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Optimal Incentives for Public Sector Workers:

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Optimal Incentives for Public Sector Workers: The Case of Teacher-Designed Incentive Pay in Texas

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Abstract

Pay for performance is a popular public education reform, and millions of dollars are currently being targeted for pay for performance programs. These reforms are popular because economic and management theories suggest that well-designed incentive pay programs could improve teacher effectiveness. There is little evidence about the characteristics of a well-designed incentive pay plan for teachers, however. This study takes advantage of a recent natural experiment in Texas to explore the optimal design of teacher incentive plans. We find that when given the opportunity, teachers design relatively weak incentive pay plans. In turn, those relatively weak incentives do not appear to have induced any significant changes in teacher productivity, although they did have a significant impact on teacher turnover. As such, our evidence suggests that the types of incentives that appeal to teachers (and their unions) may not be optimal from the employer perspective.

1. INTRODUCTION

Pay for performance is a popular public education reform. Teacher merit pay is a key element of the compensation packages in the Denver, Houston and New York City public school systems. Florida, Minnesota, and Texas have allocated over $550 million to incentive pay programs that reward teacher performance. In 2006, the United States Congress appropriated $99 million per year for five years to provide Teacher Incentive Fund grants to schools, districts, and states to develop and evaluate administrator and teacher pay for performance plans. In 2009, the Obama Administration earmarked part of the *American Recovery and Reinvestment Act* for the development and implementation of teacher pay for performance programs.

Such reforms are popular because economic and management theories suggest that well-designed incentive pay programs could improve teacher effectiveness. Although there are many challenges to overcome when implementing incentive pay in the public sector,[2] teacher performance incentives are expected to reward effective teachers for the additional effort they put in to being effective, to encourage less effective teachers to seek out more effective instructional strategies, to reduce turnover among highly skilled teachers, and to attract teachers who are particularly good at the incentivized activities. To the extent that incentives encourage teachers to upgrade their skills or adopt more effective practices, those incentives can have positive impacts that persist even if the incentive programs do not.

There is little evidence about the characteristics of a well-designed incentive pay plan for teachers, however. Some of the literature suggests that effective incentive plans must offer relatively large awards to induce behavioral changes. The reasoning is that few teachers would bother with changing their professional practices for a relatively nominal sum. On the other

[2] For example, see Murnane and Cohen (1986), Ballou (2001), Dixit (2002), Burgess and Ratto (2003) or Goldhaber et al. (2008).

hand, the experimental economics literature suggests that plans with only a handful of awardees can be less effective at changing behavior than plans that offer an array of possible awards. The logic here is that when workers know the abilities of the other plan participants, they may accurately conclude that other participants will win the large awards, and therefore that increased effort on their part would not be rewarded. Such individuals have more incentive to change if there is a range of awards, even if the dollar amounts are relatively modest. Still other research suggests that group-based incentives are the most effective strategy when teamwork and cooperation are integral to the production process—as is arguably the case in education.

This study takes advantage of a recent natural experiment in Texas to explore the optimal design of teacher incentive plans. In 2005, the Governor of Texas established by executive order the Governor's Educator Excellence Grants (GEEG) program. GEEG was a three-year program that distributed $10 million per year in non-competitive federal grants to 99 high-performing schools serving low-income students. Grants ranged between $60,000 and $220,000, with the average award equal to 5.2 percent of instructional payroll at the recipient school.

A key feature of the GEEG program is that each participating school developed its own incentive pay plan within a fairly broad set of guidelines defined by the Texas Education Agency (TEA). TEA guidelines also required that teachers play a significant role in the design and approval process of their school's incentive pay plan.[3] Thus, the GEEG program represents a unique opportunity to explore optimal incentives not only from the perspective of the employer—by examining changes in teacher productivity and retention in GEEG schools—but also from the perspective of the employee—by examining the preferences revealed by the incentives teachers design for themselves.

[3]All plans had to be approved by a school-based committee with significant teacher participation as well as by the district and local school board. All plans also needed to be accompanied by at least three letters of support from affected teachers when submitted to TEA for final approval (TEA 2006).

We find that when given the opportunity, teachers design relatively weak incentive pay plans. In turn, those relatively weak incentives do not appear to have induced any significant changes in teacher productivity, although they did have a significant impact on teacher turnover. As such, our evidence suggests that the types of incentives that appeal to teachers (and their unions) may not be optimal from the employer perspective.

2. THE OPTIMAL INCENTIVES LITERATURE

Three strands of literature inform our analysis of incentive pay plans in Texas. The first is the literature on the optimal dispersion of incentive awards. The second is the literature on the choice between individual and group incentives. The third is the modest literature on worker preferences regarding incentive pay. We examine each strand of the literature with an eye toward what it can tell us about the optimal design of teacher incentive pay plans.

2.a. The Optimal Dispersion of Incentives Awards

The TEA guidelines for the GEEG program—which advise that annual teacher incentives should range from $3,000 to $10,000 per teacher (TEA 2006)—are clearly predicated on the presumption that the optimal award structure is one with a small number of relatively large awards. Such a structure has intuitive appeal. The intent of the GEEG program is to induce a behavioral change in teachers, so it seems reasonable that the awards must be large enough to motivate change.

On the other hand, the literature on optimal personnel incentives is much less definitive. As discussed in Freeman and Gelber (2006), economic theory suggests that higher payoffs lead

to greater effort, but also that multiple prizes can be more effective than a single large prize that most participants have little chance of winning.

In an experimental analysis, Freeman and Gelber (2006) find that the optimal incentive structure depends on the amount of information workers have about their relative skills. When workers are not aware of the abilities of other participants, a larger prize elicits the greatest effort. However, when workers have a chance to observe the other potential recipients in action, an array of intermediate rewards elicits more total effort from the group than does a single large prize. Freeman and Gelber conclude that when workers are well informed about the abilities of their co-workers (as would generally be the case in a school setting), workers who can reasonably predict that they have little or no chance of winning do not respond to winner-take-all incentives.

Other experimental economists have found similar patterns. For example, Harbring and Irlenbusch (2003) report that as the number of prizes falls, more people disengage from the incentive pay system (as evidenced by very low effort). Vandegrift, Yavas and Brown (2007) find that a winner-take-all award structure produces higher average performance than a series of smaller awards that add to the same sum, but also that a significant number of individuals chose not to participate in a winner-take-all incentive pay plan when the other participants have higher ability.

2.b. The Choice Between Individual and Group Incentives

The TEA guidelines also favor individual incentives over group incentives,[4] and again, the literature is mixed on the subject. On the one hand, traditional economic theory suggests that

[4] TEA guidelines report the intent of the GEEG program is to reward highly-effective teachers. Campus-wide incentives were explicitly discouraged. Furthermore, at least 75 percent of all funds received by a school must be "used only for classroom teachers…a classroom teacher means 'an educator' who is employed by a school district

individual incentives can be stronger than group incentives because individuals are not able to free ride on the efforts of other members of the group (Holstrom 2002). On the other hand, Kandel and Lazear (1992) and Che and Yoo (2006) use theory to argue that peer pressure, mutual monitoring, and shared learning can make group incentives stronger than individual incentives when the working relationship is expected to be long lived. Chillemi (2008) develops a model indicating that group incentives are more effective than individual incentives when workers care about their co-workers material benefit.

The empirical and experimental literature is also mixed. Freeman and Gelber (2006) find that individual incentives are systematically more effective than group incentives in an experimental setting, while Hamilton, Kickerson and Owan (2003) find that switching from individual incentives to team incentives raised worker productivity in a California firm. Nalbantian and Schotter (1997) find that competition between teams of workers is more effective than group-wide incentives. Encinosa, Gaynor and Rebitzer (2007) find that individual incentives induce greater work intensity than do group incentives for large groups, but not for small ones.

Two randomized control trials—an Indian experiment analyzed by Muralidharan and Sundararaman (2008) and a sequence of Israeli experiments analyzed by Lavy (2004)—directly compare individual incentives with group incentives for teachers.[5] Muralidharan and Sundararaman (2008) randomly sampled 500 rural schools in a large Indian state (Andhra Pradesh) and assigned them to one of four treatment groups or a control group, with each group comprising one hundred schools. One of the treatment groups had an individual teacher pay

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and who, not less than an average of four hours each day, teaches in an academic instructional setting or a career and technology instructional setting. The term does not include a teacher's aide or a full-time administrator." (TEA, 2006).

[5] An analysis comparing individual with group incentives under Texas Educator Excellence Grant Program (TEEG) is ongoing.

bonus system tied to student test score gains, while another had a school-wide bonus, also tied to test score gains. The remaining two treatment groups received input-based resource interventions (one provided an extra-paraprofessional teacher and another provided block grants). The individual and group awards were calibrated so that incremental spending was roughly equivalent in the four different treatment groups.

Muralidharan and Sundararaman (2008) found that students enrolled in schools with either type of teacher incentive outperformed students in the other three groups, not only on the incentivized subject areas of the test, but also on the non-high-stakes subject areas. Students enrolled in the individual incentive treatment condition outperformed those students in the team incentive condition after the second year of implementation. Furthermore, they found no significant difference in the input-based resource interventions and the control condition.

Lavy (2004) compared the cost-effectiveness of an individual bonus scheme with that found in his previous analysis of group bonuses for teachers (Lavy 2002). He found that the cost per unit gain in the individual teacher incentive program was greater than that in the group incentive programs, suggesting that group incentives are more cost-effective than individual incentives, at least in the context of Israeli schools. Lavy concluded that these outcome-based interventions were more effective than input-based reform strategies implemented a few years prior to the group bonus program.

2.c. Worker Preferences and Personnel Incentives

Few researchers have explored worker preferences regarding incentive schemes. Niederle and Vesterlund (2007) find that even when there are no gender differences in performance, men are twice as likely as women to choose an incentive scheme that rewards individual performance, a pattern they attribute to male overconfidence. However, Eckel and

Grossman (2002) find that women tend to be more risk averse than men, a tendency that could also lead women to disproportionately favor group incentives. Because teaching remains a disproportionately female occupation, these studies suggest that teachers may have a bias toward group incentives.

Encinosa, Gaynor and Rebitzer (2007) directly examined the incentive structures that workers design for themselves in their analysis of pay for performance among physicians. They conclude that small groups are more likely to adopt equal sharing rules than are large groups, but that when mutual assistance is important, large groups must offer weaker incentives to achieve the same level of mutual aid. Not surprisingly, they also find that groups with more risk-averse members adopt lower-powered incentives.

Within the education sector, a number of researchers have examined surveys of teacher preferences regarding incentive pay, but most have focused on preferences regarding the behaviors being rewarded (e.g. extra pay for mentoring other teachers, incentives for teaching in shortage areas, or incentives for increasing student performance) rather than on preferences regarding the nature of the incentives for any given objective.[6] Seminal work by Ballou and Podgursky (1993) found that teachers in urban areas, as well as Black and Hispanic teachers, were more supportive of pay for performance, while teachers with more experience and female teachers were less supportive of pay for performance. More recently, Goldhaber, DeArmon, and DeBurgomaster (2007) found that veteran and female teachers are less supportive of pay reform in general. They also found that secondary school teachers were more supportive of certain reforms, including pay for performance and bonuses for teaching in a hard-to-staff subject, than were elementary school teachers.

[6] For a survey of the literature on teacher incentive plans, see Podgursky and Springer (2008).

Milanowski (2007) surveyed students preparing to become K-12 teachers, and found that likely entrants to the teaching profession favored individual incentives over group incentives. He also concluded that beginning teachers may be more supportive of incentive pay than are more experienced teachers. Goldhaber, DeArmond, and DeBurgomaster (2007) surveyed a random sample of public school teachers in Washington State about various compensation reforms. They found that those teachers who have positive opinions of their principals and negative impressions of other teachers in their school are more likely to support pay for performance bonuses for highly-effective teachers, a finding also reported in a pilot study of teachers in an urban school district in Florida (Jacob and Springer, 2008).

3. TEXAS GOVERNOR'S EDUCATOR EXCELLENCE GRANT (GEEG)

Texas's GEEG program identified the 100 highest-poverty high-performing schools in the state and awarded them noncompetitive grants, ranging from $60,000 to $220,000 each year for three years.[7] Schools were first notified of their eligibility during the 2005–06 school year and were required to develop and submit their incentive plan applications by the end of that school year. Because one school never finalized the design of its GEEG program plan with the TEA, a total of 99 schools participated in the program.

3.a. The GEEG Program Guidelines

While schools were responsible for designing their own incentive pay plans, those plans had to follow a series of guidelines established by the TEA. TEA guidelines divided the GEEG program funding in to two parts. Part 1 funds provide incentive awards for full-time teachers. Part 2 funds could be used to provide incentive pay awards to other school personnel, or to fund

[7] Most schools received between $150 and $200 per pupil for each of three years, which was equivalent to between 2.6 and 16.5 percent of a recipient school's instructional payroll.

professional development programs for teachers, mentoring programs for teachers, new teacher induction programs, etcetera. Seventy-five percent of the total awarded to a school was dedicated to Part 1 incentives, while the remaining 25 percent was dedicated to Part 2.

Within the Part 1 funding category, the TEA guidelines stipulated that incentive pay awards must be based on success in improving student performance by objective measures, and on collaboration with faculty and staff that contributes to improving overall student performance at the school. While schools had near complete discretion in devising their measures of student performance and collaboration, both elements were necessary components of the incentive pay plans.

In addition to the two necessary elements, campuses could also include two optional criteria. According to the TEA guidelines, Part 1 incentives can also be based on a teacher's on-going initiative, commitment, and professional involvement in activities that have a direct impact on student achievement, or on a teacher's assignment to a hard-to-staff subject area.

TEA guidelines recommend that Part 1 awards should be at least $3,000 and no more than $10,000 per teacher. However, eligible-schools could opt out of this proviso by offering a brief justification in their grant application in favor of alternative award distribution model. Interestingly, the majority of GEEG schools designed and implemented incentive pay plans that offered *maximum* awards of less than $3,000 per teacher.

3.b. The GEEG Program Schools

The GEEG program was targeted at the highest performing, highest poverty schools. In order to participate in the program, schools had to be in the top third of Texas schools with respect to the share of economically disadvantaged students during the 2004-05 school year.

TEA stratified the distribution of schools by type, so elementary schools had to be in the top third of the poverty distribution for elementary schools, middle schools had to be in the top third of the distribution for middle schools and so on. Ultimately, the minimum threshold share of economically disadvantaged students for elementary schools was 81.3 percent, for middle schools was 65.4 percent, for high schools was 55.8 percent, and for schools that serve mixed grades was 70.5 percent.

Schools were also required to be either high performing or high improving. High performing schools received one of the two highest ratings under Texas' accountability system.[8] High improving schools were in the top quartile according to the state's measure of demographically-adjusted student performance gains, the Comparable Improvement index.[9] TEA's Office of Planning, Grants, and Evaluation stratified the set of program participants so that there was a roughly equal number of high performing and high improving schools at each level of schooling (i.e., elementary, middle, and so on). All schools that were Exemplary in 2004-05 school year and in the top third with respect to student poverty were in GEEG, as were the schools with the highest shares of economically disadvantaged students in each grade type that were Recognized in 2004-05 school year. As a result, all schools that were not in the GEEG program were either lower performing or lower poverty than the GEEG schools.

[8] The two highest rating are Recognized and Exemplary. A Recognized rating in 2004-05 school year meant that for every subject and every student subgroup at least 70 percent of the tested students passed the high-stakes assessment, while an Exemplary rating increased this standard to at least 90 percent of the tested students in each subject and subgroup.

[9] TEA determines the Comparable Improvement (CI) rankings by matching each Texas public school annually to 40 other Texas public schools on the basis of student demographics. TEA then calculates the average change in student test scores from one year to the next and places schools into quartiles based on their relative position among their 40 most comparable schools. A school in the top quartile of CI has one of the 10 largest average gains in TAKS scores among the 40 schools in its reference group.

4. EVALUATING THE INCENTIVE PLANS FROM THE EMPLOYEE PERSPECTIVE

We follow a revealed preference model of employee perspectives, and assume that the teacher-designers of the GEEG incentive pay plans chose plan characteristics that suited their preferences (or at least the preferences of the median teacher). Thus, we rely on an analysis of the plan characteristics and their determinants to indicate employee preferences regarding plan design features. We also interpret teacher turnover as a signal of teacher preferences. If turnover is significantly lower in GEEG schools with particular program characteristics than in other GEEG schools, then we conclude that teachers generally prefer those characteristics.

4.a. The GEEG Incentive Pay Plans

We base our analysis of the GEEG program plans on three primary sources of information. First, all GEEG schools were required to submit their incentive pay plans to TEA by May 2006 for approval. The National Center on Performance Incentives (NCPI) at Vanderbilt University analyzed the TEA approved proposals to identify the major elements of each school's incentive pay plan. We rely on their classification of plans in our analysis. Second, we use administrative data from TEA on teacher characteristics, campus assignments and earnings. Finally, we used publicly available data on school characteristics from Texas' Academic Excellence Indicator System (AEIS).

Following the literature on optimal incentives, our analysis focuses on two dimensions of the GEEG incentive pay plans—the unit of accountability and the dispersion of incentive awards. The unit of accountability indicates whether the plan offered individual or group incentives. The dispersion of incentive awards indicates whether the plan offered a small number of relatively large awards, or a large number of relatively small awards.

The teacher was the most common unit of accountability for student performance. Forty-seven schools measured student performance exclusively at the teacher level, and another 19 schools combined teacher-level evaluations with more aggregate measures. However, contrary to the explicit intent of the GEEG program, nearly one third (32) of the GEEG schools relied exclusively on the school as the unit of accountability. The unit of accountability could not be determined for one school.

To measure the dispersion of incentive awards in a school, we calculated the Gini coefficient associated with the most unequal distribution of awards possible, given the parameters of the school's plan and the amount of available funding. The Gini coefficient is a common measure of financial inequality that takes on a value of zero when the distribution is perfectly equal and takes on the value of one when the distribution is perfectly unequal. The most unequal distribution of Part 1 awards that fully exhausts the available funds is one in which as many teachers as possible receive the maximum designated award, one teacher receives any residual Part 1 funding, and the remaining teachers receive nothing. The Plan Gini is the Gini coefficient for this distribution of awards.[10] A winner-take-all pay plan would thus have a Plan Gini of one, while a plan with equal sized awards for every individual would have a Plan Gini of zero.

The Plan Gini could be calculated for 94 of the 99 schools participating in the GEEG program. The sample mean for the Plan Ginis is 0.34, with the highest value of a Plan Gini coefficient being 0.77. Three schools have Plan Ginis of 0.00 indicating that every teacher could

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[10] More specifically, the maximum potential Gini coefficient for school k equals:

$$G = 1 + \frac{1}{N} - [\frac{2}{mN^2}]\sum_{i=1}^{i=n}(N - i + 1)y_i$$

where, N is the number of teachers in school k, m is the average award per teacher in school k, y_i is the individual award of teacher i in school k, and the teachers in school k have been sorted from the teacher with the lowest GEEG award or no GEEG award (y_1) to the teacher with highest GEEG award (y_N).

receive the maximum proposed award. The distribution of Plan Ginis suggests that all GEEG schools rejected a winner-take-all incentive structure, while at least some schools designed purely egalitarian incentive plans.

4.b. The Determinants of Plan Characteristics

A number of school and teacher characteristics could reasonably be expected to influence plan design. To isolate the impact of teacher preferences, we need to control for the other possible determinants of the incentive plan design. Table 1 presents descriptive statistics for the potential design determinants used in this analysis.

[INSERT TABLE 1 ABOUT HERE]

Strong incentives are more likely where outcomes are easier to measure (Holmstrom and Milgrom, 1987), and the more homogeneous the student body, the easier it is to attribute differences in performance to differences in teachers. Our analysis includes the share of students who are economically disadvantaged as a measure of the homogeneity of students. Even though all GEEG schools have a high share of economically disadvantaged students, those with the highest shares are more homogeneous with respect this important determinant of student achievement than other GEEG schools.

Our analysis includes a measure of school size (the log of fall enrollment) because the literature suggests that small groups are more likely to adopt egalitarian incentive structures than large groups. It is also easier to monitor free riding in smaller schools, suggesting egalitarian awards may be an effective incentive design in small schools.

The literature also suggests that the median teacher would reasonably prefer a more egalitarian structure when there is significant variation in teaching ability within the school.

Where there is significant variation in ability, the median teacher has little hope of winning a winner-take-all tournament, and would rationally prefer a plan with a greater dispersion of awards. Our analysis includes a measure of teacher homogeneity—the Gini coefficient for teacher base pay. If all of the teachers share the same step on the salary scale, the Gini coefficient would be zero. As the teachers become increasingly dissimilar with respect to experience and educational attainment, the salary Gini increases.

Several studies suggest that beginning teachers are more accepting of performance incentives than are more experienced teachers.[11] Therefore, we include in the analysis the average years of experience for teachers in the school. Several studies also suggest that preferences regarding teacher incentive pay plans may vary by gender, with male teachers more likely than female teachers to be supportive of incentive pay programs. Our analysis includes the share of teachers who are male, which ranges from a minimum of zero to a maximum of 63 percent. On average, 26 percent of teachers in schools participating in the GEEG program are male.

We include per-pupil GEEG funding as an indicator under the presumption that schools with more generous per-capita funding might be more willing to spread the wealth. We include the share of newly hired teachers in the analysis to capture the possibility that schools with a history of higher turnover might reasonably be expected to choose a different incentive design. Finally, because there could be differences across school types, we include indicators for whether a school was high performing or high improving, and indicators for elementary and secondary schools.[12]

[11] For example, see Ballou and Podgursky (1993), Goldhaber et al. (2008) or Jacob and Springer (2007).
[12] The omitted category is middle schools. We exclude mixed schools from this part of the analysis because there are only five mixed schools with complete data.

Panel A of Table 2 presents the results of our multinomial logit analysis of the units of accountability. Schools were categorized into those with school-level incentives, those with individual incentives, and those with a mix of school- and individual-level incentives. We find a significant relationship between teacher homogeneity and the unit of accountability. Contrary to expectation from the literature, schools with more homogeneous teacher corps are *more* likely to rely exclusively on school-wide measures of student performance. Less homogeneous schools are more likely to use individual incentives.

[INSERT TABLE 2 ABOUT HERE]

On the other hand, we find no systematic differences across the three units of accountability with respect to the other potential determinants of the design features in a school's incentive pay plan. Schools with a higher share of new teachers are no more likely to favor school-wide plans than other design features. Small schools are no more reliant on school-wide awards than large schools. Further, elementary schools are as likely as middle and secondary schools to design plans that reward individual teachers.

Panel B of Table 2 presents the results of our analysis of the distribution of plan awards. The logical plan determinants explain a significant share of the variation in plan equality. For example, we find that schools with more homogeneous teachers tend to design more egalitarian plans than schools with less homogeneous teachers. The relationship is consistent with the finding that schools with more homogeneous teachers tend to devise plans where the unit of accountability is the school.

The evidence suggests that schools with more economically homogeneous students also were more likely to adopt egalitarian plans. This is somewhat surprising. It should be easier to measure teacher performance when the students are more similar from one classroom to another.

Theory suggests that individual incentives are more likely to be adopted and effective when outcomes are easier to measure (Holmstrom and Milgrom, 1987), and one of the most frequently cited reasons for stakeholder opposing compensation reform is that evaluations of teachers and schools will not be fair (Ballou and Podgursky, 1993; Murnane and Cohen, 1986).[13] Such issues should be minimized when the students are more homogeneous.

We find no evidence that high performing schools design more egalitarian incentive pay plans than do high improving schools. We also cannot support the idea that schools with more experienced teachers design more egalitarian plans, or that the share of newly arrived teachers or the share of male teachers influences award equality. However, consistent with their review of theory and evidence on compensation systems, Encinosa, Gaynor and Rebitzer (2007) conclude that small schools are more likely than large schools to adopt egalitarian incentive plans.

4.c. Plan Characteristics and Teacher Turnover

Incentive plans with attractive features should help schools retain effective teachers. To further examine the attractiveness of the various plan characteristics, we examine the preferences revealed by teacher turnover. As is typical in the literature (e.g. Imazeki, 2005), we assume that teachers choose to leave their current positions only if their expected utility from staying is lower than their expected utility from their best alternative situation. Thus, the probability that a teacher leaves her current position is a function of the wages and nonwage aspects of her current position, wages and nonwage aspects of alternative positions, and individual characteristics that might alter the shape the utility function. Probit analysis of an expected utility model provides the foundation for the empirical analysis of the effect of incentive pay plans on teacher retention.

[13] For a discussion of some of the difficulties in separating student academic achievement from student background and prior academic achievement, in the context of teacher incentive pay, see Buddin (2007).

Data for the turnover analysis comes from a variety of sources. Data on teacher characteristics, including compensation, turnover and teaching assignment, come from the administrative records of the TEA and Texas' State Board for Educator Certification (SBEC). Data on other nonwage school, district and location characteristics come from the TEA, the National Center for Education Statistics, and the U.S. Bureau of Labor Statistics. The data cover the six academic years from 2002-03 through 2007-08. The GEEG program was in effect for the last three years of the analysis period. The analysis is restricted to individuals who taught more than half time during at least one year of the analysis period, and include data only for GEEG schools. Teachers who were also administrators were excluded from the analysis.

We use a simple binary variable indicating whether a teacher left a GEEG school from one year to the next. Teachers are considered retained if they are teaching in the same school in the subsequent academic year. Teachers are identified as having "turned-over" if they moved to another school within the same district, moved to another school in a different district, or if they left teaching altogether. On average, 20 percent of public school teachers in Texas turn over each year during the analysis period.

Theory indicates that a teacher's decision to stay or go is influenced by the wage and nonwage characteristics of the current position. We measure a teacher's monthly wage as her full-time equivalent base pay, plus any monthly supplements for teaching English as a Second Language (ESL).[14] We use indicators of a teacher's classroom assignment to measure nonwage aspects of the position. The assignment indicators take on a value of one if a teacher was assigned to teach mathematics, science, language arts, fine arts, vocational education, bilingual education, special education, a foreign language, or to teach in a self-contained classroom that is subject to the TAKS test. Teachers can have multiple assignments.

[14] The ESL supplement is the only salary supplement specifically designated for teaching duties.

Our analyses also include controls for a teacher's years of experience (and its square) and indicators for a teacher's gender, race (black, Hispanic or Asian/Indian), educational attainment (no degree, masters degree or doctorate), and certification status (certified in any subject, and specifically certified in mathematics, science, special education or bilingual education). In addition to individual teacher characteristics, we include two indicators for local labor market conditions outside of education. First, we use the NCES Comparable Wage Index (CWI) to measure the prevailing wage for college graduates in each school district (Taylor and Fowler, 2006).[15] Second, data on unemployment rates by labor market come from the U.S. Bureau of Labor Statistics.

Table 3 presents selected marginal effects from probit analyses of the relationship between the three units of accountability and teacher turnover.[16] The probit analyses are based solely on variations in turnover among GEEG schools. We incorporate school fixed effects to capture variations in school characteristics, including those that may have influenced a school's decision to adopt particular plan designs. To allow for a correlation in the errors across multiple observations of the same teacher, the robust standard errors are adjusted for clustering by individual. [17]

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[15] We extended the CWI through 2008 using the original Taylor and Fowler (2006) methodology.

[16] In this context, the marginal effects indicate the change in the probability of turnover associated with a small change in the variable of interest. When the variable of interest is binary, the marginal effects indicate the change in the probability of turnover associated with changing the binary variable from zero to one.

[17] Because teacher salaries are potentially influenced by the same factors that influence teacher turnover, the researchers also estimated the various probit models in Tables 3 and 4 using instrumental variables. The instruments for salary were the cost of living in the labor market (as measured by the fair market rent on a two-bedroom apartment) and an array of district characteristics typically used to model voter demand for education–tax base per pupil, the share of residential property in the tax base, and the percent of the adult population with at least a bachelors' degree. Data on fair market rents came from the U.S. Department of Housing and Urban Development, while data on tax bases and residential shares came from TEA. Data on the educational attainment of the population came from the 2000 U.S. Census of population, school district files. The researchers used the teacher-weighted means of the instruments for all traditional school districts in the same metropolitan area, micropolitan area or rural county as instruments for the charter schools. In all cases, the instruments were highly correlated with salaries, but one could not reject the hypothesis that the teacher's monthly salary was in fact exogenous. Therefore, only the probit analyses are presented here.

As Table 3 illustrates, the unit of accountability used in the GEEG incentive pay plan had a significant influence on teacher turnover. For teachers as a whole, there were no significant differences in turnover between schools with teacher-level incentives, those with school-level incentives and those with mixed-level incentives in any of the GEEG program years. However, aggregation masks interesting differences between teachers with different levels of experience. Among beginning teachers, turnover was significantly lower in schools with only campus-level incentives than in schools with only teacher-level incentives, but only during the first year of the GEEG program. [18] In the second and third years of the program, there were no differences in turnover among beginning teachers attributable to the unit of accountability used in a school's plan.

Among experienced teachers, turnover was significantly lower in schools with teacher-level incentives than it was in schools with mixed-level incentives during the first year of the GEEG program, but significantly higher in schools with teacher-level incentives than in schools with mixed level incentives during the second year of GEEG. In the third year of GEEG, there were no differences in turnover attributable to the unit of accountability used in a school's plan.

[INSERT TABLE 3 ABOUT HERE]

Table 4 presents selected marginal effects and standard errors from probit analyses of the relationship between the Plan Gini coefficients and teacher turnover. As with the analysis of units of accountability, this analysis incorporated school fixed effects and was based solely on variations in turnover among GEEG schools. The analysis covers the 94 GEEG schools for which necessary data were available. To allow for a correlation in the errors across multiple observations of the same teacher, once again, the standard errors are adjusted for clustering by individual.

[18] We follow the NCES and define beginning teachers as those with less than four years of teaching experience.

[INSERT TABLE 4 ABOUT HERE]

As Table 4 illustrates, the degree of inequality in a school's incentive pay plan also had a significant influence on teacher turnover. The analysis suggests that teacher turnover was an increasing function of plan inequality in the second year of the GEEG program. In other words, schools with relatively individualistic plans had higher turnover than one would otherwise expect, but only in the second year of GEEG. In both the first and the last years of the program, there is no evidence that difference in plan inequality had a significant influence on differences in teacher turnover across program schools.

Table 4 also displays estimates for beginning and experienced teachers. As the second and third columns indicate, we find that the relationship between plan inequality and turnover differs between beginning and experienced teachers. In particular, the evidence suggests that variations plan inequality had no significant impact on turnover among experienced teachers, but did influence turnover among beginning teachers. In the second year of implementation, increases in plan inequality led to substantially higher than expected turnover among beginning teachers.

4.d. Optimal Incentives from the Employee Perspective

The evidence on employee preferences on incentive plans indicates that the teacher-designers of the GEEG incentive plans preferred relatively weak incentives. None of the plans had a winner-take-all incentive structure, and more than half of the plans had a group incentive component. Despite the TEA's guidelines encouraging individual-level incentive pay plans, a surprisingly large number of schools adopted plans that relied exclusively on group incentives. Furthermore, most schools also ignored TEA guidelines regarding the size of the incentive

awards, choosing to offer a large number of relatively modest awards rather than a small number of large awards.

The teacher-designers of the GEEG incentive pay plans were more likely to adopt weak incentives in situations where organizational and management theory suggests strong incentives would be more effective. For example, schools where it should be easier to measure the output of individual teachers were more likely to adopt highly egalitarian plans. Our analysis also suggests schools where the teachers were more alike with respect to experience and educational attainment more frequently adopted egalitarian and group incentive pay plans.

Although we find no evidence that schools with a high proportion of beginning teachers designed plans that were systematically different from those designed in other schools, the evidence on teacher turnover suggests that there may be differences between experienced and beginning teachers with respect to their incentive plan preferences. Compared with other schools participating in the GEEG program, those that adopted more individualistic programs (as indicated either by the unit of accountability or the degree of inequality in the plan) experienced higher than expected turnover among beginning teachers, at least during the second year. This may indicate a preference for weaker incentives among beginning teachers, although it could also indicate that beginning teachers were more likely to be disappointed in the resulting distribution of incentive awards.

In contrast, the turnover patterns among experienced teachers indicate a mild preference for more individualistic programs during the first year of the program, but we detect no such pattern in subsequent years. One possible interpretation for this pattern is that experienced teachers were willing to give stronger incentives a try, but were disappointed in the results.

5. EVALUATING GEEG PLANS FROM THE EMPLOYER PERSPECTIVE

Employers typically have two objectives when implementing incentive pay plans. The first is to align employee incentives with the interests of the employer to increase productivity of both the employee and organization. The second is to impact labor-market selection by attracting more effective workers and by reducing turnover among high productivity workers without raising compensation for low productivity workers. We examine the impact of the GEEG program on measures of both organizational productivity and employee retention. As with the evaluation from the employee perspective, we focus on comparisons within the set of schools participating in the GEEG program rather than comparisons between GEEG and non-GEEG schools. Since all high performing, high poverty schools were included in the GEEG program, comparisons between GEEG and non-GEEG schools could be problematic.

5.a. Increasing Student Performance

Student achievement is one of the obvious outputs of the education process, and the one most often mentioned when discussing education reforms. The fact that schools participating in the GEEG program were required to develop plans that rewarded teachers for measurable improvements in student achievement further supports the importance Texas policymakers have placed on improving student outcomes. We use an interrupted time series to study the effect of the program on student achievement gains.

We use changes in student performance as a measure of worker productivity, and examine the extent to which differences with respect to the units of accountability or dispersion of awards lead to differences in student performance. Data for this part of the analysis come from the TEA's administrative data files. Publically available, school level aggregates are drawn from AEIS. Restricted use, student-level data on mathematics and reading test scores are drawn

from the Public Education Information Management System (PEIMS), which contains longitudinal, student-level achievement data for grades 3 through 11 in mathematics and reading.

We use a student's spring-to-spring test score gain in mathematics and reading as the outcome variable. Test scores are measured on the state's high-stakes accountability test, the Texas Assessment of Knowledge and Skills (TAKS). Raw scale scores from TAKS are not expressed on the same developmental scale from one year to the next or from one grade to the next. Since the structure of the TAKS tests may lead to smaller or larger gains at various points on the achievement distribution, we calculated standardized test score gains for each student by grade, year, and subject.[19]

Our study of student achievement before and after implementation of the GEEG program benefits from the fact that students move frequently between GEEG and non-GEEG schools during the analysis period. For example, sixth graders could age out of a GEEG elementary school into a non-GEEG middle school, or enter a GEEG middle school from a non-GEEG elementary school. Restricting the analysis only to student level data from GEEG schools would greatly reduce the precision with which student fixed effects could be estimated, and therefore increase the imprecision in the estimates of program effects.

[19] We also estimated all models using a standardized gain score that took the statewide distribution of the students' prior year assessment scores and dividing them into 20 equal intervals for each year and grade combination. We then calculated the mean and standard deviation of the test score gain for all students starting in a particular interval for each of those combinations. A student's test score gain is standardized by taking the difference between that student's nominal gain and the mean gain of all students in the interval over the standard deviation of all student gains in the interval. The standardized gain score has a mean of zero and standard deviation of one and can be interpreted as an individual student's test score gain compared to the mean test score gain at a particular place in the achievement distribution. This alternative standardization strategy was adopted to account for the possibility that it is easier to achieve gains when students have substantial room for improvement than it is when students are already relatively high achievers. This approach also lessens the chances that mean reverting measurement error will bias estimates of a GEEG treatment effect. A similar strategy has been implemented by Hanushek, Kain, Rivkin, and Branch (2005) and Springer (2008). Again, we found no programmatic effects. Coefficient estimates are available from the authors.

Rather than restricting the sample, we adopted a two-stage analysis. In the first stage, we used all the available data on student performance to estimate school effects for each school, each year. In the second stage of the analysis, we used variations in school characteristics and plan design features to explain the variation in the first-stage estimates of the annual school effects for GEEG schools.

More specifically, the first stage models the performance of student i in year t as a function of student characteristics that do not change over time, student characteristics that can change over time, and year-specific school effects. We presume that the marginal effect of time-varying individual characteristics need not be constant over time. Thus, the first stage model can be expressed as:

$$= \quad + \quad + \quad + \quad +$$

where y_{it} is the standardized gain score of student i in year t, x_{it} is a vector of student characteristics that can change over time (namely indicators for whether or not a student is limited English proficient and economically disadvantaged), S_{ist} is an indicator that takes on a value of one if student i attends school s in year t (and zero otherwise) and the G_{gt} are school by year indicator variables. Because β_t varies over time, one can think of the x_{it} vector as containing separate variables for each year-characteristic interaction. Thus, rather than having a single indicator variable for limited English proficiency (LEP) that has the same effect across all years, there is an indicator for being LEP in the 2003-04 school year and another for being LEP in the 2004-05 school year.

Subtracting the person-specific means from each observation yields the "within" transformation:

$$- \quad =(\quad - \quad) \quad + \quad (\quad - \quad) \quad + \quad (\quad - \quad) \quad + \quad -$$

where the overbars indicate person-specific means. Given time-variant β, δ and γ, this transformed model is block diagonal—all observations from any one year have a block of zeros for all of the other-year variables—and can be estimated year-by-year from the transformed data using generalized least squares. Given the extremely large number of indicator variables required for the analysis, we were forced to adopt this approach rather than estimate equation 2 using untransformed data.

The coefficients on the school indicators in the above regression represent the best available estimate of the effect of school s on student performance in year t. The second stage of the analysis uses these estimated annual school effects for GEEG schools as the dependent variables in a regression of annual school effects on school characteristics, including the GEEG plan design features. To reflect measurement error in the estimates of annual school effects, the second stage regression is weighted by the inverse of the standard errors of the annual school effects from the first stage regression. Weighting by the inverse of the standard error give more influence to annual school effects that are measured precisely than to annual school effects that are less precisely measured.

Table 5 presents the coefficient estimates for the second stage regression with respect to the unit of accountability and the Plan Gini. As with the analyses of employee preferences, this analysis incorporates school fixed effects and is based solely on variations in annual school effects among GEEG schools. All models include an array of indicators for student demographics, and three common indicators of school educational inputs—the average teacher salary (exclusive of incentive pay), the average teacher experience, and the teacher-pupil ratio.

[INSERT TABLE 5 ABOUT HERE]

As the table illustrates, differences in student outcomes across incentive structures were insignificant. For both reading and mathematics, variations in the Plan Gini had no power to explain variations in annual school effects. We could not reject the joint hypothesis that indicators for the GEEG years and the Plan Gini were jointly insignificant in either equation. Similarly, we could not reject the hypothesis that the GEEG year indicators and the unit of accountability indicators were jointly insignificant.

Depending on the specification of the statistical model used, we found that the GEEG program had a weakly positive, negative or negligible effect on student test score gains.[20] The instability in the estimates may be related to common measurement problems associated with standardized tests or the statistical methods used to control for selection bias. Furthermore, the small number of GEEG schools adopting any given plan design necessarily makes these estimates imprecise. Nevertheless, it is important to examine teacher mobility patterns when evaluating the GEEG program. Recognizing educator incentive systems can raise the overall quality of the workforce through the differential recruitment and retention of more effective workers, in the long run, student performance may increase significantly simply through differential recruitment and retention of high performing teachers.

5.b. Reducing Turnover Among the Highly Productive

Turnover is costly for school districts, so one of the employer objectives under the GEEG program was the targeted retention of high performing teachers. To evaluate the impact of the plan on this employer objective, we explore the extent to which the actual receipt of a GEEG award impacted an individual teacher's turnover decision, by adding indicators for the bonuses received by individuals to the baseline analyses in tables 3 and 4.

[20] Tables are available upon request.

In this analysis, teachers are presumed to know by the end of the school year whether they will receive an award the following fall, and if so, the amount of the actual award. Teacher bonuses for the 2005-06 school year were distributed in the fall of 2006, thus we model the bonus award as influencing whether a teacher returns to the same school for the 2006-07 school year. Similarly, we model the GEEG bonus for the 2006-07 school year as influencing whether a teacher returns for the 2007-08 school year, and the GEEG bonus for the 2007-08 school year as influencing whether a teacher returns for the 2008-09 school year

Arguably, the relationship could work the other way around. Schools could have chosen to withhold awards from a teacher who quit, even though the teacher had met the performance criteria. However, more than one third (34.8 percent) of the teachers who turned over during the three years of the GEEG program still received GEEG bonus awards. Therefore, it is reasonable to presume that the expectation of awards influences turnover, and not the reverse.

Data on the individual awards distributed in 2006 are available for 85 of the 98 GEEG schools for which PEIMS personnel data are available. Data on the individual awards distributed in 2007 are available for 84 schools, and data on the individual awards distributed in 2008 are available for 72 schools. Unfortunately, data from all three years are only available for 52 GEEG schools. Rather than lose nearly half of the sample to missing data, we included in the analysis indicators for whether or not the school provided award data in 2006, 2007 and in 2008. These indicators take on the value of one if the bonus data are missing, and zero otherwise. The awards variables (Bonus 2006, Bonus 2007 and Bonus 2008) take on the value of the individual award in the corresponding year, and zero otherwise. The awards variables are set equal to zero for all teachers in a non-respondent school. To allow for a non-linear relationship between the probability of teacher turnover and the size of the bonus award, the analysis includes the squares

of the individual bonus awards. Interaction terms allow the effect of a bonus on turnover to vary according to the plan design features.

Figures 1 and 2 illustrate the estimated influence of program design on the relationship between the size of the GEEG bonus award and the probability of teacher turnover (all other things being equal). Appendix Tables A1 and A2 present the corresponding marginal effects and robust standard errors. Again, these analyses incorporate school fixed effects, allow for a correlation in the errors across multiple observations of the same teacher, and are based solely on variations in turnover among GEEG schools.

The horizontal line each figure indicates the expected turnover rate in the absence of the GEEG program, while the curves indicate the expected turnover rates, once all of the non-GEEG influences on teacher turnover have been taken into account. Expected turnover rates were calculated using the method of recycled predictions, holding constant at the mean all of the teacher, school and student characteristics in the model.

The first part of this analysis, illustrated in figure 1, examines the interaction between the unit of accountability—teacher, campus, or mixed—and the size of the reward that teachers received. In all cases, the probability of turnover surged among teachers who did not receive a GEEG award, while it fell sharply among teachers who did receive such an award. As a general rule, there were no significant differences in this pattern between schools with teacher-level incentives, those with school-level incentives and those with mixed-level incentives. However, there were significant differences in the first year of the program for experienced teachers, in the second year of the program for beginning teachers, and in the third year of the program for teachers as a whole. In these three cases, teachers who received no award were significantly more likely to leave the campus under all three incentive structures, but the effect was much less

pronounced in schools that designed plans with only teacher incentives than it was in schools with at least some group incentives. Figure 1 illustrates this result for all teachers in the third year of the GEEG program.

[INSERT FIGURE 1 ABOUT HERE]

The second part of this analysis, illustrated in figure 2, examines the interaction between plan equality and the size of the award that teachers received. In all three years of the GEEG program, the analysis suggests that teachers who received no award were much more likely to turnover when their school had a low degree of plan inequality than when their school's plan had a high degree of plan inequality (all other things being equal). In other words, when the plan was designed to reward all teachers equally, the failure to receive an award was an especially strong predictor of teacher turnover.

Figure 2 illustrates this pattern for the first year of the GEEG program. The Minimum Inequality curve traces out the relationship between the size of a teacher's bonus award and the probability that the teacher will turn over, assuming that the school's incentive plan was perfectly egalitarian (i.e. the Plan Gini was equal to zero). The Maximum Inequality curve traces out the relationship between the size of a teacher's bonus and the probability that the teacher will turn over, assuming that the schools incentive plan was highly unequal (i.e. the Plan Gini was equal to 0.77, the maximum value for the Plan Gini among GEEG schools). As the figure illustrates, a teacher who received no award was twice as likely to turnover in 2005-06 if the school had a perfectly egalitarian award structure than if the school had a highly unequal award structure.

[INSERT FIGURE 2 ABOUT HERE]

Among beginning teachers, the proposed award equality had no significant influence on the impact of receiving an award in the first or second year of the GEEG program. Beginning teachers in schools with highly unequal award plans were no more or less likely to turnover than teachers in schools with perfectly egalitarian award plans, once the size of the individual's own award was taken into account.

However, the pattern changed in the third year of the GEEG program. Turnover among beginning teachers became sensitive not only to the individual's own award, but also to the equality of the school's incentive plan. The more egalitarian the school's incentive plan, the larger was the expected reduction in turnover associated with receiving a substantial incentive award in the final year of the GEEG program. Thus, once the size of the individual's own award was taken into account and the incentive plan had been operational for a few years, beginning teachers appear to favor more individualistic incentives.

Among experienced teachers, the degree of inequality in the GEEG plan proposal had an influence on the impact of receiving an award in the first two years of the GEEG program, even after controlling for the size of the individual's own award. The turnover rate among experienced teachers who received no award was significantly higher in schools with plans that were very egalitarian than it was in schools with plans that were highly unequal. There was no evidence that plan equality influenced turnover among experienced teachers in the third year of the program, once the size of the individual's own award was taken into account.

5.c. Optimal Incentives from the Employer Perspective

We find no evidence of a significant association between student achievement gains and the incentive plan's unit of accountability or dispersion of awards. Given the measurement error inherent in any analysis of standardized test scores and the small number of GEEG schools adopting any particular plan design, these estimates are necessarily imprecise, and could be masking significant effects. Furthermore, nearly all of the GEEG schools adopted relatively weak incentive plans, so we have no evidence about the effectiveness of stronger teacher incentives. Nevertheless, our evidence suggests that a wide variety of incentive plans are equally effective (or equally ineffective) at inducing changes in teacher productivity.

On the other hand, the evidence does suggest that the GEEG program encouraged some teachers to turnover who otherwise would not, and encouraged other teachers to stay who otherwise would have left. The more egalitarian the school's incentive plan, the more likely that experienced teachers who received no award would turn over. If we assume that teachers receiving bonus awards are more effective in the classroom than non-recipients, then the positive relationship between GEEG awards and teacher retention suggests that the GEEG program increased retention of those teachers that schools particularly wished to retain.

6. CONCLUSIONS

Because teachers played such a major role in the design of the incentive plans, the GEEG program in Texas provides an opportunity to evaluate incentive pay from two alternative and possibly competing perspectives—those of the employee and the employer.

The evidence strongly suggests that teachers prefer relatively weak incentive. The GEEG incentive plans systematically offered smaller awards to a higher proportion of teachers than was obviously intended by the TEA. Intriguingly, weak incentives were more common in situations

where organizational and management theory suggests strong incentives would be more effective at inducing behavioral changes.

Perhaps because the incentive structures were so weak, we find no evidence that variations in plan design led to variations in student performance gains. Schools with relatively strong incentives did not experience greater gains in student performance than did schools with relatively weak incentives.

On the other hand, we find relatively strong evidence that the incentives had an impact on teacher turnover. Teachers who received no award had a heightened probability of turnover, while teachers who received relatively large awards had a greatly reduced probability of turnover. If we assume that award recipients were more effective in the classroom than non-recipients—which might be a relatively strong assumption—then the evidence suggests that even weak incentives achieved the objectives of employers. The GEEG program increased retention of those teachers that schools particularly wished to retain.

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Table 1. Determinants of Plan Characteristics, Descriptive Statistics

	Mean	Standard Deviation	Minimum	Maximum
Percent economically disadvantaged students	91.24	9.43	42.90	100.00
Average teacher experience	10.82	3.37	3.00	20.85
Teacher salary Gini	0.09	0.02	0.04	0.16
School size	6.12	0.84	3.50	7.67
GEEG funding per pupil	0.25	0.24	0.10	1.82
Share of teachers new to school	0.18	0.12	0.00	0.60
Share of teachers male	0.26	0.16	0.00	0.63
Elementary school	0.53	0.50	0.00	1.00
Secondary school	0.21	0.41	0.00	1.00
High improving school	0.47	0.50	0.00	1.00

Source: Authors' calculations

Table 2. Determinants of Plan Characteristics and the Distribution of Teacher Awards

	Panel A: Units of Accountability		Panel B: Distribution of Proposed Awards
	Teacher and School	*Teacher Only*	*Plan Gini*
(model)	(1)		(2)
Percent economically disadvantaged students	0.069 (0.05)	0.003 (0.04)	-0.006 (0.002)**
Average teacher experience	-0.116 (0.10)	-0.07 (0.10)	-0.009 (0.01)
Teacher salary Gini	27.006* (14.86)	31.390** (14.31)	2.808 (0.806)***
School size	-0.117 (0.92)	0.968* (0.55)	0.084 (0.033)**
GEEG funding per pupil	-2.397 (3.79)	2.541 (2.00)	0.031 (0.09)
Share of teachers new to school	0.504 (3.65)	0.485 (2.47)	0.119 (0.17)
Share of teachers male	3.309 (2.29)	2.002 (2.65)	0.065 (0.15)
Elementary school	-0.279 (0.93)	0.854 (0.73)	-0.056 (0.05)
Secondary school	0.908 (1.19)	0.182 (1.14)	-0.099 (0.058)*
High improving school	-0.942 (0.73)	0.052 (0.56)	-0.003 (0.04)
Constant	-7.315 (7.82)	-9.588* (4.96)	0.191 (0.34)
Observations	97		94
Wald Chi^2 (20)	48.46		…
Probability of a Greater Chi^2	0.0004		…
Pseudo R^2	0.1002		…
R^2	…		0.3

Robust standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Source: Authors calculations.

Table 3: The Impact of the Unit of Accountability on the Probability of Teacher Turnover in GEEG Schools

	Marginal Effects from Probit Analysis		
	All Teachers	Beginning Teachers	Experienced Teachers
Base Salary (log)	-0.202	0.045	-0.049
	(0.041)***	(0.129)	(0.068)
School enrollment (log)	0.148	0.256	0.099
	(0.026)***	(0.060)***	(0.032)***
Comparable Wage Index	1.083	1.513	0.864
	(0.207)***	(0.457)***	(0.248)***
Unemployment Rate	0.038	0.073	0.030
	(0.006)***	(0.014)***	(0.007)***
Teacher Only 2006	-0.019	0.036	-0.044
	(0.018)	(0.044)	(0.018)**
Campus Only 2006	-0.035	-0.063	-0.032
	(0.020)*	(0.041)	(0.023)
GEEG 2006	-0.030	-0.036	-0.011
	(0.017)*	(0.038)	(0.021)
Teacher Only 2007	0.031	0.032	0.052
	(0.020)	(0.045)	(0.026)**
Campus Only 2007	0.003	0.048	-0.001
	(0.022)	(0.053)	(0.026)
GEEG 2007	-0.025	-0.022	-0.044
	(0.020)	(0.047)	(0.023)*
Teacher Only 2008	-0.009	-0.001	-0.005
	(0.019)	(0.041)	(0.022)
Campus Only 2008	0.000	0.003	-0.008
	(0.022)	(0.048)	(0.025)
GEEG 2008	-0.076	-0.123	-0.070
	(0.025)***	(0.052)**	(0.029)**
GEEG-TEEG	0.017	0.042	0.012
	(0.015)	(0.033)	(0.017)
Observations	22,600	5,875	14,839

All models also include school fixed effects, student demographics (percent low income, Hispanic, Black and limited English), teacher demographics (experience, race, gender, educational attainment), classroom assignment, coaching assignment, and certification status.

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: The Impact of the Plan Equality on the Probability of Teacher Turnover in GEEG Schools

	Marginal Effects from Probit Analysis		
	All Teachers	Beginning Teachers	Experienced Teachers
Base Salary (log)	-0.214	0.028	-0.085
	(0.041)***	(0.136)	(0.071)
School enrollment (log)	0.125	0.211	0.082
	(0.026)***	(0.063)***	(0.031)***
Comparable Wage Index	1.025	1.409	0.862
	(0.212)***	(0.467)***	(0.253)***
Unemployment Rate	0.037	0.074	0.030
	(0.006)***	(0.014)***	(0.008)***
Plan Gini 2006	-0.041	-0.004	-0.071
	(0.041)	(0.083)	(0.047)
Plan Gini 2007	0.093	0.173	0.044
	(0.039)**	(0.085)**	(0.045)
Plan Gini 2008	0.044	0.002	0.029
	(0.039)	(0.085)	(0.046)
GEEG 2006	-0.030	-0.022	-0.019
	(0.018)	(0.041)	(0.022)
GEEG 2007	-0.037	-0.042	-0.035
	(0.021)*	(0.048)	(0.024)
GEEG 2008	-0.083	-0.103	-0.077
	(0.025)***	(0.058)*	(0.030)***
GEEG-TEEG	0.006	0.023	0.003
	(0.014)	(0.031)	(0.016)
Observations	21,947	5,764	14,343

All models also include school fixed effects, student demographics (percent low income, Hispanic, Black and limited English), teacher demographics (experience, race, gender, educational attainment), classroom assignment, coaching assignment, and certification status.

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: The Impact of Program Characteristics on Student Performance Gains

	Math School Effect	Math School Effect	Reading School Effect	Reading School Effect
Percent economically disadvantaged	0.007	0.003	0.001	-0.003
	(0.004)	(0.004)	(0.004)	(0.004)
Percent limited English proficient	0.001	-0.003	0.002	-0.002
	(0.007)	(0.007)	(0.007)	(0.007)
Percent African American	-0.017	-0.014	-0.003	0.000
	(0.016)	(0.015)	(0.015)	(0.015)
Percent Hispanic	-0.001	0.001	0.007	0.009
	(0.012)	(0.012)	(0.011)	(0.011)
Percent native American	-0.051	-0.027	0.030	0.055
	(0.069)	(0.068)	(0.067)	(0.067)
Percent Asian/Pacific islander	-0.002	-0.044	0.030	0.008
	(0.045)	(0.043)	(0.044)	(0.042)
Percent Special Education	-0.001	-0.003	-0.003	-0.004
	(0.008)	(0.008)	(0.008)	(0.008)
Percent Bilingual program	0.000	0.004	-0.000	0.002
	(0.007)	(0.007)	(0.007)	(0.007)
Percent gifted and talented program	-0.008	-0.010	-0.011	-0.013
	(0.008)	(0.008)	(0.008)	(0.007)
Average teacher salary	-0.008	-0.006	-0.005	-0.000
	(0.015)	(0.014)	(0.014)	(0.014)
Average teacher experience	-0.001	-0.004	-0.004	-0.004
	(0.015)	(0.015)	(0.015)	(0.014)
Teacher-student ratio	0.001	0.004	0.011	0.008
	(0.014)	(0.014)	(0.014)	(0.014)
Plan Gini	0.022		-0.117	
	(0.121)		(0.119)	
Mixed units of accountability		0.014		-0.043
		(0.065)		(0.063)
Teacher only unit of accountability		-0.010		-0.003
		(0.054)		(0.052)
Constant	0.044	0.182	-0.450	-0.295
	(1.228)	(1.216)	(1.201)	(1.183)
School Fixed Effects?	yes	yes	yes	yes
Year Fixed Effects?	yes	yes	yes	yes
Observations	424	433	424	433
R-squared	0.53	0.53	0.32	0.32

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Figure 1: The Influence of Receiving a GEEG Award on the Probability of Teacher Turnover in 2007-08, by the Unit of Accountability

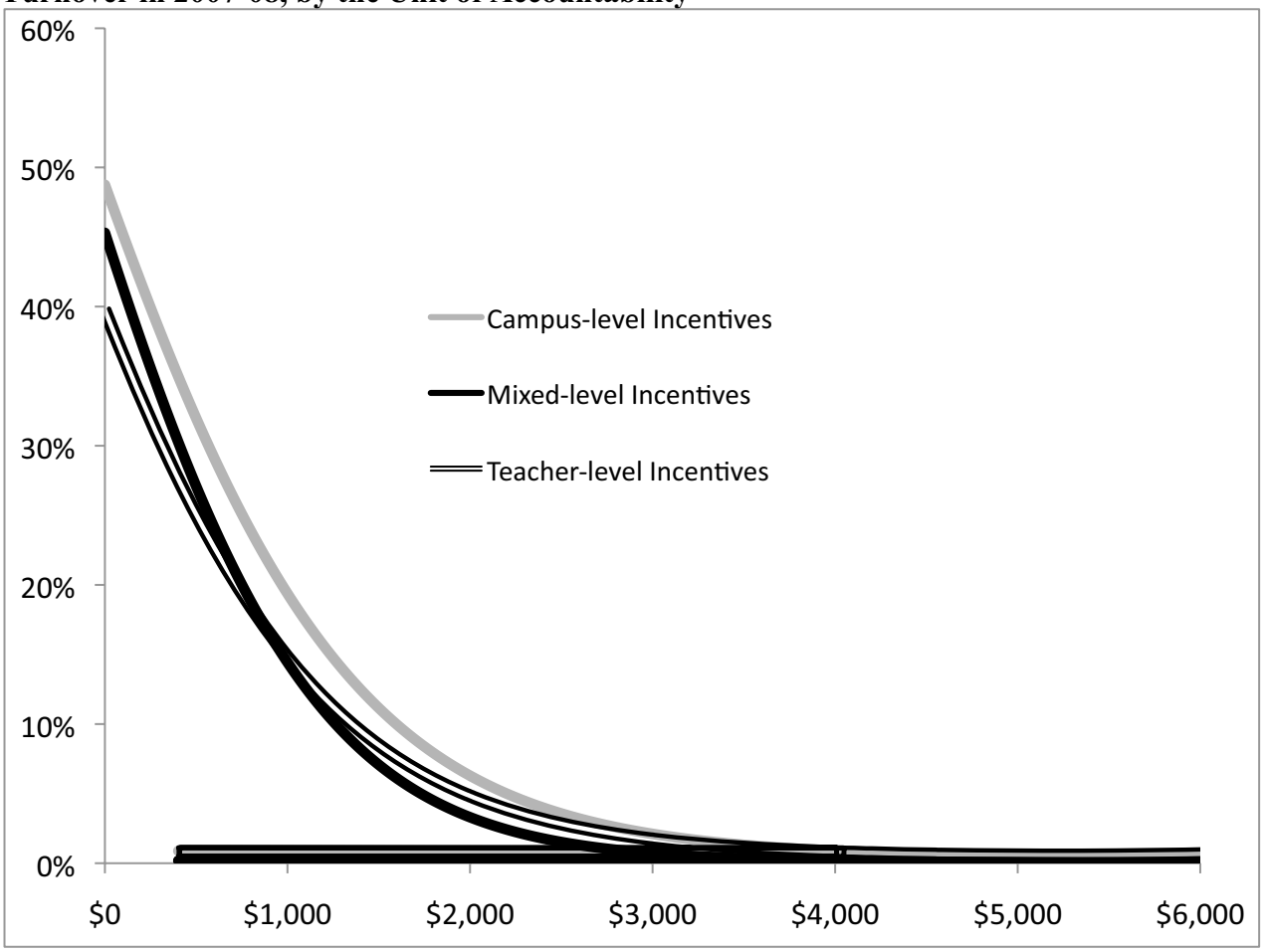

Figure 2: The Influence of Receiving a GEEG Award on the Probability of Teacher Turnover in 2005-06, by Plan Inequality

Table A1: The Effect of Individual GEEG Awards and Units of Accountability on Turnover

	Marginal Effects from Probit Analysis		
	All Teachers	**Beginning Teachers**	**Experienced Teachers**
Teacher Only 2006	-0.044	-0.007	-0.073
	(0.020)**	(0.049)	(0.019)***
Teacher Only 2007	-0.021	-0.075	0.009
	(0.023)	(0.043)*	(0.030)
Teacher Only 2008	-0.033	-0.061	-0.011
	(0.021)	(0.040)	(0.028)
Campus Only 2006	-0.041	-0.074	-0.034
	(0.022)*	(0.044)*	(0.025)
Campus Only 2007	-0.004	0.040	-0.007
	(0.028)	(0.069)	(0.033)
Campus Only 2008	0.022	-0.056	0.030
	(0.030)	(0.047)	(0.038)
Bonus_2006 X Teacher only	0.025	0.025	0.034
	(0.016)	(0.029)	(0.016)**
Bonus_2006 X Campus only_	0.014	0.002	0.001
	(0.017)	(0.033)	(0.019)
Bonus_2007 X Teacher only	0.049	0.129	0.030
	(0.021)**	(0.053)**	(0.023)
Bonus_2007 X Campus only_	0.021	0.055	0.007
	(0.024)	(0.057)	(0.027)
Bonus_2008 X Teacher only	0.039	-0.017	0.040
	(0.021)*	(0.043)	(0.025)
Bonus_2008 X Campus only_	0.027	0.054	0.021
	(0.022)	(0.043)	(0.027)
Bonus Amount 2006	-0.136	-0.178	-0.159
	(0.016)***	(0.033)***	(0.018)***
Bonus Amount 2007	-0.266	-0.369	-0.226
	(0.019)***	(0.049)***	(0.022)***
Bonus Amount 2008	-0.252	-0.303	-0.232
	(0.019)***	(0.036)***	(0.023)***
Bonus Amount Missing 2006	-0.104	-0.084	-0.114
	(0.011)***	(0.032)***	(0.009)***
Bonus Amount Missing 2007	-0.129	-0.177	-0.106
	(0.007)***	(0.014)***	(0.009)***
Bonus Amount Missing 2008	-0.154	-0.188	-0.140
	(0.005)***	(0.011)***	(0.005)***
Bonus Amount 2006, squared	0.009	0.019	0.014
	(0.002)***	(0.005)***	(0.002)***
Bonus Amount 2007, squared	0.024	0.029	0.022
	(0.002)***	(0.004)***	(0.002)***

Bonus Amount 2008, squared	0.020	0.021	0.019
	(0.002)***	(0.004)***	(0.002)***
GEEG 2006	0.155	0.139	0.230
	(0.032)***	(0.062)**	(0.043)***
GEEG 2007	0.283	0.372	0.217
	(0.037)***	(0.076)***	(0.045)***
GEEG 2008	0.211	0.211	0.196
	(0.046)***	(0.094)**	(0.058)***
GEEG TEEG	0.029	0.085	0.017
	(0.016)*	(0.037)**	(0.018)
Base Salary (log)	-0.184	0.086	-0.001
	(0.039)***	(0.126)	(0.064)
Black	-0.020	-0.016	-0.023
	(0.009)**	(0.021)	(0.011)**
Hispanic	-0.039	-0.074	-0.019
	(0.008)***	(0.018)***	(0.009)**
Asian/American Indian	-0.058	-0.072	-0.062
	(0.013)***	(0.025)***	(0.017)***
Male	-0.003	-0.018	0.001
	(0.006)	(0.013)	(0.007)
Years of Experience	-0.003	0.069	-0.009
	(0.001)**	(0.018)***	(0.002)***
Experience, squared	0.000	-0.019	0.000
	(0.000)***	(0.006)***	(0.000)***
Experience missing	0.009		
	(0.014)		
No Degree	-0.054	-0.100	-0.058
	(0.021)***	(0.030)***	(0.030)*
MA	0.050	0.022	0.046
	(0.008)***	(0.023)	(0.008)***
PhD	0.076	0.163	0.059
	(0.038)**	(0.096)*	(0.042)
TAKS	0.023	0.024	0.023
	(0.007)***	(0.015)	(0.008)***
Language Arts	0.015	0.013	0.015
	(0.008)*	(0.017)	(0.009)
Math	0.005	-0.044	0.026
	(0.010)	(0.020)**	(0.013)*
Science	-0.021	-0.002	-0.025
	(0.009)**	(0.020)	(0.011)**
Foreign Language	0.007	0.059	-0.010
	(0.017)	(0.043)	(0.018)
Fine Arts	-0.005	0.026	-0.016
	(0.011)	(0.028)	(0.012)
Vocational-Technical	-0.033	-0.030	-0.018
	(0.013)***	(0.031)	(0.016)

Special Education	0.030	0.074	0.018
	(0.015)*	(0.035)**	(0.018)
Bilingual	0.024	0.007	0.035
	(0.011)**	(0.023)	(0.014)***
Math Certified	0.014	0.077	-0.006
	(0.013)	(0.035)**	(0.015)
Science Certified	0.050	0.017	0.051
	(0.014)***	(0.031)	(0.017)***
Bilingual Certified	-0.005	0.006	-0.024
	(0.009)	(0.022)	(0.010)**
Special Ed Certified	0.019	0.039	0.013
	(0.010)*	(0.026)	(0.011)
Certified	-0.072	-0.076	-0.125
	(0.012)***	(0.019)***	(0.030)***
Coach	0.003	0.004	-0.008
	(0.010)	(0.022)	(0.012)
Percent Ed students	0.191	0.349	0.063
	(0.092)**	(0.226)	(0.106)
Percent LEP students	0.027	0.066	0.126
	(0.076)	(0.162)	(0.092)
Percent Hispanic students	-0.018	0.239	-0.033
	(0.237)	(0.569)	(0.310)
Percent Black students	-0.132	0.227	0.005
	(0.286)	(0.688)	(0.367)
School enrollment (log)	0.109	0.196	0.062
	(0.026)***	(0.059)***	(0.031)**
Comparable Wage Index	1.047	1.503	0.821
	(0.201)***	(0.446)***	(0.237)***
Unemployment Rate	0.039	0.077	0.030
	(0.006)***	(0.013)***	(0.007)***
Campus Fixed Effects?	Yes	Yes	Yes
Observations	22,600	5,875	14,839

Robust standard errors in parentheses
*** significant at 10%; ** significant at 5%; *** significant at 1%**

Table A2: The Effect of Individual GEEG Awards and Plan Inequality on Turnover

	Marginal Effects from Probit Analysis		
	All Teachers	Beginning Teachers	Experienced Teachers
Plan Gini 2006	-0.210	-0.228	-0.268
	(0.058)***	(0.114)**	(0.065)***
Plan Gini 2007	-0.102	-0.059	-0.158
	(0.057)*	(0.125)	(0.067)**
Plan Gini 2008	-0.038	-0.115	-0.054
	(0.061)	(0.120)	(0.072)
Plangini X Bonus Amount 2006	0.071	0.116	0.088
	(0.025)***	(0.050)**	(0.024)***
Plangini X Bonus Amount Missing 2006	0.204	0.331	0.204
	(0.121)*	(0.253)	(0.139)
Plangini X Bonus Amount 2007	0.110	0.078	0.150
	(0.034)***	(0.079)	(0.044)***
Plangini X Bonus Amount Missing 2007	0.174	0.275	0.168
	(0.110)	(0.242)	(0.127)
Plangini X Bonus Amount 2008	0.102	0.289	0.072
	(0.037)***	(0.081)***	(0.042)*
Plangini X Bonus Amount Missing 2008	-0.014	0.087	0.015
	(0.102)	(0.213)	(0.121)
Bonus Amount 2006	-0.151	-0.205	-0.182
	(0.016)***	(0.030)***	(0.017)***
Bonus Amount 2007	-0.292	-0.321	-0.282
	(0.021)***	(0.045)***	(0.027)***
Bonus Amount 2008	-0.278	-0.437	-0.243
	(0.021)***	(0.047)***	(0.024)***
Bonus Amount Missing 2006	-0.137	-0.167	-0.131
	(0.017)***	(0.038)***	(0.013)***
Bonus Amount Missing 2007	-0.149	-0.195	-0.128
	(0.009)***	(0.016)***	(0.011)***
Bonus Amount Missing 2008	-0.155	-0.200	-0.141
	(0.012)***	(0.023)***	(0.011)***
Bonus Amount 2006, squared	0.009	0.017	0.015
	(0.002)***	(0.004)***	(0.002)***
Bonus Amount 2007, squared	0.027	0.030	0.024
	(0.002)***	(0.004)***	(0.003)***
Bonus Amount 2008, squared	0.024	0.029	0.022
	(0.002)***	(0.004)***	(0.002)***
GEEG 2006	0.230	0.255	0.315
	(0.041)***	(0.074)***	(0.053)***
GEEG 2007	0.349	0.390	0.340
	(0.045)***	(0.091)***	(0.058)***
GEEG 2008	0.249	0.288	0.246

	(0.054)***	(0.106)***	(0.068)***
GEEG TEEG	0.025	0.071	0.014
	(0.016)	(0.036)**	(0.018)
Base Salary (log)	-0.200	0.048	-0.035
	(0.039)***	(0.133)	(0.066)
Black	-0.026	-0.029	-0.024
	(0.009)***	(0.021)	(0.011)**
Hispanic	-0.039	-0.078	-0.020
	(0.008)***	(0.018)***	(0.009)**
Asian/American Indian	-0.060	-0.065	-0.067
	(0.014)***	(0.026)**	(0.017)***
Male	-0.002	-0.015	0.002
	(0.006)	(0.013)	(0.007)
Years of Experience	-0.002	0.073	-0.008
	(0.001)*	(0.018)***	(0.002)***
Experience, squared	0.000	-0.020	0.000
	(0.000)***	(0.006)***	(0.000)***
Experience missing	0.023		
	(0.014)		
No Degree	-0.051	-0.108	-0.056
	(0.021)**	(0.030)***	(0.033)*
MA	0.051	0.033	0.046
	(0.008)***	(0.023)	(0.009)***
PhD	0.074	0.155	0.064
	(0.038)*	(0.100)	(0.044)
TAKS	0.024	0.020	0.026
	(0.007)***	(0.015)	(0.008)***
Language Arts	0.015	0.027	0.015
	(0.008)*	(0.017)	(0.009)
Math	0.002	-0.051	0.025
	(0.010)	(0.020)**	(0.014)*
Science	-0.021	0.005	-0.028
	(0.010)**	(0.021)	(0.011)**
Foreign Language	0.006	0.050	-0.007
	(0.017)	(0.043)	(0.019)
Fine Arts	0.003	0.043	-0.010
	(0.011)	(0.028)	(0.013)
Vocational-Technical	-0.028	-0.020	-0.015
	(0.013)**	(0.034)	(0.016)
Special Education	0.030	0.070	0.014
	(0.015)*	(0.035)**	(0.017)
Bilingual	0.022	-0.002	0.036
	(0.011)*	(0.023)	(0.014)**
Math Certified	0.014	0.098	-0.011
	(0.014)	(0.036)***	(0.015)
Science Certified	0.052	0.028	0.051

	(0.015)***	(0.032)	(0.017)***
Bilingual Certified	-0.004	0.007	-0.023
	(0.009)	(0.022)	(0.010)**
Special Ed Certified	0.021	0.039	0.019
	(0.010)**	(0.026)	(0.012)
Certified	-0.072	-0.078	-0.134
	(0.013)***	(0.020)***	(0.032)***
Coach	0.006	0.006	-0.005
	(0.011)	(0.022)	(0.012)
Percent Ed students	0.115	0.176	0.028
	(0.088)	(0.203)	(0.102)
Percent LEP students	-0.085	-0.171	0.068
	(0.079)	(0.171)	(0.095)
Percent Hispanic students	-0.038	0.203	-0.042
	(0.238)	(0.567)	(0.300)
Percent Black students	-0.221	-0.035	-0.085
	(0.292)	(0.705)	(0.365)
School enrollment (log)	0.105	0.208	0.051
	(0.026)***	(0.061)***	(0.031)
Comparable Wage Index	0.959	1.243	0.799
	(0.206)***	(0.455)***	(0.242)***
Unemployment Rate	0.036	0.070	0.029
	(0.006)***	(0.013)***	(0.007)***
Campus Fixed Effects?	Yes	Yes	Yes
Observations	21,947	5,764	14,343

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

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