# Using Local Knowledge in Setting Teacher Compensation: Competition, Discretion, and Incentives in the Public and Private Sectors

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## I. Introduction

The chronic underperformance of many public schools despite the continual growth in resources per pupil devoted to public education has been a continuing source of concern by the public. Indeed, this problem seems to have occupied considerable time of many state legislatures over the past decade or more. An assortment of reforms have been proposed and tried in various places at various times.

A particularly popular one is to institute some type of teacher incentive pay, with a common theme being to tie teacher pay to test score performance of students. This takes many forms, but often tie pay to the performance of students at the school on standardized tests and perhaps relate teacher pay directly to the test scores of her/his students. Other popular types of reform are those that alter the institutional governance of the school by changing the authority of school principals or by instituting school choice programs. Vouchers and charter schools are leading examples of the latter. A full voucher program is something akin to privatization of the provision of educational services, but not its funding. Charter schools can be very similar in this regard. Though what charter schools may do varies from state to state, they are usually private organizations that are exempt from many of the administrative rules that bind the regular public schools and whose source of revenue is almost entirely reliant on the families that select them. Both introduce private organizations and more competition into school systems. This paper develops a model of setting teacher incentive pay in public and private schools, in both competitive and non-competitive settings, and considers the effects of mandating rewards for student test scores on teacher effort and school performance.

In what follows, we consider carefully the roles of "local" knowledge and of the decision rights of school administrators and parents. By local knowledge, we are guided by the meaning of Hayek (1945), who emphasized the importance of knowledge of "particular circumstances" in attaining economically efficient outcomes and how decentralized decision makers must be relied on to use it. In the context at hand, what is meant by local knowledge is knowledge of unique and subtle characteristics, needs, and accomplishments of teachers and students and ultimately of the school in providing educational services. Much of this knowledge is held by school administrators, teachers, and parents and is hard to quantify and transfer to others. This is in contrast to general knowledge, such as standardized test scores, which is straightforward to quantify and transmit to others.

Decision rights, or discretion, is considered for three groups. The first is school administrators. We model teacher pay setting where school administrators have full discretion in establishing pay for teachers and also where discretion is limited by pay-setting mandates, i.e., rewards for student test scores. When school administrators have discretion, they may base rewards on their local knowledge and also are free to use general knowledge, e.g., test scores. The model is a variant of the principal-agent genre, where teachers are the agents. In such models, the agents have discretion is selecting effort levels. Here, teachers decide how much effort they put into various tasks, including effort toward building student test scores and into other aspects of education such as creativity and development of work habits. Their efforts are affected by the local knowledge they have of their students and the incentives they face. Finally, we consider that parents, though school choice programs, may have discretion in which school their

children attend. Again, if choice programs are available, parents can use their local knowledge of teachers and schools, as well as general knowledge, in making this decision.

The rewards and incentives for school teachers would seem to be quite important because there is a large and growing literature suggesting that teachers have a large effect on the educational outcome of students. Though easily observed teacher characteristics such as certification and advanced degrees do not have much effect on student test score performance, recent empirical research shows that teachers do make a difference in this regard. Rockoff (2004) and Rivkin, Hanushek, and Kain (2005), for example, demonstrate that some teachers consistently have classrooms of students that outperform others in achievement on test scores and that this difference in performance is quite sizable. Presumably, the intent of teacher incentives is to motivate teacher effort to attain these better student outcomes.

There is ample evidence that teachers respond to incentives. As an example, Figlio and Kenny (2007) find that individual teacher merit pay is associated with better test scores for the school. Also, Eberts, Hollenbeck, and Stone (2002) show that student course completion is higher in alternative schools when teachers are rewarded for it. Lavy (2009) finds that cash rewards to teachers for improving students' performance on matriculation exams were effective. Jacob (2005) finds that student math and reading scores were higher after penalties were put in place for low-performing schools. His findings also suggest that teachers engage in "teaching to the test" rather than broader educational efforts, though Greene, Trivett, and Winters (2007) do not find much evidence of this sort in their study. This raises the question of whether incentives for test

scores distort teacher effort away from other educational activities, perhaps to the detriment of overall educational value. This is analyzed closely in what follows below.

Teachers presumably can be rewarded for the performance on things other than the test scores of students. In fact, there is considerable evidence that school principals are well informed (i.e., have local knowledge) regarding the quality and performance of each of the teachers. See Jacob and Lefgren (2008) for an example of the evidence on this. It should not be surprising that school administrators, who work around their teachers every day, gain information about teacher quality that is not reflected in test scores. Given the authority to do so, school administrators can use this information to reward teachers. This more subjective measure of performance is likely to capture a broader, but imperfect, picture of the teacher's contributions to educational value. This possibility is modeled below as allowing school administrators to use this information as an additional avenue for providing incentives to teachers. How this aspect of incentive provision is altered by test score mandates is discussed, as is the effect of school choice.

The difficulties of implementing a reward system based on complicated, subtle, subjectively measured, and hard to assess aspects of jobs have been pointed out and analyzed in detail in the private-sector, competitive setting. See Prendergast (1999) for a survey. It is well recognized (e.g., Lavy (2007)) that these issues apply in the education setting as well. As pointed out by Neal (forthcoming), despite these difficulties, the competitive process will reward of firms that adopt the most efficient incentive systems and human resource practices and promote their survival. This competitive process is frequently lacking for public schools.

The modeling of the incentives established by the school administrator is similar to Holmstrom and Milgrom (1991) where incentives are established for agents who do multiple tasks. Too great an incentive for one task relative to the other leads to a distortion of effort and possibly a reduction in value. Therein lies a potential problem of state mandates for higher rewards for test scores. Below, we examine this more thoroughly.

Regarding the role parents, there is evidence that parents value better performance on test scores by their children, but that they also value other aspects of their children's educational experience. See, for example, Jacob and Lefgren (2007). Additionally, parents possess crucial local knowledge of their children, teachers, and schools. Enabling parents to act upon this knowledge is most easily embraced by allowing school choice. This also provides heightened competition, inducing school administrators to adopt efficient reward systems for teachers. This line of discussion is in the spirit of commentary by Neal (forthcoming), Podgursky and Ballou (2001), and Hanushek and Rivkin (2004). We model this below.

Section II of the paper begins the formal modeling. We start with the idea that school administrators observe many aspects of a teacher's performance and develop an overall assessment of how competent the teacher is. Also, the administrator has access to the standardized test scores of each teacher's students. Teacher rewards may be based on each of these pieces of information. We assume that teachers exert effort in three aspects of their jobs: raising test scores, improving the administrator's assessment, and to other, unmeasured aspects of education. The basic incentive system is reviewed, as well as how teachers are expected to react to incentives attached to the measures of performance. We

discuss the importance of the nature of the test that students take, i.e., whether it is broad or narrow and complementary or not to other aspects of education.

Section III considers pay setting by the competitive, private-sector organization where school administrators have full discretion and parents have competitive options easily available for their children's schooling. The outcome here is constrained, first-best. Rewards for each measured aspect of teacher performance depend on its importance in raising educational value and also how much it distorts incentives for other aspects of educational value. How heavily test scores are rewarded depends on these two factors.

Section IV modifies the model to consider the case of an administrator operating in a public organization facing little competition. In this setting, there are reasons to think that the payoff function for the school administrator will differ. In fact, it seems sensible that the form of an organization changes the payoffs to organization managers and acts much like an alternation of the manager's incentive system. For example, in the classic analysis of the limited-liability corporation, changing from a proprietorship to a corporation lower the cost of capital but, because of ownership dilution, reduces the rewards for managerial effort.[1] In the contrast between public and private organizations, political constraints and the lack of residual income claimancy for public entities alter the rewards to the school administrator. We show how this is transmitted to the teacher incentives that the administrator sets. Though a somewhat different approach, the result is similar to that of Dixit (1997, 2002) and Acemoglu, Kremer, and Tian (2007) in that incentives for public-sector managers are dulled. This is passed along to public organization employees in the form of muted incentives. Though overall incentives for

[1] See the classic paper of Jensen and Meckling (1976).

teachers are muted, there is likely a distortion favor of rewarding test scores because of the easy transmission of this information to the voting public.

Section V asks, in the above discussed settings, what is the effect of mandating teacher incentives for test scores, in effect removing a degree of discretion from school administrators. Here we discuss the effects regarding both narrow tests and broad tests and for public schools without competition and for private, competitive schools. Naturally, in the private, competitive setting, no mandate improves things since in this environment schools attain the efficient outcome. For public schools in a noncompetitive environment, it is possible for mandated rewards for test scores to improve overall education, but only under certain conditions. Primarily, this condition is that the test has to be broad enough to be a good reflection of actual educational value and not be too distortionary regarding teacher effort.

In light of the pitfalls of mandating rewards for test scores, section VI turns to ideas of institutional reform to induce greater educational value from schools. We draw upon the ideas of Jensen and Meckling (1992) who emphasize that it is important to tie decision making power with incentives to make good decisions.[2] In the context at hand, if school administrators have discretion in pay setting, it makes sense that they have incentives to set pay appropriately. In this light, one can alter the institutional framework so that school administrators are insulated from political influences on their decision making and are rewarded for improvements in educational value. Various institutional rules are discussed but in the end, school choice initiatives, such as charter schools and voucher plans, seem much more likely to be the most effective in this regard.

[2] An early discussion of this is in Hayek (1944), p. 126.

Lastly, section VII concludes. The paper's conclusions are consistent with the sometimes neglected commentaries on the use of knowledge by Hayek (1944, 1945) and later by Jensen and Meckling (1992). These works emphasize the importance of local knowledge and making use of this knowledge requires the discretion and incentives to do so. The local knowledge school administrators have about teachers is an example of this, as well as knowledge by parents, and institutional reform involving private ownership with competition is a way to provide both the discretion and incentives.

## II. Teacher Assessment, Test Scores, and Incentives for Teachers

The basic set up of the model follows closely the multitask principal-agent model of Holmstrom and Milgrom (1991). We consider three broad aspects of teacher performance that can affect the educational value attained by the student. Only two of these activities are measured, perhaps with error, and so compensation can be based only on these two.[3] Teachers have discretion over how they allocate their effort among the three activities and is affected by the reward system.

Let:

T = the test score performance of a representative student of the teacher at the school,

A = the school administrator's assessment of the teacher's performance, and

N = aspects of teacher performance that are not observed by third parties.

We can allow the observed aspects of teacher performance to be measured with error such that $T = T^* + \varepsilon_T$ and $A = A^* + \varepsilon_A$, where $T^*$ and $A^*$ are the true, underlying values and the $\varepsilon_i$'s are white noise with expected value zero and variances $\sigma_i^2$ , i=T,A. Define educational value as V and assume that V is a function of T, A, and N as V = V(T,A,N).

[3] It is assumed that compensation is not based directly on educational value. In the public sector setting, measuring this is problematic. However, even in the private sector, rewards based on measures other than the value of output are quite common for a number of reasons.

It is assumed that A reflects "local" knowledge, i.e., knowledge acquired by the school administrator that is specific to the school and teacher that is difficult to summarize and transmit elsewhere. Thus, one must rely on the school administrator to use this knowledge. The value of N reflects teacher effort regarding local knowledge specific to the teacher. In contrast, T is information that is readily summarized, transmitted and understood by others.

It is presumed that performance of students on the test, T, is influenced by teacher effort at increasing student test scores. Naturally, this entails fostering an understanding of the tested material. However, the nature of this effort may vary depending on the character of the test. For a narrowly designed test, this may be narrow effort, e.g., a focus on computational math problems. Also, if the test is easily "gamed," it also may involve "strategic" effort such as teaching specific problems on the test, taking steps so that low-achieving students do not take the exams, and even extreme actions such as altering student answers. For these types of narrow and/or easily gamed tests, the marginal product of T in producing educational value, $V_T$, is very small.[4]

The administrator's evaluation, A, is expected to reflect broader, less objectively-defined aspects of teacher effort, e.g., effort directed at communication, problem solving, and creativity as well as other efforts in teamwork and dealing with parents. This also may include nurturing other intangibles such as hard work, perseverance, and responsibility. The unobserved aspect of teacher performance, N, is presumed to reflect

[4] An alternative way to structure the model is to think of T, A, and N as three outcomes produced by different types of effort, say $t_1$, $t_2$, and $t_3$, where $T=T(t_1,t_2,t_3)$, $A=A(t_1,t_2,t_3)$, $N=N(t_1,t_2,t_3)$,and $V=V(t_1,t_2,t_3)$. If one inverts the T, A, and N functions to solve for $t_1$, $t_2$, and $t_3$ in terms of T, A, and N then substitutes into the V function, one obtains V=V(T,A,N). Likewise, if one starts with a cost of effort function of $C=C(t_1,t_2,t_3)$, it is converted to C=C(T,A,N) in an analogous fashion. The model then proceeds as in the text.

similar efforts regarding intangibles and less objective aspects. Naturally, the importance of these aspects of teacher effort in producing educational value is reflected in their marginal products, $V_A$ and $V_N$.

In this scenario, consider a simple model of incentives and teacher effort. Suppose that teacher's the certainty equivalent of utility is given by $U = Y - C(T,A,N) - \frac{1}{2}\rho R$, where Y is the teacher's expected income, $C(\cdot)$ is the utility cost of effort, $\rho$ is the coefficient of absolute risk aversion, and R is the variance of teacher income. The term R is to be defined below. The school administrator observes T and A (possibly with measurement error as noted above) and may base compensation on them. V is not used directly to reward teachers but is perceived by parents. Let Y be a linear function[5] of the test scores of the teacher's students and the administrator's measure of teacher performance so that $Y = b_0 + b_T T + b_A A$.

If T and A are measured with error as indicated above and is Y linear, then the variance of income, R, is $b_T^2\sigma_T^2 + b_A^2\sigma_A^2$, assuming $\sigma_{TA}=0$. With $\varepsilon_T$ and $\varepsilon_A$ following a normal distribution and utility having constant absolute risk aversion form, one obtains the certainty equivalent utility as given above.

Now, consider the teacher's utility maximizing choices of T, A, and N. Utility is given by $U = Y - C(T,A,N) - \frac{1}{2}\rho R = b_0 + b_T T + b_A A - C(T,A,N) - \frac{1}{2}\rho(b_T^2\sigma_T^2 + b_A^2\sigma_A^2)$. For illustration, it is convenient to assume a functional form for C. Let $C = \frac{1}{2}k_T T^2 + \frac{1}{2}k_A A^2 + \frac{1}{2}k_N N^2 + k_{TA}TA + k_{TN}TN + k_{AN}AN$ . This cost function displays increasing marginal costs for each of the arguments. The $k_{ij}$ parameters indicate how one argument influences the marginal cost of another.

[5] Actual rewards for teachers are likely to be nonlinear; indeed Ahn (2008) and Vigdor (2008) find this to be the case for North Carolina's rewards to teachers for better test scores. Linearity is a simple and tractable way to capture the idea that rewards are tied to T and A.

The first-order conditions for teacher utility maximum are:

(1) $\partial U/\partial T = b_T - C_T = b_T - (k_T T + k_{TA} A + k_{TN} N) = 0$

(2) $\partial U/\partial A = b_A - C_A = b_A - (k_A A + k_{TA} T + k_{AN} N) = 0$

(3) $\partial U/\partial N = - C_N = -(k_N N + k_{TN} T + k_{AN} A) = 0$

Equation (1) indicates that the teacher selects the target level of T such that the marginal benefit of having students with greater test scores, $b_T$, equates with the marginal cost of doing so, $C_T$. Equation (2) is a similar expression for attainment of the level A. Equation (3) is likewise for N, but there is no direct compensation for N. For N to be positive, it must lower the marginal cost of at least one of the other types of effort.

From these equations, we can solve for T, A, and N and determine how they change in response to the incentives $b_T$ and $b_A$. From those, straightforward comparative statics show that:

(4) $\partial T/\partial b_T > 0; \quad \partial A/\partial b_A > 0,$

i..e, greater rewards for T and A raises each of them, respectively. The cross effects of $b_T$ on A and N and of $b_A$ on T and N are ambiguous and depend on the cross partial derivatives in the cost of effort function. This is quite sensible.

Consider the "virtuous" case where each type of effort lowers the marginal cost of the other, i.e., $k_{TA}$, $k_{TN}$, and $k_{AN}$ are all negative. Here, an increase in either incentive raises all types of effort. The more worrisome case (and perhaps more plausible one) is where more effort in improving the test results raises the marginal cost of the other aspects of education, A and N. This implies that $k_{TA}$ and $k_{TN}$ are positive. Also suppose that that $k_{AN}$ is negative, meaning greater effort in A lowers the marginal cost of N. This, too, seems plausible given how A and N are defined. In this case, we obtain:

(5) $\partial A/\partial b_T < 0$; $\partial N/\partial b_T < 0$; $\partial N/\partial b_A > 0$; $\partial T/\partial b_A < 0$

Greater rewards for the test reduce the other aspects of educational effort. Greater rewards for the administratively measured effort increases the unobserved aspects of output but reduces test scores. Stronger incentives thus do not unambiguously increase educational value.

This simple result is reflective of much of the debate regarding the use of test scores as incentives for teachers, i.e., that it diverts teachers from other important educational tasks, perhaps to the detriment of educational value. This is especially likely an issue for poorly designed and/or easily gamed tests. Poorly designed tests do not correlate well with educational value. Also, in this scenario, teacher effort to raise test scores tends to be narrow and probably is not complementary to other educational efforts. Thus, encouraging better scores on poorly designed tests not only serves to add little to education directly, they further reduce value by distorting behavior away from other effort that could add value. In other words, we get more T, which for poorly designed tests adds little to value, and a reduction in reduce value-adding A and N.

Regardless of the test quality, the effects of each type of teacher incentive compensation on all aspects of effort are important in the design of the incentive system.

## III. Incentive Pay Under Competitive, Private Schools with Discretion

Here, we consider school administrators setting the parameters of the teacher compensation function, $b_0$, $b_T$, and $b_A$. In practice, administrators are subject to many influences, both political and economic. With conditions of competition, private ownership, and full discretion in pay setting, the decentralized market emulates the constrained, first-best outcome. Consider the school administrator's payoff function and

being closely approximated by the net income of the school. This can result from the administrator being the owner of the school or an employee-manager of a private organization with full incentives.[6] Administrators set pay for teachers and so may use the local knowledge they have. Also, assume that the school operates in a competitive market and this implies that schools can sell the schooling services they produce for their value, V. Schools also are subject to competition for teachers as well as.

Thus, the payoff function per teacher for the school administrator is $F = V - Y = V(T,A,N) - (b_0 + b_T T + b_A A)$. Assume constant returns to scale in the number of teachers so the maximum payoff is attained by maximizing net value per teacher. Capital costs are assumed to be fixed and therefore suppressed. Administrator effort is costly but this effort is considered to be on matters not related to pay setting and also is suppressed. The payoff maximizing compensation schedule is chosen subject to the fact that the teacher chooses T, A, and N according to their optimizing supply of effort functions, $T^*=T(b_T,b_A)$, $A^*=A(b_T,b_A)$, and $N^*=N(b_T,b_A)$.

To compete for teachers, schools must set a compensation schedule so that teacher utility is at least as high as could be attained in an alternative job. Call this alternative utility $U^M$. Thus, school must set pay such that $Y - C(T^*,A^*,N^*) - \frac{1}{2}\rho R = b_0 + b_T T^* + b_A A^* - C(T^*,A^*,N^*) - \frac{1}{2}\rho R \geq U^M$, where T*, A*, and N* are as defined above. These are the individual rationality and incentive compatibility constraints discussed in the principal – agent literature. Assuming the constraints hold with equality, this implies that $b_0 + b_T T^* + b_A A^* = C(T^*,A^*,N^*) + \frac{1}{2}\rho R + U^M$. The school

[6] For administrators as the hired managers of school owners, the principal-agent problem emerges regarding how to provide incentives for school administrators. Thus, one might consider another layer of incentives with owners providing incentives to the administrators who then set incentives for teachers. Rather than trying to model more steps in this hierarchy, we focus on just two.

administrator chooses $b_T$ and $b_A$ to maximize his/her payoff F = V – Y subject to the above constraints. Substituting the constraint regarding Y into the objective function yields $F = V(T^*,A^*,N^*) - C(T^*,A^*,N^*) - \frac{1}{2}\rho R - U^M$. Maximizing this function yields the constrained, first-best outcome.

With assumption the that the function relating value to T, A, and N is linear, explicit solutions for $b_T$ and $b_A$ can be found. Letting $V = \alpha_T T + \alpha_A A + \alpha_N N$, we find[7]

(6) $$b_T = \frac{\left[\alpha_T \Delta_T + \alpha_A \rho \sigma_A^2 \left(\frac{\partial A}{\partial b_T}\right) + \alpha_N \left(\rho \sigma_A^2 \left(\frac{\partial N}{\partial b_T}\right) - \frac{k_{TN}}{\Delta}\right)\right]}{H}$$

(7) $$b_A = \frac{\left[\alpha_A \Delta_A + \alpha_T \rho \sigma_T^2 \left(\frac{\partial T}{\partial b_A}\right) + \alpha_N \left(\rho \sigma_T^2 \left(\frac{\partial N}{\partial b_A}\right) - \frac{k_{AN}}{\Delta}\right)\right]}{H}$$

where $\Delta$, $\Delta_T$, $\Delta_A$, and H are all positive based on second-order conditions.

To interpret, it is easiest to start with the case where there is no risk in the model (either risk aversion is absent or variances are zero) and where there is no unmeasured aspect of value that matters, i.e., $\alpha_N$=0. Here, we get the simple outcome that $b_T = \alpha_T$ and $b_A = \alpha_A$. If all aspects of effort are measured and there is no risk, then marginal incentives equal marginal product.

Now take the case where there is no risk, but $\alpha_N$>0. Equations (6) and (7) become

(8) $$b_T = \alpha_T - \frac{\alpha_N k_{TN}}{\Omega}$$

(9) $$b_A = \alpha_A - \frac{\alpha_N k_{AN}}{\Omega}$$

where $\Omega = \Delta H > 0$. Here, one can see how rewards for each type of effort optimally diverge from the marginal products of the observed efforts. Consider the case where

[7] I thank William Hoyt for his assistance in arriving at this formulation of equations (6) and (7).

$k_{TN}>0$, i.e., increasing effort for T raises the marginal cost of N. Then $b_T$ is less than $\alpha_T$. How much less depends on how important N is in producing value (the magnitude of $\alpha_N$) and the size of $k_{TN}$. If increasing effort regarding A lowers the marginal cost of N ($k_{AN}<0$), then $b_A> \alpha_A$. Where $k_{TN}$ and $k_{AN}$ are both positive, then rewards for T and A both exceed their individual marginal products.

When the test is poorly designed, it was noted above it is likely that $\alpha_T$ is small and $k_{TN}$ is positive and large. Here, it is optimal to have a small reward for the test. Similarly, if $k_{AN}$ is negative greater rewards for A is optimal. This is especially true if the productivity of efforts based on local knowledge, A and N, are important. These foreshadow the potential pitfalls of heavy reliance on rewarding T.

In the more general case with risk in the model, we have the results from (6) and (7). The basic ideas discussed in the previous paragraph still hold. However, further cross-effects are present. If $\partial A/\partial b_T<0$, then this reduces the incentives put on T. Likewise, if $\partial T/\partial b_A<0$, this lessens the optimal incentive for A.

**IV. Pay Setting in Noncompetitive, Public Organizations**

This section considers pay setting by school administrators in the scenario where schools are in a noncompetitive setting and are public organizations. Administrators are assumed to still have discretion in how they set pay. Differences emerge because the different institutional setting alters the payoff function of school administrators. This is translated into a different incentive system for teachers. A noncompetitive environment and being a public institution are two distinct concepts and are considered separately. We also consider how to introduce nonprofit organizations into the model.

### *A. Imperfect Competition*

There is not an obvious way to alter the above model to fit naturally with the standard industrial organization models of imperfect competition. Cournot-type models often deal with choices of quantities and imperfect competition models of quality consider an array of qualities along a line or circle in product characteristic space. Neither approach seems to fit the setting at hand.

Consider the following simple way to characterize imperfect competition among schools. In the competitive case, total revenue received for delivering value V equals V. In value falls (rises) by $1, total revenue falls (rises) by $1. In setting where there is imperfect competition, the revenue received by a school may not fall dollar-for-dollar with changes in value. Consider a school that lowers V. If parents do not have options, many will continue to send their children to the school and the school's total revenue does not fall commensurately. Similarly, an increase in V does not generate a corresponding increase in revenue. Most all the children are at the school anyway. A way to characterize this is to assume that the school's revenue function is $S=S(V)$, where $0<S'<1$.

The only change that this entails to the competitive model is that the school administrator's payoff function becomes $F = S(V) – Y$. Because $S'<1$, there is a reduced return for creating value, dulling the administrator's incentives.

### *B. Public Sector Institutions*

Most schools are not privately owned; they are usually public sector enterprises. Operating in this institutional setting is expected to alter the behavior of school

administrators by changing their payoff function which, in turn, alters how they establish pay and incentives for teachers.

There have long been a number of distinctions drawn between private and public institutions. Some key ones are the following. Public institutions rely on taxation for their funds rather than voluntary sources. Output is not directly sold to users. These likely put less pressure on public agencies to provide value and cover costs, thereby weakening incentives. This is affiliated with the idea that voters are often rationally ignorant and so public-sector outcomes are overly influenced by special interests rather that net value creation. Public institutions are not structured so that managers are residual income claimants. These suggest a distortion in the payoff function of public sector officials tending to reduce incentives to maximize net value.

Dixit (1997, 2002), building on the work of the multitask principal-agent model of Holmstrom and Milgrom (1991) and the common agency work of Bernheim and Whinston (1986), develops a model where the government agent has multiple principals, each with different objectives. The divergent interests of the principals pull the government agent in many directions, weakening overall incentives.[8]

Acemoglu, Kremer, and Mian (2007) develop a model in the context of rewards for student test scores that gives similar implications regarding public organizations. In their model, politicians can have some influence on the performance of schools through good policy and are judged by voters based on the school performance of students as well as other factors. Because politicians do not fully control school outcomes and their

[8] Oddly, this effect works entirely through the imposition of risk on the agent and disappears under risk neutrality or when outcomes are measured without error.

success with voters is determined by this and many other factors, incentives are diluted for delivering the value maximizing outcome for schools.

The approach taken here is somewhat different, but the outcome is broadly consistent with these papers. Here, we consider several of basic ideas that are well established and suggest how they will alter the payoff function for the public school administrator.

Perhaps the most obvious way that public schools differ from their private counterparts is that the revenue of the school is a budget determined by a political process. This process is such that changes in value produced by the school are not immediately reflected in the school revenue. Let B represent the school's budget and assume the $B=B(V)$. If $B'=0$, there is no relationship between V and B. It is likely, however, that low enough value will produce some repercussions on the school's budget, so we assume the $0<B'<1$. The political process mutes the relation of V to B. In this regard, public ownership is similar to our modeling of noncompetitive settings.

A second important aspect of the public sector is that there is no lawful residual income claimancy, i.e., school administrators cannot keep the net revenue, $B(V) - Y$, from operating the school. Thus, the utility gained by the administrator from an operating surplus is not the value of the surplus itself. It is unlikely to be zero, however. The administrator's job probably is safer when the budgeted revenue covers cost. Also, the residual of revenue over cost might be spent to enhance workplace amenities, thus enabling net income in-kind rather than in-cash. Still, the benefits are less than if provided in cash. For these reasons, we characterize this aspect of public ownership as altering this aspect of the payoff to the administrator to $\theta(B-Y)$, where $\theta<1$.

Another possible non-pecuniary benefit that the administrator might acquire is making the teachers happier. To the extent that administrators have a higher payoff by improving the utility of the teachers, this suggests that teacher utility enters the administrator's objective function as $\varphi(Y-C-\frac{1}{2}\rho R)$, with $\varphi>1$. Political support plays a role here, too. Administrators that take actions to improve the political support of their organization are likely to benefit. Thus, if teachers are a strong political voice, this reinforces the idea of teacher utility receiving a higher weight in the administrators' payoff function. Teacher unionization typically galvanizes teacher political clout, buttressing this idea.

Visibility of positively perceived actions will enhance political support and visible, negative actions reduce it. Administrators who avoid visible actions that are negative and engage in ones that are positive will improve their lot. So, while raising teacher utility can improve administrator welfare, doing so simply by handing cash over to teachers will generate negative publicity and reduce political support. This is modeled as having cash transfers to teachers carry a discount factor $\delta<1$, making this component of the administrator's payoff $\varphi(\delta Y-C-\frac{1}{2}\rho R)$. It is better to gain the political support and happiness of teachers by the less visible method of lowering their costs of effort or risk rather than through the visible and potentially politically charged way of increasing their cash income.

Regarding visibility, test scores typically are easy to report and widely visible to the populace as a whole. In a public sector setting, this implies that good scores are especially helpful in generating political support. This is less true of teacher performance measured by the administrator, A. This involves more detailed and subtle judgments that

are not easy to convey to the public. Thus, higher test scores will be weighted move heavily in the administrator's payoff function. We will assume that improvements in test scores carry the weight $\theta_T>1$.

Putting this together, this yields a public sector administrator payoff function of $F_P = \theta(B(V)-Y) + \varphi(\delta Y-C-\frac{1}{2}\rho R)$, where T in the V function carries a greater weight $\theta_T$. Letting $V = \alpha_T T + \alpha_A A + \alpha_N N$, this can be rewritten as $F_P = \theta(B(\theta_T\alpha_T T + \alpha_A A + \alpha_N N)-Y) + \varphi(\delta Y-C-\frac{1}{2}\rho R)$, or $F_P = \theta(B(\theta_T\alpha_T T + \alpha_A A + \alpha_N N) + (\varphi\delta-\theta)Y - \varphi(C+\frac{1}{2}\rho R)$. As one can see, since $\theta<1$ and $\varphi>1$, the public sector administrator underweights value and overweights C relative to the competitive, private sector scenario. The exception to this is that the component of V attributed to T will carry a higher weight $\theta_T$.

The effect of Y on the administrator's utility function is unclear. It depends on the sign of $\varphi\delta-\theta$. The term Y is expected to carry a greater positive weight ($\varphi>1$) because of the potential benefits to the administrator of keeping teachers and teachers' unions happy. However, this benefit is discounted by the negative political consequences of a visible transfer of cash to teachers ($\delta<1$). Increasing Y also lowers net school revenue, but this cost is discounted by the factor $\theta<1$ since the administrator does not bear the full cost of increasing Y. Assesses the magnitude of this net effect is difficult. To gain expositional ease while still capturing some insight, it is assumed that these effects net out to approximately zero. Thus, it is assumed that $F_P \approx \theta(B(\theta_T\alpha_T T+\alpha_A A+\alpha_N N) - \varphi(C+\frac{1}{2}\rho R)$.

### *C. Pay Setting*

The school administrator chooses the compensation policy to maximize $F_P$. For ease of solution and exposition, let the budget function, $B(\cdot)$ linear so that B =

$B \cdot (\theta_T\alpha_T T+\alpha_A A+\alpha_N N)$. Then the solution is a simple transformation of that in equations (6) and (7) is given by:[9]

(10) $$b_T = \frac{\theta B}{\phi}\frac{\left[\theta_T\alpha_T\Delta_T+\alpha_A\rho\sigma_A^2\left(\frac{\partial A}{\partial b_T}\right)+\alpha_N\left(\rho\sigma_A^2\left(\frac{\partial N}{\partial b_T}\right)-\frac{k_{TN}}{\Delta}\right)\right]}{H}$$

(11) $$b_A = \frac{\theta B}{\phi}\frac{\left[\alpha_A\Delta_A+\theta_T\alpha_T\rho\sigma_T^2\left(\frac{\partial T}{\partial b_A}\right)+\alpha_N\left(\rho\sigma_T^2\left(\frac{\partial N}{\partial b_A}\right)-\frac{k_{AN}}{\Delta}\right)\right]}{H}$$

or, in the case of zero risk or no risk aversion

(12) $$b_T = \frac{\theta B}{\phi}\left[\theta_T\alpha_T - \frac{\alpha_N k_{TN}}{\Omega}\right]$$

(13) $$b_A = \frac{\theta B}{\phi}\left[\alpha_A - \frac{\alpha_N k_{AN}}{\Omega}\right]$$

Because $\theta < 1$, $B<1$, and $\varphi>1$, there is a tendency for incentives to be reduced. Recall that $\theta<1$ reflects the muted benefits to the administrator of raising value. The combined effect of public ownership and imperfect competition induces $B<1$ and reinforces this. The term $\varphi>1$ magnifies the cost to the administrator of raising incentives. The net effect is a dilution of incentives.

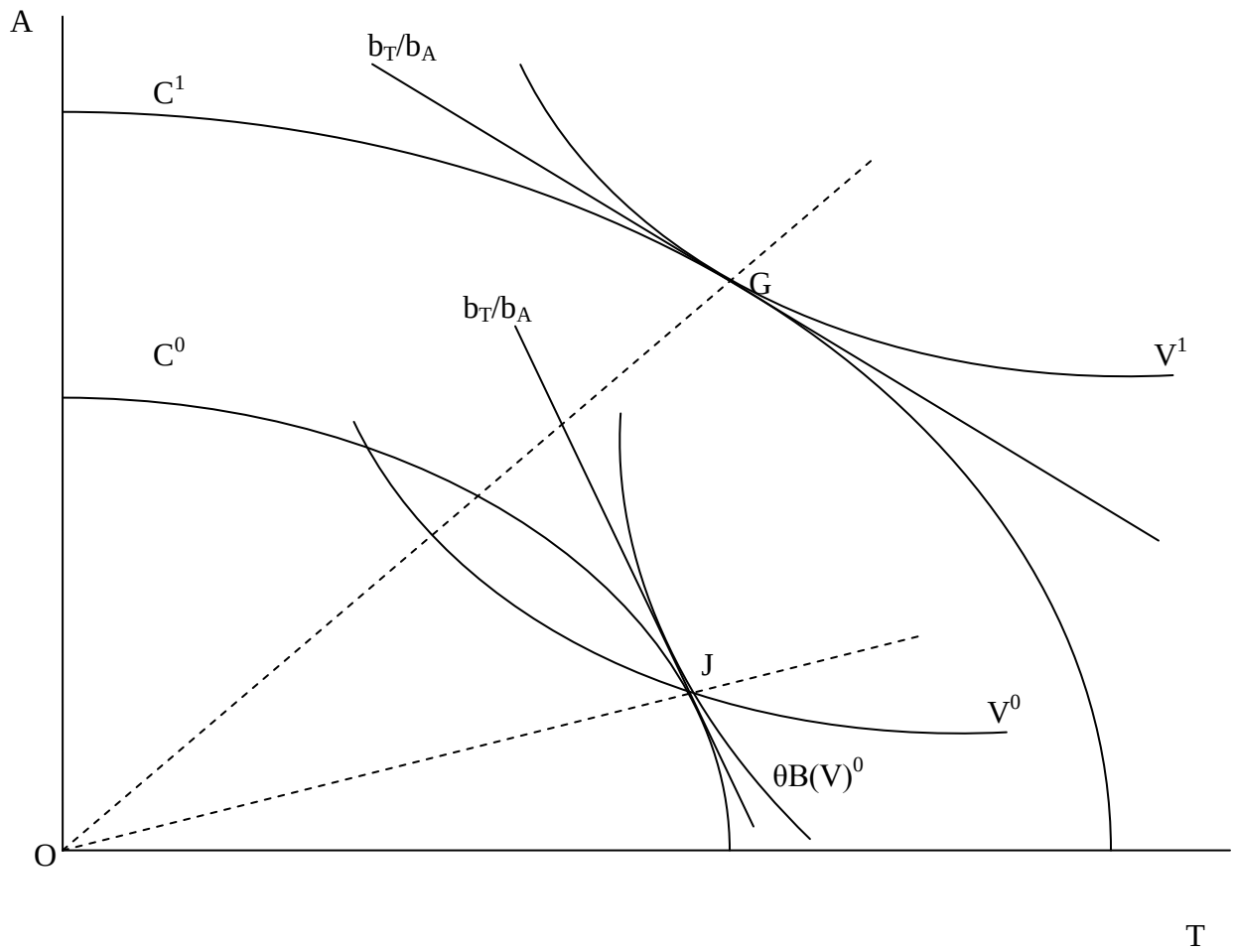
The exception to this is test scores. Because of their visibility and potential for improving political support from the populace as a whole, the benefit of providing incentives for T is magnified by the factor $\theta_T>1$. Thus, incentives for T may be stronger than for the competitive, private case, depending on the net effect of their increased visibility versus the diluting effects of the lack of residual income claimancy and competition. It is also clear that relative incentives are altered in the noncompetitive, public sector setting. The ratio of the test score incentive to the measure performance

[9] It is assumed that the teacher participation constraint is satisfied.

incentive is $b_T/b_A$. It is larger in this case than in the competitive, private case due to the factor $\theta_T$ that magnifies test score rewards for the public sector.

Figure 1 illustrates this outcome. Point G is the equilibrium in the competitive, private schools case. The curve $V^1$ is an isovalue curve between T and A, drawn assuming that N adjusts to the utility-maximizing level. At G, the slope of isovalue curve

Figure 1



$V^1$ is equal to $b_T/b_A$ and is the outcome attained in the competitive case. A teacher indifference curve is given by $C^1$, again assuming that N optimally adjusts. In competitive equilibrium, its slope equals $b_T/b_A$.

In the noncompetitive, public sector case the equilibrium is given at point J. Here, there is a tangency $b_T/b_A$ to teacher indifference curve $C^0$ and to the isovalue curve distorted by the public, noncompetitive payoff function, $\theta B(V)^0$. As illustrated, point J shows reduced and distorted incentives.

***D. The Nonprofit Organization***

Private, nonprofit organizations are common in the schooling market, though not as common as public institutions. Religious-affiliated schools are good examples of this. They have claim on the residual income of the school, but their legal, nonprofit status binds them not to take the residual as direct cash income. Charter schools might also fall into this category. Charter schools are similar to private schools in the sense that they have to compete for customers. Typically, their budget is determined by whether students enroll, not by some political process, so their net income is V-Y, though the net revenue collected per student is usually mandated and need not equal V. Also, many charter schools are nonprofit organizations, making the analysis similar to private schools.

The fact that nonprofit organizations cannot take their residual income, V-Y, in cash makes them similar to the public sector in that regard. This fact suggests that the gain in utility to the school administrator from V-Y is muted, as for public sector organizations. Also, "buying" the happiness of teachers may be a way to spend the

residual, suggesting that the school administrator places a larger weight on Y-C, again like the public sector.

While this seems to indicate that nonprofits can be modeled like public institutions, there are factors that weigh against this. Nonprofit institutions are supported by stakeholders interested in promoting a non-cash goal. In the context of nonprofit schools, that presumably is the value of educational services provided, V. School administrators who are able to raise V are more likely to succeed in their jobs. Thus, the gains from a higher V will be heightened in a nonprofit organization relative to the public one. Similarly, nonprofits seek and attract individuals who place a lower weight on their own utility if they are of service to "the cause." This serves to lower the weight on Y-C compared to the public sector. The upshot is that private, nonprofit firms in a competitive setting are likely to be much more like competitive, private, profit-seeking firms than public organizations.

**V. Mandating Rewards for Test Scores and Removing Discretion**

If point J in Figure 1 is a good approximation of many public schools, ones see the issue with allowing discretion in pay setting for school administrators. With distorted incentives to use their information, school administrators dull teacher incentives to the detriment of school performance. A perhaps natural reaction is to mandate teacher incentives. Doing so from the outside must rely on generally available information which implies reliance on test scores. Many states have implemented teachers rewards based on the test scores of students at each school and there is increasing interest in measuring individual teacher performance in raising student test scores and the potential of tying teacher bonus pay to this. Additionally, with the increased emphasis on rewarding test

scores may come an implicit reduction in the ability of school administrators to reward their evaluations of teacher performance, A. In effect, the discretion is removed from the school administrator in setting pay. This section takes up the question of how this is likely to affect schools regarding the incentive system and the value of educational services provided, both in the public, noncompetitive environment and for private, competitive schools.

In making this analysis, consider two sorts of dichotomous distinctions, one between good and bad schools and another between good and bad tests. By good schools, we mean ones that reasonably approximate the private, competitive outcome of point G in Figure 1. This may come about through competition induced by Tiebout mobility or through a wider availability of private schools or charter schools. Bad schools are the converse. Good tests are ones for which the marginal product of T ($\alpha_T$) is high and bad tests are ones where it is low. Also, it may be that bad tests are more likely to raise the marginal cost of other teaching activities and good tests are less likely to do so.

Now consider mandating rewards for different types of tests and schools. The removal of discretion in pay setting comes about with a mandated value of $b_T$ above what the school administrator would otherwise set and an implicit limit on $b_A$. These work to require an increase in $b_T/b_A$. For good schools that approximate the equilibrium at point G, any mandate of $b_T/b_A$ above the value established in this setting is distorting and reduces net welfare. This reduction is worse if the test is bad, but still has negative consequences if the test is good.

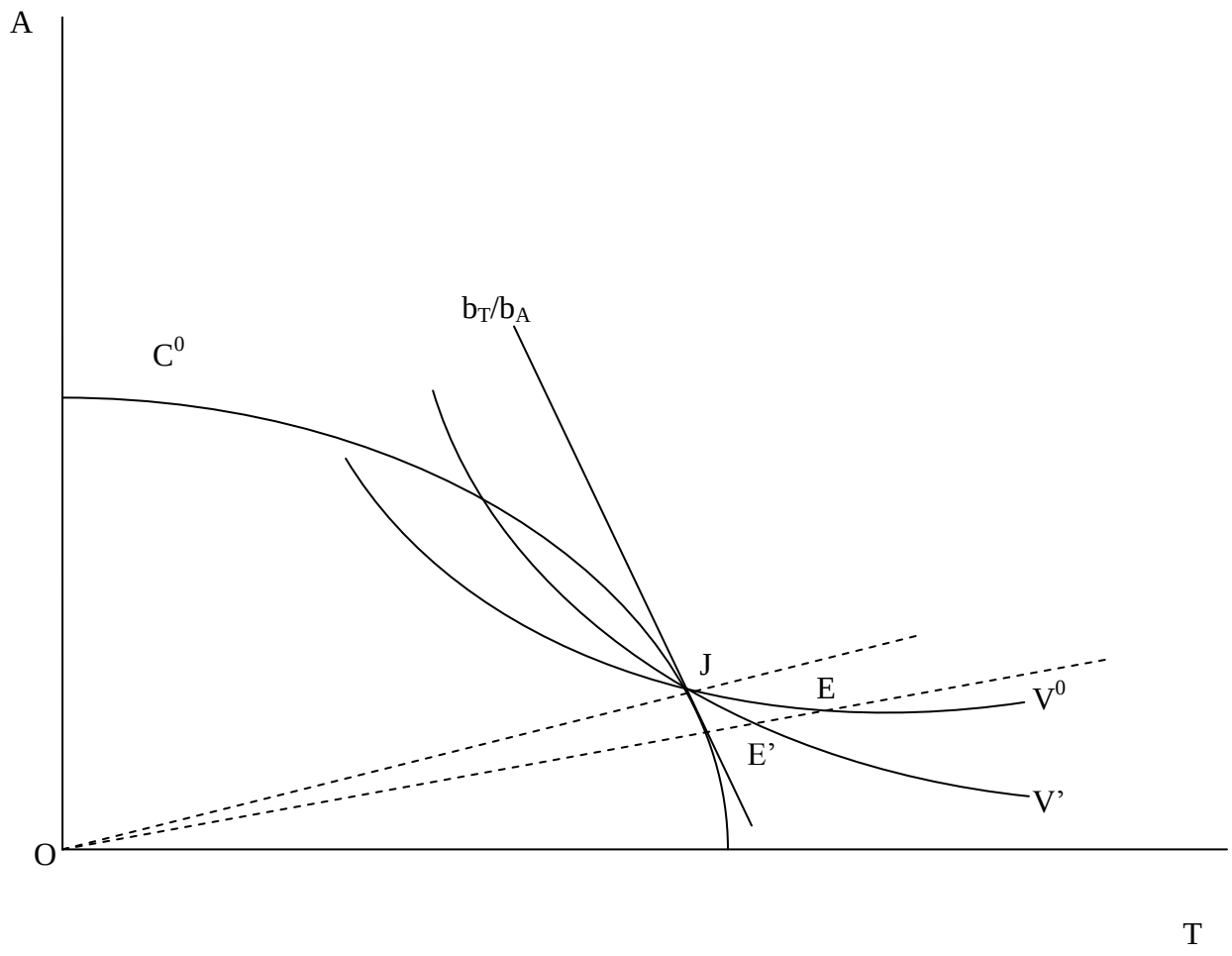
The more relevant case is that of bad schools. These are schools where decisions regarding incentives for teachers are distorted due to the influence of public ownership and lack of competition. This results in a lower value of educational services produced as at point J in Figure 1. The question here is whether a mandate to increase the reward for test scores improves outcomes or not. This depends, in part on whether the test is bad or good.

When a mandate for stronger test score rewards is put in place, this induces teachers to shift effort to generating higher test scores and away from other types of effort. Naturally, this causes T to rise and A (and possibly N) to fall. For bad tests, the higher T is associated with only a small increase in V (if any) and can easily be offset by the reduction in A. These shifts in effort can lower the value of educational services produced. For a good test, this is less likely to be the outcome. Increases in T induced by a higher $b_T$ will increase V unambiguously. A may still fall, but not be enough to cause the net effect on V to be negative.

This point is illustrated in Figure 2. The figure replicates the part of Figure 1 regarding the equilibrium for the noncompetitive, public school, shown at point J. The mandate for a higher $b_T/b_A$ induces the school to move along the ray OE instead of OJ regarding its pay setting. Whether greater value is created depends on whether the school's new equilibrium point is beyond point E (on isovalue curve $V^0$) or not. As drawn, this requires a large increase in T and only a small reduction in A. If the isovalue curve through J has a steeper slope as V' (reflecting a higher marginal product of T), the situation is different. As can be seen, increasing value requires a smaller increase in T

and can tolerate a larger reduction in A. Thus, for good tests, the mandated $b_T/b_A$ is more likely to result in greater educational value produced.

Figure 2




Note, though, regardless of this outcome, V will not be produced in the cost minimizing way. The public institution tends to distort rewards toward test scores since they are more visible. The test score reward mandate, by adding to this reward, increases the size of the distortion toward T and away from A.

## VI. Test Score Rewards Versus Institutional Change

As described above, mandating higher rewards for tests scores and removing discretion in pay setting are likely to be a mixed blessing at best. Such mandates for an entire state will have negative consequences for the good schools in the state and positive consequences for the set of bad schools, but only if the test is well designed. Given complaints that one hears about the nature of tests mandated by state departments of education, there are serious doubts that the tests being given and rewarded are good. If so, mandates for increased test score rewards have negative consequences for all schools.

An alternative to the above approach is to promote institutional reform. By institutional reform, we mean changes in the rules by which schools operate, thereby altering the discretion of school administrators and their payoff functions regarding pay setting. This implicitly changes their incentives, which are transmitted to teachers. Awarding school administrators more discretion is quite simple in principle. In order for this to be effective in obtaining the efficient incentive system, the payoff function for school administrators needs to be changed to look more like that of the competitive, private school. In order to see what this takes, recall the objective function for the public school administrator's choices of $b_T$ and $b_A$:

$$F_P \approx \theta(B(\theta_T\alpha_T T+\alpha_A A+\alpha_N N) - \varphi(C+\tfrac{1}{2}\rho R).$$

In order to move to the value maximizing outcome, the giving discretion to school administrators must be coupled with changes that move the values of $\theta$, B, $\theta_T$, and $\varphi$ closer to one. This is consistent with the analysis of Jensen and Meckling (1992). They argue that, where possible, efficient organizations combine discretion with the incentive to use it properly.

School choice programs are a way of accomplishing this. The idea is that this increases the responsiveness of the school's revenue (or budget) to V. i.e., it raises B. They do so by allowing the parent to move the child and the funding if the parent believes value is not being delivered. Choice programs come in a variety of forms, including magnet programs, open enrollment, charter schools, and voucher programs. Of these, only the latter two are likely to be very effective in raising overall educational value. Magnet schools typically enroll the top students with the remaining students allocated to the other schools. Likewise for open enrollment programs in that the best schools fill up quickly and the other schools are allotted the remaining students. Regardless of how bad the school is, it is almost guaranteed being filled and retaining its funding. No school administrator will see declining enrollment and have to suffer its consequences. The only incentive this provides is the likely preference for having the better students at the school rather than the worst.

Where vouchers are allowed to be used broadly and charter laws are unrestrictive enough so that charter schools are reasonably available, schools can lose students to other schools without being allocated more students to make up for the loss. Funding and the school administrator's rewards are likely to seriously suffer for schools with continually declining enrollment.

Other parameters that distort the setting of teacher incentives, $\theta$, $\theta_T$, and $\varphi$, have to do with the political influence on school administrators and the lack of residual income claimancy in the public sector. Institutions and practices that isolate schools from politics and/or somehow tie administrator rewards to value created move school administrator incentives in the right direction. There may be various organizational changes that can

shield school administrators from local politics. An example is stronger job guarantees for school administrators, so they feel more job security even in the face of politically unpopular actions. This can reduce their sensitivity to test scores and perhaps induce less worry about adverse teacher reaction to policies, serving to lower $\theta_T$ and $\varphi$ toward one. However, this would induce less concern over value created, further reducing $\theta$.

Another possibility is to encourage more parental participation by various means, including use of site-based management councils. These councils typically are boards that review major school decisions and have representatives from the school administration, teachers, and parents. The hope is that the parent representation makes the operation of the school more responsive to V and therefore increases $\theta$. This may work in that direction, but inclusion of teachers on the council increases the weight put on teacher utility, increasing rather than reducing $\varphi$. A further suggestion is for school administrators to be evaluated on a basis that more closely reflects parents view, perhaps with use of parent satisfaction surveys or similar information.

While each of these may have some positive effect, they are simply dancing around the obvious approach. Privately operated competitive schools, either as charter schools or traditional private schools, are much less distorted by political considerations and the ability of parents to remove their students and their funding sharpens the sensitivity of school administrators to educational value. This enables the school system to indirectly tap into the vast pool of specialized knowledge that parent have about their children.

## VII. Conclusion

This paper illustrates some familiar aspects of decentralized decision making and the use of information. In this context, school administrators have knowledge specific to their situation, i.e., the performance of the teachers. Limited use of that knowledge in setting teacher incentives, and use of only broadly available information (test scores), leads to less-than-desired outcomes. As pointed out by Hayek (1944, 1945) long ago, better outcomes are forthcoming when local, specific knowledge is used, but this relies on having appropriate incentives for school administrators to set teacher pay. This is absent for public sector institutions that face little competition. Mandated pay based on limited, general information seems unlikely to overcome the problems presented by the noncompetitive public institution in this regard. Allowing discretion to school administrators and providing them with the incentives to use it appropriately seems to be most readily attained by competitive, private institutions.

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