Testing implications of a tournament model of school district salary schedules

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Abstract:
Using panel data on the salary schedules of public school teachers and administrators, I look for evidence of a tournament wage structure. A tournament model is presented, where teachers compete for promotion to administrators. Districts can create incentives for teachers by offering either a higher pay premium for promotion or a larger probability of promotion. The model predicts an inverse relationship between these two values. Evidence supporting this prediction is found in the data. In contrast, an alternative model of incentive pay, where returns to seniority substitute for imperfect monitoring, is not supported empirically. This result is consistent with intuition that tenure protections make it hard for districts to fire shirking teachers, making returns to seniority a poor method of providing incentives.
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Article:

1. Introduction

A great deal of debate is centered on numerous recently implemented or proposed incentive pay, or “pay-for-performance” initiatives for public school teachers, in which teacher pay is linked to student outcomes like test scores or attendance.[1] As the impacts of these explicit incentive pay programs are being studied, it remains possible that salary schedules of teachers and administrators without explicit incentive pay schemes may contain implicit incentives in them to elicit teacher effort. One possible avenue for these incentives is through a tournament model, where teachers compete for positions as school administrators. If the salary increase for being promoted to an administrative position is sufficiently large, and if promotion depends on a teacher’s performance, then the opportunity for advancement provides an incentive for teachers to increase their effort levels.

The classic tournament model (Lazear & Rosen, 1981) shows that firms can provide incentives to all workers through compensation schemes that pay according to a worker’s ordinal rank rather than her productivity, and this contract can provide an efficient allocation of resources. Malcomson (1984) shows that the payoffs to tournament promotion depend on the probability of winning the tournament. Empirical evidence in support of this theory comes from tournaments with a single winner, where it has been shown that the larger the number of contestants (i.e. the smaller the fraction of contestants winning), the higher the prize differential for winning. Main, O’Reilly, and Wade (1993), Eriksson (1999) and Conyon, Peck, and Sadler (2001) verify this with respect to competition for promotion to CEO.[2]

The purpose of this paper is to test whether the pay schedules of teachers and administrators exhibit evidence of a tournament. I develop a two-period principal-agent tournament model and use it to show that, in the optimal contract, a district trades off between higher promotion probability and higher salary differential between administrators and teachers. The promotion probability is measured by the ratio of administrators to teachers in a district. Using panel data on the wage schedules and teacher/administrator ratios of school districts, I test this relationship at the district level.

An alternative method of providing incentive pay to teachers may come from the returns to seniority found explicitly in most public school teachers' contracts, discouraging workers from shirking by offering greater rewards if they stay on the job. Lazear's (1979,198 1) model of deferred compensation, where workers are paid less than their marginal productivity when young and more when old, has been verified empirically in previous studies (e.g., Kotlikoff & Gokhale, 1992), though never with teacher salaries. If this is the case with contracts for teachers, then returns to seniority may be an efficient way to pay teachers. To determine if returns to seniority are being used as incentive pay, one can look at how workers are monitored to see if those who are monitored more closely are offered a flatter wage-seniority profile. I also test this model, using as a proxy for monitoring intensity the ratio of teachers to school administrators, coordinators, or supervisors.

This paper can be understood in relation to Ballou and Podgursky (2002, hereafter "BP"), who also investigate the determinants of returns to seniority among public school teachers. The factor which they find to be the most important determinant is rent-seeking by teachers' unions. They also offer three alternate explanations for returns to seniority, which they dismiss without testing: human capital, where the wage profile represents growth in teacher productivity; the Lazear (1979, 1981) model of imperfect monitoring; and turnover costs (Salop & Salop,1976). Their rent-seeking hypothesis is supported by the data, which show that unionized districts offer higher returns to seniority than non-unionized districts.

This paper makes two contributions to the discussion begun by BP, one minor and one major. The minor contribution is that I test BP's imperfect monitoring explanation for returns to seniority, and I find no empirical support for it. This is consistent with BP's intuition that because of tenure laws, shirking teachers are hard to fire. The major contribution that this paper makes is offering another explanation for teacher salary schedules, one based on a tournament model as described above. This model is tested using data on salaries of both teacher and school administrators, and the results verify the predictions of the model.

The next section of the paper presents the tournament model. Section 3 describes the data, and Section 4 presents empirical results.

2. Model

The model is similar to the two-player tournament model of Lazear and Rosen (1981). That model has one winner and one loser; the model here has a continuum of workers with a fraction of winners. The winners are those teachers promoted to principals, and the losers are those who stay on as teachers. I show that firms provide incentives to workers either through a larger fraction of workers winning or through a higher payout to winners. These methods of incentives are substitutes, so the ratio of administrators to teachers should be negatively correlated with the pay premium for administrators. Also, the model predicts that the payoff to the losers is uncorrelated with the fraction of winners. That is, the returns to seniority for employees who stay on as teachers are uncorrelated with the ratio of administrators to teachers. This prediction conflicts with a prediction of the imperfect monitoring model, thus providing a way to test the two theories against each other.

Suppose that a firm employs workers for two periods with perfect monitoring. The firm offers advancement to workers in the second period based on their (perfectly observed) effort in the first period. Let w0 be the first period wage, and w1 and w2 be the winners' and losers' second period wages, respectively. Workers have a utility function that increases in wages and decreases linearly in effort: $U = v(w_0) - e_i + \beta[Pv(w_1) + (1-P)v(w_2)]$, where P is the probability of being promoted. Since monitoring is perfect and promotion depends only on worker effort in the first period, effort in the second period is irrelevant. Worker i chooses an effort level e_i of either zero or one. The promotion probabilities are based on this effort level; let $P0$ be the probability of promotion given $e_i = 0$ and P_1 be the probability given $e_i = 1$.

The firm offers promotions only to those workers with a high effort level in the first period, and the fraction of those workers promoted is q. That is, $P_0 = 0$ and $P_1 = q$. Worker utility for each choice of effort is thus

$$U(e=0) = v(w_0) + \beta v(w_2)$$
$$U(e=1) = v(w_0) - 1 + \beta(qv(w_1) + (1-q)v(w_2))$$

Workers have a reservation utility of $v(w_r)$. The firm chooses w_1 and w_2, the wages of the winners and losers, respectively. If the firm wants to induce high effort from all workers, its maximization problem is

$$\max_{w_1,w_2} \pi(1) - w_0 + \beta[\pi(1) - qw_1 - (1-q)w_2]$$

such that

$$v(w_0) - 1 + \beta(qv(w_1) + (1-q)v(w_2)) \geq v(w_r)$$
$$v(w_0) - 1 + \beta(qv(w_1) + (1-q)v(w_2)) \geq v(w_0) + \beta v(w_2)$$

The first inequality is the participation constraint, ensuring that workers prefer the contract to not working at all. The second inequality is the incentive constraint, ensuring that workers prefer a high effort level over a low effort level.

It can be shown that both constraints bind. Solving the model thus yields the following solutions, expressed in terms of the inverse of the utility function $v^{-1}(\cdot)$.

$$w_1 = v^{-1}\left(\frac{1}{\beta q} + \frac{1}{\beta}(v(w_r) - v(w_0))\right)$$

$$w_2 = v^{-1}\left(\frac{1}{\beta}(v(w_r) - v(w_0))\right).$$

These equations generate two key testable predictions. First, the returns to promotion, expressed as w_1/w_2, are negatively correlated with *q*, the fraction of workers promoted ($\partial(w_1/w_2)/\partial q < 0$). This result is a generalization of a prediction in Malcomson (1984) stating that prize spread increases with tournament size in tournaments with one winner.[3] What really matters to the workers is their probability of promotion. In tournaments with only one winner, this probability is inversely related to the number of contestants; more generally, this probability increases in the number of promotions offered and decreases in the number of contestants .[4] Second, the returns to seniority for the losers, expressed as w_2/w_0, is independent of *q* ($\partial(w_2/w_0)/\partial q = 0$). That is, the fraction of winners has no effect on the payout to the losers. In this model employers are not trading off between returns to seniority and number of promotions; all incentives arise from the tournament. [5]

I map this model onto the data by calling administrators the winners of the tournament and experienced teachers the losers of the tournament. Hence the two predictions of the model are that the ratio of administrator salary to experienced teacher salary is negatively correlated with the ratio of the number of administrators to teachers, and that the returns to seniority for teachers, measured as a ratio of experienced teachers' salaries to beginning teachers' salaries, are not correlated with the ratio of administrators to teachers.

I will also test the predictions of an alternate model, one in which imperfect monitoring by the principal leads to an increase in second period wages for the agent. The model is a simplified version of the model in Lazear (1979, 1981). Here I summarize the key predictions. Imperfect monitoring is modeled by a probability of detection *p*. If shirking workers are detected, they are fired. Returns to seniority are defined as the ratio of the second period wages to the first period wages. Under the optimal contract, a higher probability of detection reduces the returns to seniority. Intuitively, the harder it is for the firm to catch the worker cheating, the more the firm has to pay him to induce him to work. Note that this prediction conflicts with the second prediction of the tournament model above, so that the models can be tested against each other.

The relevance of the monitoring theory to the market for teachers is complicated by the presence of teacher tenure, and the associated difficulty of firing teachers. The model assumes that if a shirking teacher is caught she is fired. The data do not include information on tenure laws, but they do mention the number of teachers fired. From the 1999–2000 Schools and Staffing Survey data, the average number of teachers "dismissed for poor performance" in a district is 1.94, compared to an average district teacher count of 409.7, a firing rate of less than half of one percent. Fossey (1998) claims that from 1987 to 1995 only 55 teachers in the whole nation lost their teaching credentials due to incompetence, and in 39 states no teachers lost theirs. Such a low firing rate suggests that tenure laws have an impact on a district's ability to fire teachers. If so, the monitoring model is not likely to accurately describe the dynamic incentives faced by teachers. The empirical work below shows that the data offer very little support to the monitoring model, and teacher tenure protections are likely part of the reason.

Table 1
Summary statistics

Teacher salary data from SASS[a]	
BA no experience	23133 (6074)
BA 10 years experience	32241 (6813)
MA 20 years experience	34396 (9463)
District demographic data from SASS	
Poverty rate	0.140 (0.105)
At-risk rate	0.404 (0.239)
Minority rate	0.268 (0.276)
Union representation rate	0.680 (0.467)
Charter school rate[b]	0.0814 (0.273)
Student teacher ratio	15.4 (9.62)
Total enrollment	6930 (28000)
Average school size	445 (281)
Proportion of community high school graduates	0.702 (0.232)
District staff and salary data from CCD	
Average administrator salary	76868 (93333)
Administrators per teacher	0.0575 (0.0494)
Instructional coordinator or supervisors per teacher	0.0166 (0.0342)

Mean values (standard deviations in parentheses).

[a] Salaries are in real US$ 2003. BA no experience is reported in all 3 years of SASS; BA 10 years experience is not reported in 1993–1994; MA 20 years experience is not reported in 2003–2004.

[b] Not reported in 1993–1994.

3. Data

The data come from two sources, and the most relevant summary statistics are provided in Table 1. The primary data sources are the most recent three cycles of the Schools and Staffing Survey (SASS) restricted-use data, administered by the National Center for Education Statistics, for the school years 1993–1994,1999–2000, and 2003–2004.[6] While these data come from several different surveys that were given to teachers, principals, schools, and school districts, both public and private, the unit of observation used here is the public school district. Districts can be matched up across years, but not every district is available in every year, so the data set is an unbalanced panel.[7] 98% of public school districts use a salary schedule.[8] The measures of returns to seniority used are taken from those salary schedules. I use two different measures: first, the ratio of the salary of a teacher with an MA and 20 years experience to the salary of a teacher with a BA and no experience (MA20/BA0); second, the ratio of the salary of a teacher with a BA and 10 years experience and the salary of a teacher with a BA and no experience (BA10/BA0). Because in the 1993–1994 survey districts were not asked the salary of a teacher with a BA and 10 years experience, and in the 2003–2004 survey districts were not asked the salary of a teacher with an MA and 20 years experience, I cannot use each of these measures of returns to seniority in all 3 years. Table 1 presents the average and standard deviation of the salary levels for each step of the schedule, in constant US$ 2003. The average teacher with a BA and 10 years experience earns about an extra US$ 9000 per year, or 40% more than the average teacher with a BA and no experience. For teachers with an MA, the average pay increase after 20 years is about US$ 11000 per year, or 50% more than a starting teacher with an MA.

The SASS data also include demographic and other data that are used as controls. Among children in the district, the rates of poverty, at-risk status,[9] and minorities are available. In about 70% of these districts, teachers are represented by unions, and about 8% of districts have charter schools (though this was not asked in the 1993–1994 survey). The average student-teacher ratio is 15:1, and the average district has about 7000 students. The average number of students per school is 445, and the average proportion of the district's adults who are high school graduates is about 70%. These data also include the district's state and MSA status.

Finally, additional district-level data are available from the Common Core of Data (CCD) survey, also administered by the NCES.[10] The main prediction of the tournament model is about the returns to promotion, which is calculated by comparing teacher salaries to administrator salaries. A district's average administrator salary is calculated by dividing the total amount of expenditure on school administration salaries to the total number of school administrators. The average administrator salary computed at the district level is US$ 77000, more than twice the average teacher salary, even for teachers with an MA. Thus, returns to promotion are indeed significant. The CCD data are also used to find the average number of administrators per teacher. This is used in testing the tournament model, and it is also used as one proxy for monitoring intensity in the monitoring model. The other monitoring proxy is the ratio of instructional coordinators or supervisors to teachers. The average district has about one administrator for every 20 teachers and one instructional coordinator or supervisor for every 100 teachers. While these variables are clearly imperfect measures of the true resources devoted to monitoring teachers, they do provide a useful proxy. The more administrators per teacher, for example, the less likely it is that a teacher who shirks will go unnoticed.

4. Empirical results

Before testing the main predictions of this paper's tournament model, I can first use these data to test the prediction of the imperfect monitoring model that the level of monitoring intensity is negatively correlated with returns to seniority for teachers. The measures of the returns to seniority used as the dependent variables are the ratios MA20/BA0 and BA10/BA0.[11] The two proxies for monitoring intensity are the ratios of administrators or instructional coordinators and supervisors to teachers. A dummy for unionization is included, to compare the results with other studies.

The empirical equation being estimated is the following:

$$RTS_{it} = \gamma P_{it} + X_{it}\beta + c_i + e_{it}$$

The dependent variable RTS_{it} is the measure of returns to seniority awarded in district i in year t, and P_{it} is the proxy for district i's probability of catching workers who shirk. Because I use panel data, I add an unobserved district effect c_i, which can control for any district-level features that are orthogonal to the control variables but remain constant over time. The coefficient of interest is γ, which measures how an increase in monitoring intensity affects returns to seniority. The monitoring theory says that the expected sign of γ is negative. The vector X_{it} contains other controls that may also affect the returns to seniority. This vector includes demographic characteristics of the district that may impact human capital accumulation, state-level dummies, and an indicator for whether or not teachers are unionized in the district.

Results from the random effects model regressions are presented in Table 2. In addition to the demographic controls reported, state and metropolitan status dummies are included, and they are jointly significant in all regressions. Columns 1 and 2 present regressions using BA10/BA0 and MA20/MA0 as the dependent variable, respectively. Because of the data availability in each year of the survey, the BA10/BA0 measure is available only for the 1999–2000 and 2003–2004 data, and MA20/BA0 is available only for 1993–1994 and 1999–2000. The demographic controls offer some mixed results. Consistent with the previous literature cited above, the presence of unions in a district tends to increase the returns to seniority, though this is significant only for teachers with an MA.[12] The main results, the coefficients on the proxies of monitoring probabilities, do not robustly support to the monitoring model's prediction. While I find a significant negative correlation between the ratio of coordinators to teachers and returns to seniority, it is only significant for teachers with a BA. The correlation between the ratio of administrators to teachers and returns to seniority is actually positive, though not significantly different from zero. This lack of a significant coefficient on the ratio of administrators to teachers supports the tournament model, which predicts no correlation between this ratio and returns to seniority.

Table 2
Determinants of returns to seniority

	(1) BA10/BA0	(2) MA20/BA0	(3) BA10/BA0 IV	(4) MA20/BA0 IV	(5) Teacher average
Administrators per teacher	.0554 (.0362)	.0398 (.0494)	−.870 (1.42)	4.04 (3.36)	5071** (848)
Coordinators per teacher	−.243** (.0715)	−.0490 (.0736)	–	–	349 (1333)
Poverty rate	.0768** (.0198)	.000541 (.000281)	.185** (.0624)	.00352 (.00243)	4.74 (5.43)
At-risk rate	.00460 (.00780)	−.0365** (.00951)	.0101 (.00736)	−.0585 (.0572)	487** (169)
Minority rate	.00374 (.00794)	.0266** (.00989)	−.0291** (.0101)	−.0300 (.0354)	1178** (163)
Union representation	.00900 (.00523)	.0449** (.00673)	−.00598 (.00481)	.0277** (.00984)	−165 (112)
Charter school	.00716 (.00549)	–	−.00461 (.0145)	–	–
Student teacher ratio (thousands)	−.00916 (.195)	.588 (.566)	3.21 (5.14)	−12.1 (10.3)	−23.9** (5.02)
Total enrollment (thousands)	.0000407 (.0000616)	−.0000350 (.0000880)	–	–	2.18 (1.21)
Average school size	.0000223** (.00000652)	.0000861** (.00000962)	.00002443* (.0000106)	.000150** (.000047)	.766** (.145)
High school graduation rate	.0244 (.0130)	−.000723** (.000213)	.0593 (.0833)	−.00152 (.000866)	−44.1** (4.13)
Constant	1.12** (.0169)	1.32** (.0185)	1.11** (.0499)	1.28** (.044)	5069** (271)
z-Statistic on first-stage instrument (*p*-value)	–	–	1.62 (.104)	1.64 (.101)	–
R-squared	0.459	.532	.417	.341	.137
N	6425	8537	6425	8537	10980

Standard errors of coefficient estimates appear in parentheses. Columns (1) and (3) use data from 1999 to 2000 and 2003 to 2004; columns (2) and (4) use data from 1993 to 1994 and 1999 to 2000; column (5) uses data from all three surveys. Questions about charter schools were not asked in the 1993–1994 survey, and hence that variable is absent from columns (2), (4) and (5). In the IV estimates of columns (3) and (4), total enrollment is the excluded instrument.

* Indicates significance at the 95% confidence level.

** Indicates significance at the 99% confidence level.

Because districts are choosing both the returns to seniority built into their salary schedules and these measures of monitoring intensity, endogeneity may be a problem in these regressions. An appropriate instrument would affect the ratio of administrators to teachers but not directly affect the returns to seniority. One possibility is the size of the school district as measured by total enrollment. Districts may have economies of scale; a larger district may require less administrative work per teacher than a smaller district. District size is unlikely to directly affect returns to seniority, though. Columns 1 and 2 show that this variable is uncorrelated with returns to seniority in the random effects regressions. In columns 3 and 4, I run IV random effects regressions using total enrollment as an instrument for administrators per teacher (because I only have one instrument, I exclude the other monitoring proxy, the ratio of coordinators per teacher, from these regressions). The *z*-statistic of the coefficient on the instrument in the first-stage regression is reported, and it is significant at the 90% level. The IV coefficient on the endogenous regressor, the ratio of administrators per teacher, is not significant. The presence of unions remains significantly positive for teachers with an MA, and average school size is significantly positive.

Finally, the BA10/BA0 and MA20/BA0 ratios may not offer enough detail to represent the true returns to seniority in a school district, since those are just "snapshots" of salaries offered with a particular seniority level. With the restricted-use SASS data, I am able to match up the district surveys with individual teacher surveys. Each teacher is asked her salary and the number of years she has been teaching in public schools. The ratio of these two variables (i.e. salary per year of seniority) is an alternative measure of returns to seniority. For each district, I average this measure for all of the teachers surveyed who work in that district. The mean number of teachers surveyed per district is about nine. The mean value of this teacher-level measure of returns to seniority is about US$ 5400 per year of experience. The results from a random effects regression using this measure of returns to seniority as a dependent variable are presented in column 5 of Table 2. Because the scale of this measure is many orders of magnitude higher than the BA10/BA0 or MA20/BA0 measures, the magnitudes of the coefficients in column 5 are high compared to the other columns. This measure is not correlated with the ratio of coordinators per teacher, but it is positively correlated with the ratio of administrators per teacher, which is inconsistent with the prediction of the monitoring model.[13]

Table 3
Determinants of returns to promotion

	(1) CCD	(2) CCD w/benefits	(3) SASS	(4) CCD IV	(5) CCD w/benefits IV
Administrators per teacher	−23.7** (.813)	−23.9** (.792)	−.165** (.0714)	−68.1** (25.7)	−65.7* (26.4)
Poverty rate	.000299 (.00379)	−.0000829 (.00369)	−.00000821 (.000404)	−.0246* (.0120)	−.0229 (.0122)
At-risk rate	.0621 (.127)	.0205 (.124)	−.0273* (.0133)	.896 (.489)	.839 (.499)
Minority rate	.265* (.122)	.252* (.119)	.00485 (.0133)	1.16* (.557)	1.06 (.546)
Union representation	−.116 (.086)	−.102 (.0835)	−.0197* (.00931)	−.888** (.164)	−.863** (.164)
Student teacher ratio	.0369** (.00761)	.0326** (.00741)	.000496 (.000801)	.220** (.0826)	.203* (.0845)
Total enrollment (thousands)	−.00144 (.000859)	−.00136 (.000836)	−.0000972 (.00111)	–	–
Average school size	−.000411** (.000122)	−.000367** (.000119)	.000188** (.000013)	−.000788* (.000317)	−.000777* (.000324)
High school graduation rate	−.0200** (.00291)	−.0182** (.00284)	−.000906** (.000306)	−.0346** (.00825)	−.0320** (.00846)
Constant	3.76** (.209)	3.87** (.203)	1.55** (.0243)	3.46** (.563)	3.65** (.528)
z-Statistic on first-stage instrument (*p*-value)	–	–	–	3.00 (.003)	2.83 (.005)
R-squared	.200	.201	.178	.153	.156
N	7070	7070	8375	7271	7271

Standard errors of coefficient estimates are in parentheses. Data are from the 1993–1994 and 1999–2000 surveys. In the IV estimates of columns (4) and (5), total enrollment is the excluded instrument.

* Indicates significance at the 95% confidence level.

** Indicates significance at the 99% confidence level.

I now test the main prediction of the tournament model: the ratio of administrators to teachers is negatively correlated with the returns to promotion. These returns, however, are not the same as the returns to *seniority*. In fact, the wage paid to senior teachers in this model is the wage of the losers, since senior teachers are those not promoted to administrator.[14] The winners' wage is the average wage paid to administrators in a district. This is measured in three different ways. First, the CCD reports a district's total expenditure on salaries for school administration and the total number of school administrators. The ratio of these two values is used in the "CCD" measure of returns to promotion. These values are used in generating the summary statistics in Table 1, and in the regressions in columns 1 and 4 of Table 3. Second, the CCD also reports total expenditure on benefits for school administration. Columns 2 and 5 of Table 3 include benefits as well as salary in the measure of returns to promotion. Third, one component of the SASS survey is given to school principals, who are asked their salary. For each district, I average the salaries for each principal in the district, where on average each district has 1.7 principals surveyed. This measure of administrator salary is used in the "SASS" measure of returns to promotion in column 3. In each of the five columns of Table 3, the average administrator's salary is divided by the salary of a teacher with an MA and 20 years of experience to create the measure of returns to promotion.[15] Returns to promotion are regressed on all of the controls used in the previous sections, including the ratio of administrators to teachers. The estimating equation is

$$RTP_{it} = \gamma q_{it} + X_{it}\beta + c_i + e_{it}$$

The dependent variable RTP_{it} is the returns to promotion for district i as defined above. The coefficient of interest is γ, the coefficient on the ratio of administrators to teachers q_{it}. The theory predicts that this coefficient is negative. The same set of control variables X_{it} and a district unobserved effect c_i are included.

Table 3 reports the regression results. Though not reported, all regressions also included state and metropolitan status dummies. Columns 1–3 are random effects regression estimates, while columns 4–5 are random effects IV estimates. Like in Table 2, the effects of the demographic control variables are mixed. The fraction of minority students in a district increases the returns to promotion, but this is not found with a high level of significance across specifications. The presence of teacher unions reduces the returns to promotion, a not surprising result since unions represent teachers and not administrators. Average school size and the rate of high school graduates in a community reduce the returns to promotion in all specifications except for column 6. In fact, none of the coefficients in column 6 are significant, and the *R*-squared value is very low. This is likely due to the fact that the "SASS" measure of administrator salary, taken as an average of the principals in a district who happen to be surveyed, is very noisy. In column 3, which uses this measure as a dependent variable but without IV, even the coefficients which are significant tend to be small in magnitude compared to those in the other columns.

The coefficient of interest is that on the ratio of administrators to teachers. In all five regressions, this value is significantly less than zero and quite large. The value of -23.7 in column 1 means that a one standard deviation increase in the ratio of administrators to teachers (an increase of .0494) will decrease the returns to promotion by 1.19, compared to a mean value of 1.88. In column 2, where the value of benefits paid to both administrators and teachers is included in the calculation of returns to promotion, the coefficient is almost identical. Column 3 uses the measure of returns to promotion from individual principals' SASS survey responses. Though the mean value of this dependent variable is slightly less than those in the other columns (1.45 versus 1.88), the coefficient estimate is much less. It remains highly significant.

The IV estimates in columns 4 and 5 use total enrollment to instrument for the ratio of administrators to teachers, just as in the returns to seniority regressions in Table 2. The key assumptions in these regressions are that a district's size affects the administrator to teacher ratio because of economies of scale in school districts, and that a district's size does not directly affect the returns to promotion. The first assumption is verified by looking at the *z*-statistic of the coefficient on the instrument from the first-stage regression, which is highly significant in columns 4 and 5. The second assumption is suggested by the lack of significant correlation between total enrollment and returns to promotion seen in columns 1–3. Intuitively, there is no reason why district size should affect the returns to promotion. The results from the IV estimates also support the tournament theory. The coefficients on the ratio of administrators to teachers are significantly negative in columns 4 and 5. Though the point estimates are more negative than those in columns 1 and 2, the level of significance is lower.[16]

The empirical predictions of the tournament model are found in the data: districts with higher opportunities for promotion, as measured by the ratio of administrators to teachers, offer lower returns to promotion. The main prediction of the monitoring model is the negative correlation between returns to seniority and monitoring intensity. This result is not supported in the data. This aligns with BP's intuition that the monitoring model does not apply to the market for public school teachers because of the difficulty of firing teachers due to tenure protections.[17]

The tournament model and empirical application assume that all teachers are competing for administrative positions, and those who remain as teachers are losers of this tournament. In fact, a substantial fraction of teachers do not want to become administrators because of the different skills required that they may or may not want to develop (just as university professors will not see becoming a department chair as a reward for being a superior professor). The true value of q, the fraction of workers who win the tournament, is not (# of administrators)/(# of teachers), but rather (# of administrators)/(# of teachers playing).[18] If the ratio of the number of teachers playing the tournament to the total number of teachers is the same for all districts, then the estimates of the coefficient on q are scaled upwards by that constant ratio, but their significance levels remain the same. On the other hand, if that ratio varies by district and is correlated with the error term, a bias may exist in the estimates. I am unable to determine the direction or size of this potential bias, since I have no measure of how many teachers in a district are vying for administrative positions.

Mobility between districts is an important issue. Among teachers and administrators, the amount of mobility is not insubstantial.[19] One option for considering mobility among workers is to explicitly frame it in the model, as in Zabojnik and Bernhardt (2001). The tournament model here does not constrain the firm to set its tournament based on the competitive labor market. However, the model does not assume that districts do not compete for teachers or administrators. The option for mobility is captured in the reservation wage that districts must meet to ensure their workers accept their contract. How well the current model captures the ability that districts have to alter their wage structure depends on how perfect labor mobility across districts actually is in this market. The significant heterogeneity among districts in their salary structures is evidence of imperfect mobility.[20]

Some caveats of the econometrics must be pointed out. First, though the most obvious determinant of salary may be the increased human capital developed by teachers as they gain experience, this paper does not attempt to measure the impact of human capital accumulation on wages .[21] However, I do not assume that no such impact exists. Returns to seniority and returns to promotion may differ across districts because the rate of human capital accumulation differs. The demographic characteristics of the districts included in the regressions are a means to control for this. Second, these values may contain measurement error. The proxies for monitoring intensity are imperfect, and measurement error also comes from creating a district-level measure of returns to promotion or of returns to seniority from the salaries of individual teachers or principals, as are used in column 5 of Table 2 and column 3 of Table 3. This measurement error may account for the insignificant or unexpected results in those regressions. A third caveat is that the results suffer from endogeneity bias if the instrument, total enrollment, fails the exogeneity assumption. The direction of the potential endogeniety bias is unclear.[22] Finally, the tournament for administrative positions need not be the only tournament in which teachers participate. Receiving a certification from the National Board of Professional Teaching Standards can also be considered in a tournament structure, as teachers must demonstrate superior abilities to earn the certification, and many states and districts provide salary bonuses or implicit incentives for this certification.

5. Conclusion

I have investigated how the pay schedules of public school teachers are used as incentives. A tournament model is presented where administrative positions are offered as incentives to teachers. Districts substitute between the number of these positions per teacher and the payoff to being promoted, so the tournament theory predicts that the pay increase of being promoted is negatively related to the ratio of administrators to teachers. This result is found in the data. Another model, with imperfect monitoring, predicts that monitoring intensity is inversely related to returns to seniority. I proxy for monitoring intensity in school districts using the ratio of administrators to teachers and using the ratio of coordinators or supervisors to teachers, and I find little evidence of a coefficient of the predicted sign.

Previous studies, including Ballou and Podgursky (2002), have suggested that returns to seniority in school districts are the result of rent-seeking behavior by unions, who exercise bargaining power to yield inefficient contracts. Returns to seniority may also be used as a method of incentive pay in jobs with imperfect monitoring. If this were the case, then the presence of returns to seniority in teachers' contracts would not necessarily imply inefficient contracts. However, there are two reasons to doubt that conclusion. First, the incentives in the monitoring model derive from the threat of being fired. It is widely believed that because of tenure laws, public school teachers are among the most difficult of all employees to fire. The data show that teachers have a low firing rate. The threat of being fired due to shirking is low for teachers, and hence the monitoring model is unlikely to apply to them. Second, the data do not support the predictions of the monitoring model, since no significant negative correlation is found between returns to seniority and the ratio of administrators or supervisors to teachers.

The tournament model is much more likely to apply to the labor market for public school teachers and administrators. The average salary for a school principal is double that of a teacher, so the incentives for promotion are significant. School principals are almost universally drawn from the ranks of classroom teachers. If the choice of which teachers to promote to principals is based on the teachers' output or effort levels, then these administrative positions can be efficient ways to elicit teacher effort, as in Lazear and Rosen (1981) or Malcomson (1984). The discussion among economists and policymakers regarding pay-for-performance initiatives is growing. Florida announced in February 2006 that it will link teacher pay to student test scores; Denver voters approved a pay-for-performance plan in 2005; the federal government gave US$ 99 million to a Teacher Incentive Fund. While these initiatives explicitly base teacher pay on student outcomes, the tournament model studied here may have similar effects if promotion choices are based on teachers' contributions to student achievement. While the scope of this paper is merely to identify tournament pay schemes in public schools, a useful extension would be to study their impacts and compare them with other incentive pay initiatives.

Notes:

[1] Eberts, Hollenbeck, and Stone (2002) provide a case study of a merit pay scheme and find that it increased student retention but had no effect on average GPA. Lavy (2002, 2004) finds that a merit pay program in Israel caused significant student gains and was more cost-effective than non-incentive based funding increases. Cullen and Reback (2006) study a school-level accountability system and find that administrators manipulated the composition of student test-takers to maximize scores.

[2] For more recent examples of tournament medels see Levy and Vukina (2004), Szymanski (2003), and Lin and Yang (2003).

[3] Eriksson (1999, Table 4) and Main et al. (1993, Table 4) find empirical justification for this prediction.

[4] Leonard (1990, Table 6) finds a negative correlation between the promotion rate and the steepness of pay profile using data on executive pay from U.S. corporations, consistent with this prediction.

[5] The fraction of winners q is exogenous to the firm in this model. If q were a choice variable, it is likely to take a corner solution of one or zero, since firms would not introduce uncertainty into the risk-averse workers' contract unless necessary. However, when being constrained to promote a certain fraction of workers, firms choose a compensation scheme to most effectively motivate their employees. This model is applied to school districts, and it is reasonable to assume that the districts are constrained to promote some workers; districts must have administrators to function.

[6] The public-use versions of these data sets are available online: http://nces.ed.gov/surveys/sass/.

[7] There are a total of 8261 districts, and only 1339 (16%) are present in all 3 years. 55% are only in the data set for 1 year.

[8] The school district is assumed to set its own salary schedule. Though 21 states have laws about teacher salary schedules, most of these laws set minimum salaries for teachers, and districts are allowed to exceed them. There

is no evidence in the data that all districts in these states have identical salary schedules. A list of the states and laws is available at http://www.ecs.org/clearinghouse/62/43/6243.htm.

[9] At-risk status is defined as the percentage of students eligible for free or reduced-price lunch.

[10] Available online: http://nces.ed.gov/ccd/.

[11] The MA20/BA0 measure may suffer from confounding returns to seniority with returns to education, since it compares teachers with two different levels of education. However, it may more accurately reflect the wage schedule that teachers actually face, since many teachers earn their master's degree during their teaching career. In the SASS data, only 19.3% of teachers who have been teaching 5 years or less have an MA, while 58.1% of teachers who have been teaching at least 20 years have one.

[12] The results do not change significantly when the dummy for unionization is interacted with the monitoring proxies.

[13] It is possible that teachers are monitored in other ways. For example, teachers who work at smaller schools might be less likely to get away with shirking, so average school size may be a better proxy for monitoring. However, Table 2 shows that school size is actually positively correlated with returns to seniority, contrary to the monitoring theory's prediction. Another way that teachers can be monitored is through school choice programs, like charter schools, where parents are free to move their children out of the school or district if they are unhappy with the performance. However, a dummy for the presence of charter schools in the district has no significant impact on any of the results.

[14] The assumption in the model that administrators are drawn from the ranks of teachers is supported by the data. In all years of SASS, 99% of administrators have had some experience teaching before becoming a principal.

[15] Thus the results in Table 3 come only from 1993 to 1994 and 1999 to 2000, where that variable is reported. Regressions using the salary of a teacher with a BA and 10 years of experience in the denominator (and hence using 1999–2000 and 2003–2004 data) are qualitatively similar.

[16] I also attempted an IV regression with the "SASS" measure of returns to promotion, though results were insignificant, likely due to the above-mentioned noise in that variable.

[17] In fact, this can be tested with a measure of the strength of tenure protections by district. The 1999–2000 and 2003–2004 SASS surveys ask principals if they consider tenure a "barrier to the dismissal of poor-performing or incompetent teachers" at their school, which can be used to create an index of tenure protection for each district. When the regressions of Table 2 are run only on districts that have a low value of this index of tenure protections, the results still do not support the monitoring model. Likewise, when the tenure index is included in the regressions and interacted with the proxies for monitoring intensity, they remain statistically insignificant. Though this index of tenure protection is subjective and likely noisy, it does not support the hypothesis that tenure protections are the reason for the failure of this model.

[18] This is likely to be true in other professions as well: not all managers may want to be promoted to VP, nor may all VPs want to be promoted to CEO.

[19] Hanushek, Kain, and Rivkin (2004) study teacher mobility, and Gates et al. (2006) study administrator mobility and turnover.

[20] An additional explanation for the heterogeneous salary structures among districts related to mobility is adverse selection: more able teachers may migrate to certain districts and reap the higher pay, while worse teachers are confined to certain districts with low pay. Some of this variance in districts' demand for high

quality teachers likely covaries with demographic variables controlled for in the estimation, such as the racial and economic makeup of the district.

[21] Research has been mixed in examining how experience affects teacher quality. Rockoff (2004) finds a significant positive effect; Aaronson, Barrow, and Sander (2007) do not.

[22] For example, though I control for the presence of unions, union strength may be stronger in some districts, which may increase returns to seniority and decrease the ratio of administrators to teachers. This would bias downwards the coefficient on that ratio. Alternatively, a low-achieving district may face more regulations, and this may require it to have a higher administrator to teacher ratio. The same district may have to increase returns to seniority to retain qualified teachers, biasing upwards the coefficient of interest. Similar conflicting intuitions about the direction of bias can be applied when the dependent variable is the returns to promotion.

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