment experiment on the impact of class size on student achievement. Under STAR, students were randomly assigned to classrooms of different sizes. This assignment additionally meant that students were randomly assigned into classrooms led by teachers who were or were not participating in a state sponsored performance pay program. Importantly, however, teachers were not similarly randomly assigned to participate in the performance pay program, and thus the study cannot be considered a conventional random assignment experiment of the performance pay plan. Nonetheless, they found that students randomly assigned to classrooms with teachers participating in the performance pay program made exceptional gains in math and reading, though these results could be driven by selectivity in the teachers that choose to participate in performance pay programs, rather than the incentives of the program itself.

III) Description of Program

The Achievement Challenge Pilot Project (ACPP) was a teacher and staff pay-for – performance program that operated within the Little Rock School District (LRSD) from 2004-05

to 2006-07. The stated purpose of the program was to motivate faculty and staff to bring about greater student achievement gains. The ACPP used student improvement on nationally-normed standardized tests as the only basis for financial rewards.

The funding for this project came through a partnership between private foundations and the LRSD. In the first year, private foundations supported ACPP at a single elementary school and the program expanded to include another school in its second year. In the third year the program adopted three additional elementary schools. For reasons discussed below, our analyses will focus entirely on the impact of performance-pay in the three schools that began treatment in the third year of the program. The discussion that follows describes how the program operated in these three schools.

The performance-pay program provided bonuses directly to teachers based on the average spring-to-spring achievement gain of students in the teacher's class on the composite score of the Iowa Test of Basic Skills. The composite score includes student achievement on the math, reading, and language arts portion of the exam.

Teachers whose students had an average achievement growth between 0-4%, earn \$50 times the number of students in their class; teachers whose students have an average achievement growth between 5-9%, earn \$100 times the number of students in their class; teachers whose students have an average achievement growth between 10-14%, earn \$200 times the number of students in their class; teachers whose students have an average achievement growth over 15%, earn \$400 times the number of students in their class. Table 1 displays the average bonuses that were actually earned in the schools included in the analysis. Other staff members could also earn various bonuses based on their level of responsibility.

[TABLE 1]

Schools were selected to participate in ACPP based on their high percentages of students who were struggling academically and economically disadvantaged. Table 2 reports baseline descriptive statistics for those variables used in the analyses below. About 63 percent of the LRSD students that were not in a performance-pay eligible school in 2007 qualified for the federal free and reduced lunch program, and 67 percent of these students are African American. The schools that were eligible for the program in 2007 served a more disadvantaged group of students: 88 percent of whom qualify for the federal free and reduced lunch program and 88 percent of whom are African American.

[TABLE 2]

The table also shows that students in untreated schools had baseline scores in math, reading, and language that were substantially above those of students who were in treated schools. Further, students in untreated schools made substantially larger improvements in these subjects the year before treatment took place.

IV) Data and Method

The analysis of this program was based on individual data for the universe of public school students enrolled in Little Rock, Arkansas elementary schools in the 2005 through 2007 school years, providing two observations of student test scores gains.² For each elementary student in the district, this dataset included demographic information, test scores, an identifier for the student's classroom teacher, and a unique student identifier that allows us to track each student's performance over time. The analysis focused on the impact of the adoption of the performance-

² Here and throughout this paper we use the spring term year to identify the school year. That is, the 2004-05 school year is referred to as 2005.

pay program on student proficiency in math, reading, and language, since test scores are available in those subjects.

Test scores are reported in our dataset in Normal Curve Equivalent (NCE) units. NCE's rank the student on a normal curve compared to a nationally representative group of students who have taken the test. NCE's are similar to percentile scores, but differ in that they are equal-interval scaled, meaning that the difference between two scores on one part of the curve are equivalent to the difference of a similar interval on another part of the curve. NCE scores are scaled between 1 and 99 with a mean of 50.

The analysis utilizes the differences-in-differences procedure to study the impact of performance pay. Unfortunately, the analysis had to exclude students in the schools that began the performance pay treatment prior to 2007. The reason for the exclusion is that since these schools were treated in each year for which data are available, in the analysis they would become part of the comparison group. That is, schools that had always been in the program during the period for which scores are available would be lumped together with schools that had never been in the program if they were included in the model. To isolate the effect of the program, the model needs to focus on schools that switch from not having performance pay to having it, which limits the analysis to the three elementary schools which had only one year of participation in the program.

The analysis uses an ordinary least squares regression (OLS) to estimate a model taking the form:

$$Y_{i,a,t} = \beta_o + \beta_1 Y_{i,a,t-1} + \beta_2 Student_{i,t} + \beta_3 School_{i,t} + \beta_4 Year_t + \beta_5 Treat_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where $Y_{i,a,t}$ is the test score of student i in subject a in the spring of year t ; $Student$ is a vector of observable characteristics about the student; $School$ is vector indicating the school that the

student attended; Year is an indicator variable for the year; and ε is a stochastic term clustered by teacher.³

Treat is an indicator variable for whether the observation occurred for a student attending the treatment school during the treatment year. That is, this variable is an interaction between Year = 2007 and the indicator variable for each school that was eventually treated. The coefficient for the “treat” variable represents the impact of the performance pay treatment after accounting for the differences in the test scores that occur naturally over time and within the individual schools.

A second analysis estimates a model identical to the one above, but includes a teacher fixed effect. A teacher fixed effect is a dummy variable for each teacher that controls for the average quality of each teacher. This model takes the form:

$$Y_{i,a,t} = \psi_0 + \psi_1 Y_{i,a,t-1} + \psi_2 Student_{i,t} + \psi_3 School_{i,t} + \psi_4 Year_t + \psi_5 Treat_{i,t} + \psi_6 Teacher_{i,t} + \rho_{i,t}, \quad (2)$$

where Teacher is an indicator for the student's teacher, ρ is a stochastic term clustered by teacher, and all other variables are as previously defined.

Controlling for teacher fixed effects has the potential benefit of more clearly identifying the effect of offering teachers bonuses by controlling for effective teacher already was, on average. But this potential improvement in precision comes at a price. It effectively eliminates from the analysis a large number of students whose teachers were not in those schools for more than one year. And adding dummy variables for every teacher reduces the degrees of freedom, giving the model less statistical leverage. For these reasons, this second analysis controlling for

³ Results are similar if standard errors are clustered by school. Results available from authors by request.

teacher fixed effects should not be viewed as the main analysis but should be understood as a check on the robustness of the first analysis.

In addition to estimating the overall effect of offering teachers bonuses for student test score gains, this paper also examines whether there is a differential relationship between the impact of performance-pay and a teacher's prior productivity. A large literature suggests that there are substantial differences across teachers in the ability to produce student test scores gains. One potential reason for such wide variation in teacher quality is that some teachers put forth more effort under the current system, even though the uniform pay schedule provides no direct incentive for them to do so. The idea of increasing marginal cost to effort, a fundamental assumption in economics, could lead us to expect that performance pay will have its greatest motivational impact on those teachers who were trying the least under the past system. We seek to identify any such relationship here.

To evaluate whether teachers of varying success had different responses to performance-pay an interaction between the treatment and a measure of a teacher's pre-treatment productivity can be added to the model. Since treatment begins in 2007, and test scores are only available back to 2005, the analysis utilizes the gains in 2006 as the only measure of pre-treatment productivity.

This new model takes the form:

$$Y_{i,a,t} = \phi_0 + \phi_1 Y_{i,a,t} + \phi_2 Student_{i,t} + \phi_3 School_{i,t} + \phi_4 Year_t + \phi_5 Pre_Gain_{i,a} + \phi_6 Treat_{i,t} + \phi_7 (Pre_Gain_{i,a} * Treat_{i,t}) + \rho_{i,t}, \quad (3)$$

where $Pre_Gain_{i,t}$ is the average test score gain in 2006 for students in the class of student i 's current teacher, and ρ is again a normally distributed mean zero stochastic term. If the

coefficient of the interaction of previous student gain and treatment is negative, that means lower performing teachers made the largest gains from the performance-pay policy.

The first model examines whether students learn more when their teachers are eligible for performance pay relative to how those students achieved before the program was introduced and relative to how students in other schools are achieving, controlling for observed demographic characteristics. The second model is the same as the first, but it also controls for the average effectiveness of teachers to produce learning gains. And the third model is the same as the first, but it helps identify whether performance pay had its largest effect on the best or worst teachers.

These analyses are able to estimate these equations in math, reading, and language in elementary schools. However, the grades included in the analyses of each subject differ due to limitations of the testing scheduled in Little Rock. Students were administered the math version of the ITBS in all grades K-5 in each of the three years from 2005 - 2007, and so each of these grades are included in the analyses. However, Little Rock students were not administered the ITBS language or reading test in grades 3, 4, or 5 until 2006. Further, students were not administered the ITBS reading test in Kindergarten until 2007. These data limitations mean that only students in grades 2 and 3 for the reading analyses and students in grades 1, 2, or 3 in the language analyses can be included – the only grades for which there are both a pre- and post-test score for students in both the baseline and treatment eligible year.

A potential limitation of the research design in this paper is that there may be an endogeneity problem since schools were not randomly assigned to the performance-pay treatment. That is, the selection of the schools for the program may account for some or all of the effect of the program observed. In particular, as discussed above, the treatment was made

available to schools non-randomly and treated schools had higher minority populations and lower income students on average.

The analysis is able to partially account for this endogeneity bias by including school as a dummy variable and, in one analysis, teacher fixed effects in order to account for heterogeneity in school quality. However, it is also worth noting that summary statistics indicate that any endogeneity bias should likely tend to underestimate the impact of the performance pay treatment. Note that Table 2 shows that in 2006, the year before the policy was available, on average students in eventually treated schools made smaller test score improvements in each of the three subjects used in our analyses. That is, in absence of treatment these schools were likely to have made smaller test score improvements than the control schools, which would tend to bias the estimation of the treatment effect downward. Nonetheless, this lack of random assignment is a concern with any results.

V) Results

The results from the first model, which shows the overall effect of the program on student achievement, are reported in Table 3. Recall that these results are based on a more restricted group of grades in the reading and language analyses, which accounts for the variation in the number of observations across subjects.

[TABLE 3]

In each subject there is a statistically significant, positive relationship between the performance-pay treatment and student achievement. The analyses suggest that the performance-pay treatment led to an increase of about 3.5 NCE points in math, 3.3 NCE points in reading, and 4.6 NCE points in language after only one year of participation in the program.

The size of these effects is substantial. The summary statistics for baseline achievement in these subjects reported in Table 2 can be used to put these results into terms of standard deviation units. Dividing the effect size by the standard deviation of the baseline test score in the subject, the results suggest that performance-pay increased student proficiency by 0.16 standard deviations in math, 0.15 standard deviations in reading, and 0.22 standard deviation units in language.

Table 4 reports the results of estimation of the overall treatment effect including a fixed effect for each individual teacher. The table shows that the results are qualitatively similar to those without a teacher fixed effect, with the exception that the impact of performance-pay in language becomes statistically insignificant.

[TABLE 4]

Somewhat surprisingly, the small gain in the R-Squared value between the analyses reported in Tables 3 and 4 suggest that the teacher fixed-effect is explaining very little of the variance in student achievement. That is, there doesn't appear to be much of an improvement in the precision of the model when controlling for average teacher quality despite the price that is paid for doing so.

It is possible to test the explanatory power of the teacher fixed-effect itself by estimating a regression of math test scores against only the teacher fixed-effect. That is, the amount of variance explained by the teacher fixed-effect can be computed by running the model with only that effect and no other variables. These analyses produced R-Squared values between 0.20 and 0.25 for the three subjects.⁴ This indicates that there is variation in teacher effectiveness but that here it is correlated with other regressors included in the model.

⁴ Analyses available upon request.

Table 5 reports the results of the analysis of whether there is any differential impact from the performance-pay treatment by the teacher's previous productivity. The results in each subject show that performance-pay has the greatest positive impact on the previously lowest performing teachers. In each subject the coefficient on the overall treatment effect remains statistically positive. However, there is a negative relationship between the teacher's prior productivity (measured by the average test score gain of students in the teacher's classroom in the baseline year) and the impact of performance-pay on teacher productivity. The inverse relationship between prior teacher productivity and the performance-pay effect is statistically significant in math and language, though it slightly fails to meet the 10% threshold in reading ($p = 0.114$).

[TABLE 5]

VI) Conclusion

There is much still to be learned about the effects of performance pay programs on student achievement. The evaluation of the Achievement Challenge Pilot Project in Little Rock, Arkansas only examines evidence from three elementary schools. It only shows effects after one year of participation in that program. The participating schools were not selected at random, potentially undermining confidence in these results.

Despite these limitations, the evidence from Little Rock is a significant contribution to our understanding of the effects of performance pay, especially given how little evidence is currently available. The data from Little Rock permitted analysis of the program with a rigorous research design. The results show fairly large effects after one year. And those results are robust to alternative specifications.

The most striking thing suggested by this analysis is that performance pay may have the greatest effect on improving the teachers who were previously the least effective at producing

learning gains for students. If this result holds across evaluations of other programs, performance pay may be an effective strategy not just for improving overall achievement, but also for closing the achievement gap. Because of perverse sorting effects of current teacher hiring, pay, and transfer policies, minority and low achieving students are more likely to be in schools with the least effective teachers. If it is those less effective teachers who improve more under performance pay, minority and low achieving students should experience the greatest gains.

Unfortunately, Little Rock will not offer further opportunities to explore these issues because the ACPP has been discontinued by the current school board. While the program received considerable support from the educators at participating schools – a majority of teachers at those schools had to vote for the program to participate – the program failed to win the support of the local teacher union affiliate. Political activity by that union and allied groups reversed the narrow 4-3 school board majority that had supported ACPP, leading to its cancellation.

Fortunately, careful evaluations of performance pay programs are underway in other school systems and we are likely to learn considerably more about their overall effects as well as differential effects. That broader set of knowledge is likely to have a strong influence on whether performance pay in education continues to expand or begins to shrink.

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Table 1
Summary of ACP Payouts by Year and School

School	Year	Total Bonus	Highest Teacher Bonus	Lowest Teacher Bonus	Average Teacher Bonus	Total Enrollment	Average Cost Per Pupil
Mabelvale	2006-2007	\$39,550	\$6,400	\$450	\$1,187.50	338	\$117
Geyer Springs	2006-2007	\$64,530	\$7,600	\$350	\$2,846	333	\$194
Romine	2006-2007	\$12,450	\$5,200	\$450	\$723	365	\$34

Table 2
Baseline Descriptive Statistics

Variable	All		Never Treated		Eventually Treated	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Black	0.69	0.46	0.67	0.47	0.88	0.33
Asian	0.02	0.12	0.02	0.13	0.00	0.00
Hispanic	0.04	0.19	0.04	0.19	0.06	0.23
Indian	0.00	0.06	0.00	0.06	0.00	0.05
Male	0.50	0.50	0.50	0.50	0.52	0.50
Eligible for Free or Reduced Lunch	0.65	0.48	0.63	0.48	0.88	0.33
Baseline Math	50.41	21.54	51.15	21.57	38.57	17.27
Baseline Reading	50.16	21.53	51.12	21.55	40.53	18.87
Baseline Language	49.87	21.13	50.88	21.18	40.21	18.02
Math Gain 2006	1.94	14.37	2.14	14.25	-1.29	15.83
Reading Gain 2006	1.83	14.51	1.89	14.53	1.19	14.29
Language Gain 2006	0.00	16.07	0.18	15.90	-1.75	17.45

Note: Only students included in overall math regression are included in above summary statistics for demographic variables. Reading and language test descriptive statistics include only students used in those regressions.

Table 3
Regression Results – Overall Treatment Effect

Variable	<u>Math</u>			<u>Reading</u>			<u>Language</u>		
	Coef.	t		Coef.	t		Coef.	t	
Math t-1	0.70	82.60	***						
Reading t-1				0.68	68.72	***			
Language t-1							0.68	60.12	***
Black	-4.60	-12.34	***	-4.69	-10.21	***	-2.75	-6.19	***
Asian	3.65	4.28	***	1.04	0.76		5.81	5.12	***
Hispanic	-1.14	-1.66	*	-1.62	-1.89	*	1.18	1.18	
Indian	-1.80	-1.15		-3.78	-2.01	**	-3.19	-1.27	
Male	0.03	0.12		-0.41	-1.41		-2.87	10.12	***
Lunch Eligible	-2.47	-8.31	***	-2.88	-7.24	***	-3.19	-8.02	***
Treat	3.52	2.84	***	3.29	2.35	**	4.56	2.77	***
Constant	23.11	18.82	***	19.40	19.02	***	20.04	12.56	***
Teacher Fixed Effect	NO			NO			NO		
N	13,389			5,948			8,933		
Adjusted R ²	0.6479			0.7118			0.6211		

Estimated via OLS. Models also control for school, grade, and year fixed effects. Standard errors clustered by teacher.

*** Significant at $p \leq .01$

** Significant at $p \leq .05$

* Significant at $p \leq .10$

Table 4
Overall Treatment Effect – Includes Teacher Fixed Effect

Variable	<u>Math</u>			<u>Reading</u>			<u>Language</u>		
	Coef.	t		Coef.	t		Coef.	t	
Math t-1	0.71	83.30	***						
Reading t-1				0.69	68.91	***			
Language t-1							0.68	59.88	***
Black	-4.41	-11.71	***	-4.56	-9.77	***	-2.70	-5.97	***
Asian	3.64	4.19	***	1.33	0.97		5.92	5.55	***
Hispanic	-0.86	-1.26		-1.27	-1.46		1.68	1.80	*
Indian	-1.34	-0.78		-2.89	-1.61		-3.11	-1.40	
Male	0.06	0.25		-0.43	-1.41		-2.71	-9.51	***
Lunch Eligible	-2.24	-7.52	***	-2.82	-6.90	***	-2.90	-7.21	***
Treat	5.23	3.18	***	3.05	3.31	***	2.04	1.06	
Constant	49.77	26.42	***	22.60	5.83	***	24.54	11.73	***
Teacher Fixed Effect	YES			YES			YES		
N	13,389			5,948			8,933		
Adjusted R ²	0.6950			0.7293			0.654		

Estimated via OLS. Models also control for school, grade, and year fixed effects. Standard errors clustered by teacher.

*** Significant at $p \leq .01$

** Significant at $p \leq .05$

* Significant at $p \leq .10$

Table 5
Regression Results – Effect by Prior Teacher Productivity

Variable	<u>Math</u>			<u>Reading</u>			<u>Language</u>		
	Coef.	t		Coef.	t		Coef.	t	
Math t-1	0.72	76.52	***						
Reading t-1				0.66	60.85	***			
Language t-1							0.65	49.56	***
Black	-4.17	-10.09	***	-4.57	-8.65	***	-2.48	-4.84	***
Asian	3.90	4.18	***	-0.10	-0.07		6.48	5.19	***
Hispanic	-0.79	-1.09		-1.80	-1.85	*	0.89	0.75	
Indian	0.87	0.46		-2.01	-0.95		-1.86	-0.58	
Male	-0.05	-0.20		-0.56	-1.62		-2.90	-8.67	***
Lunch Eligible	-2.62	-8.16	***	-3.07	-6.73	***	-3.61	-8.03	***
Average 2006 Gain for Teacher	0.62	18.40	***	0.22	4.30	***	0.37	8.74	***
Treat	6.93	9.02	***	3.63	1.94	*	4.24	2.41	**
Treat * 2006 Gain for Teacher	-0.48	-7.36	***	-0.35	-1.59		-0.50	-3.21	***
Constant	17.13	16.56	***	17.66	15.29	***	19.42	12.30	***
N	10,305			4,560			6,695		
Adjusted R ²	0.6756			0.7015			0.6025		

Estimated via OLS. Models also control for school, grade, and year fixed effects. Standard errors clustered by teacher.

*** Significant at $p \leq .01$

** Significant at $p \leq .05$

* Significant at $p \leq .10$

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