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Does performance related pay for teachers improve student performance? Some evidence from India*

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Abstract

In this paper data from a school survey in India is used to ask if there is evidence for the payment of performance related pay and whether such pay structures do impact on student achievement. It is shown that - after controlling for student ability, parental background and the resources available - private schools get significantly better academic results by relating pay to achievement; government schools do not. We discuss possible interpretations of this result.

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1. Introduction

The issue of whether linking teachers' pay to student performance is an effective means of improving that performance has been contentious in educational debates. Malcomson (1999, p. 2337) in surveying the literature on contract design with respect to performance related pay notes that "the objective measures of performance available are often such poor measures of the performance firms really care about that use of formal performance related pay schemes can be counterproductive". Problems arise from the ability of agents to influence the output measures and the fact that non-measured outputs may be as important as measurable ones. However, in the case of teaching, it may be relatively easy to verify outcomes, if exams can measure output and the local teachers are not allowed to mark the exams. But verifying whether teacher inputs affect outcomes may still be problematic. Students may be taught by more than one teacher so it will be difficult to link the performance of a particular student to a teacher. Schools differ greatly in the background and quality of their intakes so that exam performance outcomes, which do not control for such student-quality differences, are worthless as a basis for differential payments to teachers. These are some of the reasons advanced for resisting performance related pay in the education sector.

However, Ballou (2001, p.57) calls into question the notion that teaching is inherently unsuited to performance-based pay. He uses data from the US to show that private schools make significantly greater use of merit pay than do public school, even when the comparison is restricted to public systems that most resemble private schools with respect to their size and the type of students served. He argues that the reasons for the absence of merit pay are not inherent in the teaching technology, but are due to specific circumstances in public education,

notably the opposition of teacher unions. In Britain, while many individual teachers supported the recent introduction of a weak form of performance related pay, the teacher unions have mostly been against it on the grounds that it would create conflict and division among teachers within any given school, undermining collegiality and mutual cooperation. They also argue that it may lead to the exclusion of less able children from school since test results of students will be taken into account in the assessment of merit pay.

The result of any such selectivity would be to set up a positive correlation between teacher pay and student achievement. The logic of the case for performance related pay is that improved student achievement *causes* a rise in pay which, in turn, through greater teacher effort, *causes* improved student outcomes. In this paper we draw on data from both private and government schools to attempt to assess whether there is a causal relationship between pay and performance or, as the selectivity argument implies, there is simply a correlation induced by both variables being correlated with some other factor.

A very large literature, for both developed and developing countries, has investigated the impact of dimensions of school quality on educational achievement. Hanushek (1986) reviews 147 such achievement production function studies from developed countries and Fuller (1986) reviews 72 such studies from developing countries. More recent studies of the effects of school inputs on student outcomes include Case and Deaton (1999); Angrist and Lavy (1999); Hanushek, Kain, and Rivkin (1999); Betts and Morell (1999); Hanushek et. al. (1996); Kingdon (1996a); and Glewwe and Jacoby (1994). Some of these studies have investigated the impact of teacher salaries on student outcomes, with mixed results. Loeb and Page (2000) focus on explaining why several studies have failed to discover a positive relation between teacher pay and student outcomes. To our knowledge, few have addressed the issue of endogeneity in the positive correlation between pay and achievement, and none appear to

have the data that enables a direct comparison of the effect, for similarly aged children, across the private and government sectors.

Even if a relationship is established as running from higher wage to improved student achievement, the relationship is open to alternative interpretations. One is that a positive impact from wages onto achievement reflects the fact that higher wages likely attract better quality people into the pool for applicants for teaching jobs. A second interpretation is that higher pay raises achievement by raising the effort of existing teachers. In terms of the efficiency wage theory, better paid teachers are likely to work harder in order to increase the chances of retaining their more valuable jobs. The paper will test these alternative explanations of the wage effect on pupil achievement.

This paper does three things. Firstly, it examines whether teacher pay is responsive to measures of student performance, i.e. whether schools pay teachers performance related pay. Secondly, it asks whether higher teacher pay does raise student learning outcomes. Thirdly, it considers the interpretations that can be given to the results. The data and model are set out in section 2. Whether teacher pay is related to performance and the determinants of student achievement are the subject of section 3. Section 4 considers whether unobserved variables are an important influence on the results. In section 5 we assess possible interpretations which can be given to the results. A final section concludes.

2. The model and data

The data is drawn from a survey of pupils and schools in India where public and private school sectors have developed in parallel. The survey collected detailed information on students, their teachers and on various aspects of the school. The dataset was designed to collect information on student, teacher and school quality as well as measuring the factors which determines the

outcome for wages and student achievement. Our model consists of two equations: an earnings function for teacher's pay and a production function for student achievement. We outline both before turning to the data.

The estimate of wage is to be obtained from an earnings function for government and private school teachers of the following form:

(1) $$\text{Ln } w_{kj} = \beta_0 + \beta_1 H_{kj} + \beta_2 \text{ Ln } Q^T_{kj} + \beta_3 S_{kj} + \beta_4 \text{ Ln } Q^S_j + \beta_5 \text{ Ln } A_j + u_{kj}$$

where w_{kj} is the gross wage of the k_{th} teacher in the j_{th} school. This measure of earnings is explained by vectors of variables capturing teacher human capital (H_{kj}), teacher quality (Q^T_{kj}), teacher status (S_{kj}), school quality ($Q^S_{j,}$) and the average achievement of students taught by the teacher (A_j). It is the significance of this last variable which tests for the existence of performance related pay. We detail below, after we have introduced the data, how we propose to measure these dimensions of human capital and quality.

We next present our achievement function, analogous to a firm production function.

(2) $$\text{Ln } A_{ij} = \alpha_0 + \alpha_1 \text{ Ln } R_{ij} + \alpha_2 \text{ Ln } Q^C_{ij} + \alpha_3 \text{ Ln } Q^P_{ij} + \alpha_4 \text{ Ln } Q^S_j + \alpha_5 \text{ Ln } w_j + v_{ij}$$

where A_{ij} is the achievement score of the i_{th} student in the j_{th} school as measured in terms of scores on tests of numeracy and literacy. It is a direct measure of output. Achievement is modeled as being determined by student ability, R_{ij}; a vector of variables capturing the student and parental attributes, Q^C_{ij} and Q^P_{ij} respectively; the quality of the school Q^S_j; and finally the wage of the teacher, $w_{j.}$ It is the significance of the wage term in this equation which tests if teacher's wages do impact on achievement.

The data set consists of 902 students surveyed across 20 government-funded and 10 private schools, and a sample of 172 teachers.[1] The survey collected data on the personal and

[1] Within the government total, 10 were junior and 10 secondary schools. Within the private sector 5 were junior and 5 were secondary schools. We have included aided schools within the government sector because the state government determines one set of salary scales for both these school types and the state exchequer pays the centrally determined salaries of teachers in both these school types throughout the state. Private schools, on the other

household characteristics of all students of class 8 (13-14 year olds) in the sample schools and detailed teacher information on only those teachers who taught the sample class. Table 1 describes the variables which we use to model the determinants of wages and achievement. Table 2 shows the means and standard deviations of the variables used in the teacher pay regression. Table 3 gives similar descriptive statistics for variables used in the student achievement function.

Table 2 divides the teachers according to private and government schools. Our measure of pay is the total monthly wage payments made to the teacher. On average, wages in private schools are 38% lower than those in government-funded schools[2]. Despite this, private school teachers had marginally greater mean number of years of schooling and better results (divisions) in their own board and degree examinations, though they had fewer years of teaching experience, suggesting greater teacher turnover in private schools. This picture is remarkably similar to that in the US, where private school salaries are, on average, 40% below those in the public school sector but where, despite this, private schools employ a greater proportion of graduates of the better colleges than do public schools, though they also experience considerably higher rates of teacher turnover than those in public schools (Ballou, 1996, p.126)[3]. Table 2 shows that there is also less dispersion of pay in the public sector. This suggests either greater uniformity in the characteristics of teachers in publicly funded

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hand, are financially autonomous, receive no government assistance, and set their own pay levels individually. The survey was carried out in 1991.

[2] In Kansal's (1990) study on 233 teachers in New Delhi schools, wages in private schools were 42% lower than in government schools and in Govinda and Varghese's (1993) study of 111 teachers in Madhya Pradesh, they were 45% lower. Papola and Rodgers (1992) find that in India most small employers (less than 10 workers) do not pay the prescribed minimum wages. Many private junior schools - which are small and typically employ less than 10 teachers – pay salaries that are a fraction of those paid in government funded schools. Mann and Kapoor (1988) find that in all wage employment the differential in private and public sector wages for comparable employees is 31%.

[3] Ballou (1996) finds that US public schools screen out applicants from the best -rated US colleges but that this is not the case in private schools. He considers what plausible explanation can be given for this sub-optimal teacher recruitment policy in public schools and suggests that school administrators may attach much greater importance to applicants' affective characteristics than to cognitive ability. He concludes that "the persistence of

schools or that government-paid teachers' salaries respond much less to idiosyncratic differences between teachers and are more administratively determined.

We measure teacher status (S) by three variables: the teacher's union-membership status, whether teacher has a permanent contract as opposed to a short-term appointment, and teacher gender. So, in the teacher pay equation, i.e. equation (1), S = {UNION, PERMANENT, MALE). We measure human capital (H) by three variables: the teacher's years of education, her years of experience in teaching and whether she received pre-service teacher training. So in the teacher's pay equation H = {TEDUYRS, TOTEXP, TRAINING}. We measure the quality of the teacher by four variables: the average division (or grade) that the teacher obtained in her various board examinations and degrees; number of grades/classes she teaches; whether the subject she teaches matches the subject of her own specialization and training; and whether she took most of her board examinations as a regular candidate[4]. So Q^T ={DIVISION, NCLTAUT, SUBMATCH, REGEXAM}. School quality is measured by three variables: the number of minutes of academic instruction, the resources available to the school and its status as a junior or secondary school. So Q^S ={MINACAD, RESOURCE, JHS}. We would argue that this range of variables gives us excellent controls for the human capital characteristics of the teachers, their quality, and the quality of the school. If with these controls achievement impacts on pay, we would argue that it is not due to achievement being a proxy for these quality dimensions of the teachers or school. We turn now to how we measure the characteristics of the students.

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sub-optimal practices is likely due to the fact that public schools are quasi monopolies with only limited accountability to the public they serve".

[4] Board examinations in India can be taken by an individual either as a regular candidate or 'privately'. People following a particular degree or qualification who are enrolled in college or university are called regular candidates but those who take the examination after self-study (and are not enrolled in college or university for routine attendance of lectures or classes) are called private candidates. Private candidacy involves little or no interaction with a formal teacher to prepare for examination. Working people who wish to enhance their educational qualifications and those with no nearby access to college are more likely to take examinations privately. Taking exams 'privately' should not be confused with studying in a private school or college.

Table 3 shows the characteristics of the students, again classified by whether they belong to a government or private school. The achievement score is the average of standardized cognitive tests in numeracy and literacy. The numeracy score varies from 0 to 36 and that for literacy from 0 to 29, so the maximum possible achievement score for a student is 65 and the minimum 0. The ability of the student, R in equation (2), is measured as their score on the Raven's progressive matrices test. This is a test of non-verbal reasoning which has been widely used as an indicator of innate ability or intelligence (Boissiere, Knight and Sabot, 1985; Glewwe and Jacoby, 1994; Appleton, 1995; Alderman et. al., 1996). The test is intended to be independent of schooling[5]. The controls we have for child attributes, Q^C, are the student's age, gender, educational aspirations, hours of study at home per week, minutes taken to travel to school each day, whether child works in vacations, takes private tuition, and number of siblings. So, in equation (2), Q^C ={CHAGE, MALE, CEDASP, HSTUDY, TRTIME, VACWRK, TAKESTU, NUMSIB}. There are a large number of controls possible for parental attributes: mother's education, the wealth of the household, number of books in the household, whether parents help the child at home in her homework, and the parents' caste and religion. So Q^P ={MEDYRS, WEALTH, BOOKHOM, PARHELP, LOWCASTE, MUSLIM}.

There is clear evidence from Table 3 that private school students come from richer and more educated homes: the wealth index is nearly three times higher in the private sector and the average education of the mothers of students is over 50 per cent higher. They also have higher ability measured by the Raven's test: the test score is 36 in the private and 27 in the government sector. Private schools also have nearly twice the volume of resources per student as government schools and their students get taught for longer. It is clearly possible that

[5] Appleton (1995) reports that in early critical evaluations of the Raven's progressive matrices test, assessors argued that "it is as nearly culture-free as any other available test is or can be" and that "it may be said to have done as well as possible to avoid the effects of previous learning and established attitudes". More recently

government and private schools differ not only in their level of resources and student quality but in their teaching technology. In particular we would expect that if performance related pay is a means of improving student outcomes, for given levels of resources, it will be observed in the private rather than the government sector. We therefore estimate the pay and achievement functions separately for the two sectors.

3. The Determinants of Teacher Pay and Student Achievement

Table 4 reports the results of earning functions for teachers for both the government and private sector. In the equations we control for teacher status (the S vector described above), human capital attributes (the H vector described above), and teacher and school quality (the Q^T and Q^S vectors described above). The combined explanatory power of these variables is very high (95%) in the private sector and quite a respectable 56% in the government sector. We ask which of these factors determine pay and if schools with higher student achievement do pay their teachers more.

Table 4, columns [1] and [3], provide the answer to this question with no allowance for possible endogeneity. While in the government sector unionisation has a positive effect on pay, in the private sector unionised teachers are paid less. Relatively few private teachers are unionised and we interpret this as a quality control effect in private schools, only *very* poor quality teachers who are unionised work in the private sector. Permanence of job-contract is not rewarded in the government sector – where permanency is mandated for all teachers - but is rewarded in the private sector[6]. Gender has a small effect on pay in both sectors. In neither

there has been some debate about the extent to which the Raven's ability test is exogenous to achievement (Alderman et. al., 1996).

[6] The variable permanent seems to mean two different things in the public and private sectors. In the public sector, a duly appointed teacher by definition has a job for life, though temporary teachers are occasionally appointed on low pay on an ad hoc basis to fill a vacancy that arises which awaits filling via administrative channels

sector does teacher education level significantly affect salary. Teacher experience is not rewarded in the private sector but it is in the public sector, with the expected concave relationship. Pre-service teacher training has statistically highly significant but modest payoffs in the private school pay structure but not in the government pay structure. None of the teacher quality variables matter to teacher pay in the government sector, but in the private sector some aspects of quality are reasonably significant, given the small sample size. Some aspects of school quality matter a lot. The length of the school week has a positive and significant effect on teacher pay in the private sector but not in the public. Junior High Schools (JHS) in the private sector pay their teachers substantially less than secondary schools but this is not the case in the public sector. Finally, the variable of most interest, after controlling for all others, is the average student achievement variable. There is a highly significant effect from achievement onto pay for private, but not for government, schools. Clearly the two sectors are using very different means of rewarding their teachers.

Before turning to the issue as to whether this result can be given a causal interpretation we consider the OLS results for the student achievement function in Table 5 columns [1] and [3]. These are the OLS estimates for equation (2) where we control for ability, R; the characteristics of the student and their parents, Q^C and Q^P respectively; and the quality of the school, Q^S. In both private and government schools student ability, as measured by the Raven test, has a highly significant, and virtually identical, affect on achievement. Both student and parental characteristics affect achievement although the parental attributes seem more important for the government than the private sector. In the government sector the volume of school resources, teaching time and non-labour resources matter for achievement, for the private sector they do not. It appears from the OLS results that a different teaching technology

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in due course. However, in the private school sector, teachers on an indefinite job contract (as opposed to a fixed

is being used between the government and private sectors. These OLS results show that teacher pay has a highly significant effect on achievement for the private, but not government, sector.

We now turn to the central issue with which we are concerned. Can these results showing that pay and achievement are linked in the private sector be given a causal interpretation? Given the expectation that β_5 in equation (1) and α_5 in equation (2) are both positive, we would expect the OLS estimate of each to be upwardly biased. The identification of causal effects rests on finding appropriate instruments for average student achievement in the teacher pay regression and for average teacher pay in the student achievement regression.[7]. Given the different levels of aggregation of the two equations, it is not possible to set up a simultaneous equation system.

Table 4 columns [2] and [4] instrument student achievement. We experimented with a range of instruments, choosing as instruments variables from the vector of student characteristics which are known to affect achievement but cannot be regarded as factors relevant for teacher pay. Since the instruments for pupil achievement to be included in the teacher pay equation have to be school-level variables, the first stage equation of student achievement is run in the aggregate form, i.e. aggregating all child variables across students within a school. This implies the availability of only 20 school level observations in the government sector and 10 school-level observations in the private sector. Consequently, we were unable to include the whole vector of student variables as our set of instruments. We used the student variables most well correlated with achievement as identifying instruments for

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term, usually annually renewable, contract) consider themselves as 'permanent'.

[7] Two conditions must be fulfilled for the identification of causal effects using instrumental variables (Angrist, Imbens, and Rubin, 1996), for example when testing whether teacher pay has a causal effect on student achievement. Firstly, the correlation of the instrument of teacher pay with the error term in the achievement equation should be zero and, secondly, the covariance of teacher pay and the instrument of teacher pay should be

achievement. These were the student's age, hours of study at home, and educational aspirations (CHAGE, HSTUDY, CEDASP) in the government sector. The partial R-square of the first-stage achievement equation when including only these identifying instruments was 0.644 and they were jointly significant at much better than 1% level (F=66.9). In the private sector the identifying instruments were whether child does any vacation work or takes private home tuition (VACWRK, TAKESTU); the corresponding partial R-square here was 0.159 and the instruments were jointly significant at the 1% level (F=6.03). As seen in the bottom panel of Table 4, the validity of the instruments in both the government and private sectors was accepted in the Sargan test of over-identifying restrictions.

Table 5 columns [2] and [4] instrument teacher pay. Again we experimented, choosing as instruments dimensions of the status and human capital of teachers. Teacher characteristics were first averaged over all sample teachers within a school before being assigned to each sample student in the school. This again implies that only a few variables could be used as instruments for teacher pay, given the fewness of degrees of freedom. The instrumental variables we chose for teacher pay in the government sector were total experience and union membership (TOTEXP and MEMUNION). The partial R-square of the first-stage pay equation when including only these identifying instruments was 0.131 and the instruments were jointly significant at better than the 1% level. The instrumental variables chosen for teacher pay in the private sector were permanence of status and gender (PERMANENT and TESEX). The corresponding partial R-square was 0.197 in the private sector and the instruments were jointly significant at the 1% level. As seen in the bottom panel of Table 5, the validity of the instruments in both the government and private sectors was accepted in the Sargan test of over-identifying restrictions.

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significantly different from zero. Similarly for the case when testing whether schools pay performance-related pay,

Comparing Columns [3] and [4] in both Tables 4 and 5 we see that the effect of instrumenting is to reduce the size of achievement on pay, and that of pay on achievement, but in both cases there remains a significant effect in the private sector. How large is the effect? According to Table 4, an increase in achievement from one standard deviation below the mean to one standard deviation above raises private school teacher pay by 80%. According to Table 5, increasing private teacher pay from one standard deviation below mean pay to one standard deviation above raises student achievement by 22%.

There appears to be strong evidence both that there is performance related pay in the private sector and that such pay impacts on student achievement. In the next section we consider possible objections to these results.

4. Are unobservables important?

It is possible to argue that some unobserved factor in the achievement equation is biasing our estimate of the effects of pay on achievement. We would argue that the most obvious factors, which would be unobserved in most data sets, are the quality of the school, or the teacher, or the student. Our data set has an extensive set of controls for each of these attributes and even with this very full set of controls there is a clear positive effect of wages onto achievement in private schools. It could be argued that panel data would be preferable as, by construction, this would control for all the unobserved time invariant characteristics of student, school and teacher. However, in so far as the teacher pay term in the achievement equation is a relative pay term then it may well be a school fixed-effect, so it would be differenced out in panel data. In so far as it is a time-varying factor, using panel data would be preferable only if the measurement error associated with changes were sufficiently small to enable the data to

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i.e. when average student achievement is the endogenous variable in the teacher pay regression.

identify changes of achievement with changes in wages. While panel data would enable the analysis to be pushed further, we would argue that our controls for quality are sufficiently comprehensive to make doubtful an interpretation of the positive correlation as due to a common quality factor generating the result.

We can address the possibility of bias through omitted student ability still further than we have so far. In the previous section we argued that we had controlled for student quality by direct measures of ability and by numerous variables capturing the parental background of the students. It could be argued that a selection corrected model is required to properly allow for differences in the unobserved characteristics of pupils. As is well known, such models are subject to the problem that the results can be sensitive to the exclusion restrictions that are used to identify the achievement equation. We experimented with a range of exclusion restrictions. The lambda term from the probit was wholly insignificant in all the trials and the size and significance of the coefficient of pay was unaffected[8]. This is consistent with our earlier argument about the adequacy of our controls for ability. We interpret this as evidence that unobserved factors are not inducing a correlation between the error term and the instruments. We conclude that there is no evidence that our result is due to a failure to allow for omitted variables due to the selection of higher quality or more motivated students into private schools.

5. Interpreting the results for achievement

We have argued that for private schools there is convincing evidence for causation running from teacher's pay to achievement. We consider two potential interpretations of this result. The most popular explanation is that salaries proxy for teacher quality: raising wages

[8] The results are available from the authors. Kingdon's (1996b) study found that when controlling for selectivity of students into private and public schools, the selectivity term lambda was weakly significant (t=1.8 in private and t=-1.8 in the government) achievement functions when there were no controls for any school or teacher variables.

encourages better quality candidates to apply for teaching positions, thereby raising the average quality of teachers. A second interpretation comes from efficiency wage theory. Under this, higher wages improve student achievement by increasing teacher effort at any given level of teacher quality.

We test first for the teacher quality interpretation. We have already included as a measure of teacher quality the average division (or grade) that the teacher obtained in her various board/degree examinations. But it is arguable that there are several other dimensions of teacher quality, such as years of education, experience and pre-service training. If we find that inclusion of other teacher quality measures in the achievement production function reduces the size and significance of the wage coefficient, then the effect of wages on achievement can be interpreted as occurring via higher wages raising teacher quality. We find, however, that inclusion of teacher quality controls in the achievement function in Table 6, column [1], does not reduce the coefficient on the wage variable[9]. This suggests that wage is not capturing the effect of teacher quality.

Can the estimated achievement function be given an interpretation in terms of the literature on efficiency wages? Efficiency wage theory predicts that when monitoring worker effort is difficult, paying a worker higher than his opportunity wage elicits greater worker effort and higher effort is labor augmenting. In the test for efficiency wages that have used production functions (e.g. Levine, 1992) the Solow condition has been used to test if the

[9] While the 2SLS result in Table 5 tested for the possibility that the OLS coefficient on LNPAY is high due to endogeneity bias, the logic here is to see whether the OLS coefficient on LNPAY in Table 5 is high due to omitted variable bias, i.e. due to the fact that aspects of teacher quality are missing in Table 5. We experimented with including several different teacher quality variables other than total experience, years of teacher training and average division/grade obtained in the teacher's various examinations. These were years of teacher's education, square of teaching experience, subject matches the one taught, and whether teacher took exams as a regular candidate. It was not possible to include all of these variables together given the fewness of degrees of freedom as there are only 10 private schools in the sample. In order to conserve degrees of freedom we collapsed the two separate variables MINACAD and CLNUM into one variable, PPMINACAD which is per pupil minutes of academic instruction per week. In none of these experiments did the coefficient on wage fall below 0.30 and it continued to be significant at the 1% level.

coefficient on labor input is the same as the coefficient on the wage term[10]. We can carry out a similar test with our model. The test for efficiency wages is that the coefficient on the wage term should equal the coefficient on the time input per student. In Table 6 column [2] we report the results of using a measure of labor input per student (PPMINACAD), which is equal to the minutes of academic instruction provided per week (MINACAD) divided by class size (CLNUM). We test if the restriction implied by this particular form of the test for efficiency wages is met, namely that the coefficient on PPMINACAD and LNPAY are the same. It is clear from the regression that the restriction is accepted. This result permits the interpretation that in the private sector not only does pay impact on achievement but the private sector sets wages to elicit the optimal level of effort from the teachers.

6. Summary and Conclusions

Clearly the results reported in this paper need to be qualified. In any comparison across schools the possibility that results are sensitive to the unobservable characteristics of the school is important. We do not have panel data so we cannot use a school dummy to control for all the time invariant effects of the school. However our data set does allow controls for what have been regarded as the most important differences across schools, such as resources, teacher quality, student ability and home background. Private schools in our Indian data have a far higher volume of resources per student, their students are more able and the parents of the students richer. It is also the case that student achievement is much higher in the private sector. Given that the private schools are fee paying, none of this is a surprise. The contribution of this paper is to show that students in the private sector do better when their

[10] According to efficiency wage theory, firms that pay high wages are predicted to have higher productivity from high worker effort, low turnover etc. and employers will raise wages until the marginal benefit of higher wages (in terms of increased productivity) balances the increase in the wage bill. The test used by Levine and replicated

schools pay relatively more than similar type of schools - once allowance is made for factors that potentially improve pupil achievement in private schools. We considered two interpretations for this result. The first, namely that higher wages proxy for higher quality teachers, was not supported by the data. The second, namely that higher wages motivate higher teacher effort, had support in the data. We have argued that this is evidence for an efficiency wage pay structure in Indian private education. Monitoring of teacher effort is difficult and relative pay is effective at eliciting greater effort: performance related pay for teachers in private schools in India does improve student performance.

here tests the fundamental implication of efficiency wage theory that marginal wage increases raise productivity sufficiently to pay for themselves.

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TABLE 1 VARIABLE DEFINITIONS

Teacher status	
UNION	Member of a teacher union Y=1; N=0
PERMANENT	Permanent status Y=1; N=0
TESEX	Teacher is male Y=1; N=0
Teacher human capital	
TEDUYRS	Teacher's education in years
TOTEXP	Teaching experience in years
EXPSQ	Experience squared
TRAINING	Pre-service Training Y=1; N=0
Teacher quality	
DIVISION	Index of teacher quality. It is the average division/grade she obtained in her various degree and board exams, after assigning a value of 3 to first, 2 to second and 1 to third division.
NCLTAUT	Number of grades taught
SUBMATCH	Teaches subject of her specialization Y=1; N=0
REGEXAM	Teacher took most of her board exams as a Regular candidate? Y=1; N=0
Teacher pay	
GROSSPAY	Pay (rupees per month)
LNPAY	Log of pay
School quality	
JHS	Junior high school=1; Secondary school=0
MINACAD	Minutes of academic instruction per week
CLNUM	Class size
RESOURCE	Index of school resources. The index was constructed by giving a value of 1 for each of seventeen facilities such as availability of desks and chairs, blackboards, chalk, charts, playground, toilet, drinking water, musical instruments and educational equipment.
Child attributes	
ACHIEVE	Student's achievement score (total on numeracy and literacy tests)
CHAGE	Child's age (in months)
MALE	Child's gender MALE=1; FEMALE=0
CEDASP	Child's educational aspirations: index from 1 to 6 of the highest level to which child aspires, e.g. 1=up to grade 8; 2=up to grade 10; 4=first degree, etc.
HSTUDY	Weekly hours of home study
TRTIME	Travel time to school (minutes)
VACWRK	Child works out of school hours
TAKESTU	Student has private home tuition
NUMSIB	Number of siblings
Child ability	
SRAVEN	Score on Raven's test of ability or intelligence
Parental attributes	
PARHELP	Parents help with studies at home Y=1; N=0
MEDYRS	Mother's education in years
MEDYRSQ	MEDYRS squared
WEALTH	Index of household wealth. The variable was constructed by assigning the following values to owned assets: Car=50, scooter=15, video=15, fridge=6, telephone=5, TV=3, tape recorder, gas cooker=2 each and radio, bed(s), bicycle, and clock=1 each.
WEALTHSQ	WEALTH squared
BOOKHOM1	Less than or equal to 50 books in the house Y=1; N=0
BOOKHOM2	More than 50 books in the house Y=1; N=0
BOOKHOM3	More than 100 books in the house Y=1; N=0
LOWCASTE	Belongs to low caste Y=1; N=0
MUSLIM	Religion is Muslim Y=1; N=0

TABLE 2 TEACHER PAY EQUATION VARIABLES

		Govt.		Private	
		Mean	Sd	Mean	Sd
Teacher status					
UNION*	Member of a union	0.84	0.37	0.06	0.24
PERMANENT*	Permanent status	0.96	0.19	0.69	0.47
TESEX*	Teacher is male	0.47	0.50	0.16	0.37
Teacher human capital					
TEDUYRS	Teacher's education in years	14.89	1.36	15.28	1.08
TOTEXP	Teaching experience in years	17.01	8.32	11.60	9.15
EXPSQ	Experience squared	357.85	322.37	216.97	288.71
TRAINING*	Pre-service Training	0.97	0.17	0.87	0.34
Teacher quality					
DIVISION	Index of teacher quality	1.75	0.38	2.06	0.40
NCLTAUT	Number of grades taught	3.48	1.38	3.66	1.56
SUBMATCH*	Teaches specialization	0.46	0.50	0.61	0.49
REGEXAM*	Regular exam candidate?	0.72	0.45	0.94	0.24
Teacher pay					
GROSSPAY	Pay (rupees per month)	2482	329	1533	762
LNPAY	Log of pay	7.80	0.23	7.15	0.68
School quality					
JHS*	Junior high school	0.47	0.50	0.45	0.50
MINACAD	Minutes of academic instruction per week	1157	152	1482	367
CLNUM	Class size	35.28	17.32	41.22	7.38
RESOURCE	Index of school resources	5.84	2.90	11.94	3.20
Student achievement					
ACHIEVE	Average achievement score of class 8 students taught by the teacher	16.94	4.90	33.70	7.55
Number of Observations		104		67	

Note: Variables marked with an asterisk (*) are 0/1 variables so that their mean represents the proportion of 1's.

TABLE 3 STUDENT ACHIEVEMENT EQUATION VARIABLES

		Govt.		Private	
		Mean	Sd	Mean	Sd
Child achievement					
ACHIEVE	Student's achievement score	19.00	8.38	33.79	10.5
Child ability					
SRAVEN	Score on Raven's ability test	26.87	10.10	36.03	10.6
Child attributes					
CHAGE	Child's age (in months)	163.91	14.58	164.31	11.1
MALE*	Proportion of male students	0.46	0.50	0.63	0.5
CEDASP	Child's educational aspirations	4.23	1.38	5.06	1.1
HSTUDY	Weekly hours of home study	19.69	10.16	24.51	10.7
TRTIME	Travel time to school (minutes)	17.48	11.73	17.76	11.93
VACWRK*	Child works out of school hours	0.18	0.38	0.09	0.29
TAKESTU*	Student has private home tuition	0.37	0.48	0.28	0.45
NUMSIB	Number of siblings	4.46	1.70	3.28	1.45
Parental attributes					
PARHELP*	Parents help with studies at home	0.56	0.50	0.63	0.48
MEDYRS	Mother's education in years/10	0.71	0.46	1.11	0.45
MEDYRSQ	MEDYRS squared	0.71	0.64	1.43	0.81
WEALTH	Index of household wealth/10	1.41	1.09	3.95	2.35
WEALTHSQ	WEALTH squared	3.18	5.24	21.09	21.5
BOOKHOM2*	More than 50 books in the house	0.27	0.44	0.26	0.44
BOOKHOM3*	More than 100 books in the house	0.20	0.40	0.44	0.50
LOWCASTE*	Belongs to low caste	0.19	0.40	0.04	0.20
MUSLIM*	Religion is Muslim	0.29	0.45	0.12	0.32
Teacher variables					
DIVISION	Index of teacher quality	1.77	0.20	2.05	0.21
LNPAY	Log of gross pay	7.80	0.13	7.12	0.65
School quality					
JHS*	Junior High School	0.29	0.46	0.51	0.50
MINACAD	Minutes of academic instruction per week	1161.47	146.14	1454.78	329.30
CLNUM	Class size of the sample class 8	44.11	16.49	41.03	8.23
PPMINACAD	Per pupil minutes of academic instruction per week (MINACAD / CLNUM)	31.63	18.72	37.04	11.27
RESOURCE	Index of school resources	6.87	2.79	11.96	3.23
Number of observations		542		360	

Note: Variables marked with an asterisk (*) are 0/1 variables so that their mean represents the proportion of 1's.

TABLE 4 LN (TEACHERS PAY)

	GOVT.				PRIVATE			
	OLS [1]		IV [2]		OLS [3]		IV [4]	
INTERCEPT	6.87	[7.5]***	6.75	[7.2]***	-0.06	[0.1]	-0.49	[0.4]
Teacher status								
UNION	0.06	[2.2]**	0.06	[2.2]**	-0.54	[4.0]***	-0.53	[3.7]***
PERMANENT	0.38	[1.4]	0.38	[1.3]	0.31	[3.5]***	0.30	[3.3]***
TESEX	-0.06	[1.8]*	-0.06	[1.8]*	-0.07	[1.8]*	-0.08	[2.3]**
Teacher human capital								
TEDUYRS/100	0.69	[0.9]	0.79	[1.1]	1.08	[0.8]	1.61	[0.9]
TOTEXP	0.02	[2.9]***	0.02	[3.0]***	-0.01	[0.8]	-0.01	[0.8]
EXPSQ/1000	-0.47	[2.5]**	-0.46	[2.5]**	0.39	[1.3]	0.42	[1.2]
TRAINING	0.60	[1.5]	0.59	[1.5]	0.17	[4.2]***	0.16	[4.4]***
Teacher quality								
Ln (DIVISION)	0.07	[0.5]	0.12	[0.5]	-0.76	[0.9]	-0.52	[0.6]
NCLTAUT	-0.01	[1.1]	-0.01	[1.1]	-0.02	[1.7]	-0.02	[1.7]
SUBMATCH/100	0.32	[0.1]	0.22	[0.1]	4.91	[1.5]	5.48	[1.6]
REGUEXAM	-0.04	[0.8]	-0.04	[0.9]	0.19	[0.9]	0.22	[1.1]
School quality								
JHS	-0.07	[1.6]	-0.09	[1.2]	-0.47	[3.5]***	-0.45	[2.9]**
Ln (MINACAD)	-0.09	[0.7]	-0.06	[0.5]	0.27	[1.7]	0.38	[1.9]*
Ln (RESOURCE)	-0.05	[1.6]	-0.04	[1.3]	0.05	[0.3]	0.11	[0.5]
Student achievement								
Ln (ACHIEVE)	0.17	[1.3]	0.11	[0.7]	1.52	[5.8]***	1.30	[3.2]***
N	104		104		67		67	
R^2	0.56		0.55		0.95		0.95	
Sargan [p value]			0.16				0.23	

Robust t-values are in [ ] parentheses, allowing for correlation between observations from the same school.

In column [2] the instruments used for Ln(ACHIEVE) were CHAGE, HSTUDY and CEDASP.
In column [4] the instruments used for Ln(ACHIEVE) were VACWRK and TAKESTU.

* represents significance at the 10% level, ** at the 5% level, and *** at the 1% level.

TABLE 5 LN (STUDENT ACHIEVEMENT)

	GOVT.				PRIVATE			
	OLS		2SLS		OLS		2SLS	
	[1]		[2]		[3]		[4]	
INTERCEPT	-1.55	[0.9]	-1.87	[1.0]	-0.05	[0.1]	-0.41	[0.6]
Student ability								
Ln (SRAVEN)	0.26	[4.2]***	0.26	[4.3]***	0.24	[6.4]***	0.25	[7.7]***
Student attributes								
CHAGE/100	-0.43	[2.7]**	-0.43	[2.7]**	-0.21	[0.9]	-0.22	[0.9]
MALE	0.10	[2.1]**	0.10	[2.2]**	0.17	[3.3]***	0.15	[2.8]**
CEDASP/100	-0.62	[0.6]	-0.65	[0.6]	2.77	[1.5]	2.96	[1.6]
HSTUDY/100	0.52	[2.3]**	0.52	[2.2]**	0.34	[3.8]***	0.29	[3.1]***
TRTIME/100	0.14	[0.7]	0.15	[0.8]	0.00	[0.0]	0.00	[0.1]
VACWRK	-0.09	[1.3]	-0.09	[1.3]	-0.10	[2.0]*	-0.10	[2.1]*
TAKESTU/100	-1.80	[0.4]	-1.76	[0.4]	-8.40	[4.2]***	-8.53	[4.6]***
NUMSIB/100	0.12	[0.1]	0.13	[0.1]	-3.49	[2.5]**	-3.80	[2.6]**
Parental attributes								
PARHELP/100	-3.90	[1.6]	-3.88	[1.6]	-1.33	[0.3]	-2.37	[0.6]
MEDYRS	-0.10	[1.1]	-0.10	[1.1]	-0.07	[0.9]	-0.04	[0.5]
MEDYRSQ/100	0.07	[1.0]	0.07	[1.0]	0.04	[1.1]	0.03	[0.8]
WEALTH	0.16	[2.7]**	0.16	[2.7]**	0.03	[0.9]	0.04	[1.0]
WEALTHSQ/100	-2.29	[2.1]*	-2.30	[2.1]**	-0.22	[0.7]	-0.27	[0.9]
BOOKHOM2	0.06	[1.3]	0.06	[1.3]	0.00	[0.1]	0.01	[0.3]
BOOKHOM3	0.09	[2.7]**	0.09	[2.7]**	0.03	[0.8]	0.04	[1.1]
LOWCASTE	-0.16	[3.3]***	-0.15	[3.3]***	-0.03	[0.4]	-0.02	[0.2]
MUSLIM	-0.05	[1.2]	-0.05	[1.2]	0.01	[0.2]	0.01	[0.3]
School and teacher quality								
JHS	-0.28	[4.9]***	-0.28	[4.6]***	0.34	[4.4]***	0.34	[4.2]***
Ln (DIVISION)	0.53	[2.1]*	0.51	[2.0]*	1.69	[3.2]***	2.08	[4.0]***
Ln (RESOURCE)	0.18	[3.4]***	0.18	[3.4]***	-0.06	[1.7]	-0.00	[0.0]
Ln (MINACAD)	0.50	[3.1]***	0.50	[3.1]***	-0.02	[0.2]	0.14	[1.1]
Ln (CLNUM)	-0.12	[1.8]*	-0.12	[1.6]	-0.13	[0.9]	-0.25	[1.9]*
Teacher pay								
Ln (PAY)	0.05	[0.2]	0.09	[0.4]	0.30	[5.8]***	0.18	[2.5]**
N	542		542		360		360	
R^2	0.4307		0.4306		0.6375		0.6339	
Sargan [p value]			0.2860				0.1058	

Robust t-values in [ ] parentheses, allowing for correlation between observations from the same school. In column [2] the instruments used for Ln(PAY) were TOTEXP and UNION. In column [4] the instruments used for Ln(PAY) were PERMANENT and TESEX. * represents significance at the 10% level, ** at the 5% level, and *** at the 1% level.

TABLE 6 LN (ACHIEVEMENT) FOR PRIVATE SECTOR ONLY

	OLS		2SLS	
INTERCEPT	-0.90	[1.5]	-0.77	[1.0]
Student ability				
Ln (SRAVEN)	0.23	[6.1]***	0.25	[7.6]***
Student attributes				
CHAGE/100	-0.22	[1.6]	-0.19	[0.8]
MALE	0.15	[4.6]***	0.15	[2.9]**
CEDASP/100	2.89	[2.4]**	2.93	[1.6]
HSTUDY/100	0.31	[2.5]**	0.27	[3.0]**
TRTIME/100	0.01	[0.1]	0.01	[0.1]
VACWRK	-0.10	[2.3]**	-0.10	[2.1]**
TAKESTU/100	-7.01	[2.3]**	-7.93	[3.9]**
NUMSIB/100	-3.39	[3.2]***	-3.86	[2.7]**
Parental attributes				
PARHELP/100	-1.15	[0.4]	-2.30	[0.7]
MEDYRS	-0.03	[0.3]	-0.03	[0.3]
MEDYRSQ/100	1.48	[0.3]	2.60	[0.7]
WEALTH	0.03	[1.3]	0.04	[1.0]
WEALTHSQ/100	-0.22	[0.9]	-0.27	[0.8]
BOOKHOM2	0.01	[0.3]	0.01	[0.4]
BOOKHOM3	0.04	[1.1]	0.05	[1.1]
LOWCASTE	-0.04	[0.7]	-0.02	[0.3]
MUSLIM	0.01	[0.3]	0.01	[0.4]
School and teacher quality				
JHS	0.36	[5.2]***	0.32	[5.4]***
Ln (DIVISION)	1.76	[3.3]***	1.87	[5.2]***
Ln (RESOURCE)	-0.09	[1.0]	0.001	[0.0]
Ln (PPMINACAD)	0.15	[1.1]	0.18	[4.8]***
TOTEXP/100	0.26	[0.7]		
TRAINING	-0.26	[1.4]		
Teacher pay				
Ln (PAY)	0.30	[4.6]***	0.18	[4.8]***
RESTRICT			0.0022	[0.0] **
N	360		360	
R^2	0.62		0.63	
Sargan [p value]	--		0.075	

Robust t-values in [ ] parentheses, allowing for correlation between observations from the same school.
Both columns include labor input per pupil instead of total labor input. Column [2] imposes the restriction, which is accepted, that the coefficients on Ln (PPMINACAD) and Ln (PAY) are equal. RESTRICT is the value of the Lagrange multiplier used to impose the restriction. * represents significance at the 10%, ** at the 5%, and *** at the 1% level.