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Measuring Management Contribution through Decomposition of Efficiency Scores

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Abstract

How can we best approach the measurement of management quality? This paper begins with a review and replication of a measure for management quality developed by Meier and O'Toole (2002) using data from more than 1,000 Texas school districts over a 5-year period. This measure, based on residuals from a School Superintendent's Salary model, was found to have significant construct validity when used in a number of school output production models. An alternative measure is then proposed using Data Envelopment Analysis (DEA). Estimation of DEA relative efficiency scores for the Texas school data was found to have significantly construct validity as well for the same production models. DEA efficiency scores were then decomposed in an effort to better isolate the management quality components. The result of decomposing DEA efficiency scores provides mixed results dependent on both the specification of the original DEA model and the decomposition model. The paper ends by setting out a direction for future research.

INTRODUCTION

Unpacking the black box of public management is a central challenge for public administration scholars. Understanding its relationship with public performance is an important yet elusive goal. Theory suggests quality management matters for improving the performance of public organizations, but how do we empirically test this proposition? Building on Meier and O'Toole's (2002) work testing a residual model to measure senior level management quality, this study develops an approach using data envelopment analysis (DEA) to capture influences of broader managerial quality on school performance outcomes. The research uses the same data from over 1,000 Texas school districts as Meier and O'Toole's (2002) study, enabling insights to the research question to be drawn from their comparison.

This article contributes to that body of research seeking to empirically link public management quality with performance outcomes. The article proceeds as follows: a

review of literature defining and measuring management quality; a discussion of production theory and its theoretical implications for this study; an application of DEA; and an assessment of salary residual and DEA approaches to measuring management quality. Finally we attempt to parse out non-management elements of the DEA score, in a fashion similar to the approach of Meier and O'Toole (2002) to generate a residual measure. This is then evaluated against the other measures.

APPROACHES TO ASSESSING MANAGEMENT QUALITY

There are many approaches to understanding the concept of management quality. This literature is rich and thoroughly covered elsewhere (Brudney et al. 2000; Ingraham & Lynn 2004; Kettl & Milward 1996; Lynn et al. 1999; Meier & O'Toole 2002). Our purpose here is to frame some of the issues and measurement approaches that inform this research. Grounding this work in the field's historical tradition, such early contributors as Taylor (1916), Fayol (1916) and Gulick (1937) associated quality management with efficient use of resources. Later contributors reminded us that in the public sphere approaches to assessing management quality extend beyond interest in efficient production of goods and services to issues of effectiveness and equity (Marini 1971; Waldo 1948).

Berman and West's (2003) twist on the issue, offers managerial *mediocrity* as the quality of having only a modest commitment to the contemporary values and practices of public administration. Those contemporary values and practices, the authors argue, are: a commitment to serving the public interest, providing accountability, achieving excellence, and committing to using contemporary best practices. Managerial quality then may be described as the vigorous embodiment of these values and practices.

In the 1980s and 1990s, through such prominent vehicles as the National Performance Review (Gore 1993) and the reinvention movement (Osborne and Gaebler 1993), the field's understanding of management quality evolved to be centrally concerned with government performance. As Kettl put it, "Public management matters and it matters because the quality of public management shapes the performance of public programs" (1996: 1).

One of the largest empirical studies of management quality ever undertaken in a U.S. context was based on the premise that management matters in the delivery of public services (Ingraham et al. 2003). The Government Performance Project undertook to study the public management capacity of government agencies as the context for performance of local, state and federal governments. A criteria-based approach was used to assess management capacity within the realms of financial, human resources, information technology and capital management systems (Ingraham et al. 2003). The study was primarily descriptive and although performance outcomes were not assessed, they were expected to be associated with greater and lesser management capacity or, if you will, management quality.

Another methodological approach suggested by recent research links management quality to performance outcomes using a residual measurement technique. In the context of "best practices" research, Bretschneider, Marc-Aurele and Wu (2005) suggest that in a single output linear or nonlinear regression model, cases may be compared for better (or worse) conversion of inputs to outputs by comparing the residuals from the estimation process. "The larger residual value implies that the associated unit had somehow done a better job at using these inputs to produce the output. By this logic, the maximum-value

case is one way to think about identifying the 'best practice'" (Bretschneider et al. 2005: 314). By extension, best practices research may be one way to observe higher and lower management quality at work.

Meier and O'Toole (2002) understand senior leadership to play an integral role in management quality and seek to measure the management quality of Texas school district superintendents by using a residual approach.[1] Their main assumption is that in determining the annual compensation of superintendents, school boards in Texas base their judgments on a set of criteria, of which one is management quality (Meier & O'Toole 2002: 632). Only, management quality is not directly observable. To get around this limitation, the authors regress such factors as experience, past performance, education, size of district, and the like on superintendents' salaries; what is left in the salary equation after all of these observable characteristics have been estimated (i.e. the regression residuals), serves as a proxy for management quality. In other words, the portion of the variance in salaries not explained by observable, established predictors is suggested to be an assessment of managerial quality. Essentially this approach assumes that there is an efficient economic market of executive management and positive residuals reflect a salary premium for that higher quality management talent.

This approach is labeled by Meier and O'Toole themselves a "messy one". Indeed, at the level of construct validity, using regression residuals poses serious questions as to the potential for generalization. There is no guarantee that the residuals capture only managerial quality. In fact, they might contain many factors not included in the model, like the ability to sell oneself and physical characteristics, to name two of

[1] See their work (1999; 2002) addressing linkages between leadership aspects of management and public sector performance.

those outlined by the authors (Meier & O'Toole 2002). In a similar way variables included may not be modeled using the appropriate functional form. The relationship may be non-linear. Nevertheless, the authors contribute an unconventional and insightful way to conceptualize the measurement of management quality, particularly senior level management quality, to a field grappling with this issue.

A DEA APPROACH TO MANAGEMENT QUALITY

The approach developed here uses Meier and O'Toole's (2002) residual approach and Duncombe and Yinger's (1997) efforts to measure school district efficiency as a springboard to develop an alternative measure of management quality. A foundational assumption of Duncombe and Yinger's (1997) work is that a school district's productive efficiency influences the district's costs and educational outcomes. They use the data envelopment analysis (DEA) technique pioneered by Charnes, Cooper and Rhodes (1978) to demonstrate this point in the context of New York school districts.

DEA is a fairly common approach to studying the productive efficiency of schools (Bessent et al. 1982; Rubenstein et al. 2003) and school districts (Duncombe & Yinger 1997; Ruggiero et al. 1995). Our research takes the question of the relationship between productive efficiency and management quality as its point of departure. Why do levels of productive efficiency in public settings differ? We understand the ability of public managers to translate resources into outcomes (their productive efficiency) to be an indicator of management quality and a potentially major source of variation in a school districts ability to translate inputs into outputs.

In the context of public school districts, a critical responsibility of school superintendents and their entire management infrastructure is to use resources as

efficiently and effectively as possible. Given inputs, such as financial and socio-demographic factors of the environment ((Duncombe & Yinger 1997; Ruggiero et al. 1995; Bessent et al. 1982; Hanushek 1986; Duncombe, Miner & Ruggiero 1997), how efficiently do superintendents and their management teams convert resources into educational outcomes?[2] DEA produces a relative efficiency score such that within a sample of school districts we can observe which districts convert the specified inputs to outputs more and less efficiently relative to all other districts within the sample. Presumably, then, the quality of school district management plays an integral role in this process.

Returning to Meier and O'Toole's (2002) approach to measuring management quality, their model suggests the residual of a superintendent salary regression reflects quality of management for the superintendent. A DEA relative efficiency score containing aspects of district management quality should behave similarly to the salary residual when regressed on outcome variables. We explore this in our analysis.

Importantly, Duncombe, Miner and Ruggiero note that "efficiency may be only one goal" (1997: 2) amongst those negotiated between public managers and political representatives (Niskanen 1971). Hence, this research suggests DEA of school district efficiency as a partial measure of management quality. DEA efficiency scores should sufficiently contain aspects of management quality to make this a potentially useful contribution to the body of work addressing its measurement.

DATA & METHODS

[2] The terms "outcomes" and "outputs" are used interchangeably in this article. We use established educational outcome measures, including test scores and drop-out rates (Ruggiero et al. 1995; Duncombe, Miner & Ruggiero 1997; Rubenstein et al. 2003).

The units of analysis for our study are Texas school districts. The primary data for our analyses come from the Texas school district data set used by Meier and O'Toole in their public management study in 2002 that also includes a supplementary superintendent dataset. We have a panel of approximately 1,043 school districts spanning 5 years from 1995 to 1999 for a total N of 5,213. While more current data are available, we constrain this study to the data used by Meier and O'Toole to insure comparability. The dataset contains school district fiscal and demographic data such as race, poverty, and per-pupil expenditures. The superintendent dataset is a self-reported survey with variables containing information on superintendent race, tenure, experience, and education among other variables. The descriptive statistics of relevant variables used in our analyses are outlined in Table 1.[3]

DEA Model with Inefficiency Residuals

Data Envelopment Analysis (DEA) is a quantitative method used to analyze among other issues, the concept of efficiency. We propose a DEA score to be an alternative indicator of managerial quality that captures aggregate management effects, in contrast to a more limited measure of superintendent leadership roles as in the salary residual approach to measurement. A DEA model makes use of production function theory by estimating the relative efficiency of one unit's (school district) ability to convert inputs to outputs compared to all other units in the sample. A non-statistical technique, the approach assumes that all units are applying the same basic production technology and use the same inputs to produce the same outputs. A series of linear programming problems equal to the number of units is solved to generate the actual

[3] Meier & O'Toole provided us with an updated and revised version of the data due to some issues pertaining to recoding and over reporting. This accounts for some minor differences in our replication of Meier and O'Toole's results reported below.

scores. A perfect score of one implies no other district does better at this productive process. Efficiency scores of less than one imply at least one other unit is generating more output for the same input. These results are relative to cases in the sample. In our study, using the entire population of Texas school districts avoids any problems of sample relativity.

Another important issue when using DEA is the selection of inputs and outputs. Some studies have looked at the effects of specification in the context of education and found that at the school level DEA is relatively robust with respect to reasonable specification (Rubenstein et al 2003) as long as variables represent the main class of inputs and outputs. In this study we focus on the school district level and apply specification similar to those used by others (Duncombe and Yinger 1997; Ruggiero et al. 1995).

The DEA estimation (corresponding to resid0 below) was conducted on school districts for all years (n=5106) based on six inputs (total enrollment, percent of low-income students, Hispanic students, Black students, instructional expenditure and non-instructional expenditures) and two outputs (pass rates on standardized tests, the Texas Assessment of Academic Skills (TAAS), and the dropout rate). Since these two outputs are inverse measures of performance from one another, we multiply the dropout rate by negative one (-1) so that the maximization of the objective functions of the linear programming problems is appropriately formulated.

An alternate specification of the DEA estimation (corresponding to resid4 below) has also been conducted to test the robustness of our findings. This second DEA estimation is more demanding as it requires 9 inputs (total enrollment, percent of low

income students, Hispanic students, Black students, students in special education, percent of staff being educational assistants, percent of staff being teachers, total instructional expenditures, total revenues) and 6 outputs (dropout rate, pass rate for all students, for low-income students, pass rate on reading examinations, on writing examinations, and on math tests). The correlation between the two specifications of the DEA is 0.29. We return to this alternate specification later in this paper.

We use the reciprocal of the DEA efficiency scores, or a measure of inefficiency (i.e. 1/DEA), which is the standard approach in the literature. This transformation improves the variance properties of the indicator by allowing values to range from one to infinity instead of zero to one. Consequently the inefficiency scores improve our ability to assess their significance when used in a standard regression equation.

The last step of our DEA specification is to attempt to disentangle managerial quality from the DEA inefficiency residuals themselves. In a procedure akin to the one designed by Meier and O'Toole (2002), we use a Tobit[4] regression of the DEA inefficiency scores on a series of controls affecting the productive efficiency of school districts, and we retain the regression Tobit residuals as an indicator of managerial quality. Selecting variables for this model is highly problematic! In theory we need to identify variables that are influential in causing variation in a district's ability to efficiently convert inputs to outputs but not related to management. Ideally variables that measure variation in the complexity and harshness of school district environments are useful. Another problem is that the efficiency scores themselves are derived from complex non-linear comparisons of inputs and outputs. Often variables that tap variation

[4] Since DEA inefficiency scores range from 1 to infinity, the bounded nature of the dependent variable requires a Tobit model to maintain consistency of estimation.

in environments are correlated with inputs, like tax rates and population characteristics. Beyond these concerns, we are extremely limited by the data available to do this study. Consequently we chose the following as variables in the Tobit equation to separate out management effect; the logged revenue per pupil (environment), the logged tax rate (environment), the superintendent experience (executive level management), the percentage of teachers with one or more teaching permits (environment), the student-teacher ratio (environment), total enrollment (input) and the total pass rate (output). The last two variables were included in part to try to remove the concern that the DEA scores contain elements of the dependent variables in the final production models used to test construct validity.

ANALYSIS

Table 1 presents a summary of the data used in this study provided by Meier and O'Toole. Table 2 presents the results from Meier and O'Toole (2002) slightly altered based upon the updated and revised data provided to the authors and reported in Bretschneider, et al. (2006). Tables 3a and 3b provide results for Bretschneider et al. (2006). In that paper the inverse DEA scores were used directly along with the salary residual.[5] These results are consistent with the approach developed by Duncombe and Yinger (1997) where inefficiency is used as an independent variable in their cost-production equation. The results suggest that efficiency (inefficiency) is an important element in production equations as its inclusion clearly enhances overall explanation. In this context it did not diminish the impact of the salary residual.

[5] Bretschneider, S.I, S. Ballal, A. Genest, and S. Smith, "Construct Validity, Measurement & Management Quality: The Quality of Management isn't strained; it's just hard to measure," Presented at Fall Research Conference, APPAM, Madison, WI, November, 2006.

Table 4a presents the results from the Tobit equation attempt to model inefficiency based on the model using 6 input variables and 2 output variables while table 4b presents similar results for the inefficiencies estimated using 9 inputs and 6 outputs. These results suggest that the larger model generated results with greater face validity. Factors like revenue capacity, teacher certificates and student teacher ratios are likely to lead to less efficiency. These results are consistent with previous studies in this area. This suggests that DEA specification is important and not necessarily as robust as some others have found.

Tables 5a and 5b present the results from applying the DEA residuals to the base models. These give essentially the same overall results as using the salary residuals approach. The overall fit for the models is essentially the same. Coefficient estimates for other covariates are also quite similar. The one surprising outcome is that the DEA residual has a positive significant coefficient. Given that the original variable was appropriately negative and significant for a measure of inefficiency, these residuals seem to, at least on their face, represent some underlying variable that is in opposition to inefficiency but embedded within the inefficiency measure. As this measure increases so does the pass rate. Another result worth noting is that while the individual Tobit models suggested quite different results the two sets of residuals behave the same when used in these models. Table 6 includes both the salary and the DEA residual measures from the 6 input and 2 output approach, again, in the base models for outcomes. While both measures are statistically significant the use of both variables has only a marginal contribution to explanatory power.

Meier and O'Toole (2002) also test the impact of the salary residual on other measures of performance, including pass rate by race and poverty, average scores on other tests, dropout rates, enrollment, percentage tested, and percentage scoring above 1100 with controls.[6] We therefore ran 10 performance models with the above-mentioned measures as our dependent variables: first by replicating their original models, then substituting the residual measure with our DEA inefficiency residuals, and finally estimating the model with both the salary residual and the DEA inefficiency residual. Tables 7, 8 and 9 summarize these results for the DEA residuals from the 6 input and 2 output model. Table 7 recreates the basic results reported in Meier and O'Toole (2002) but from the revised data provided to the authors using only the salary residual. Table 8 summarizes the same basic models but substitutes the DEA residual for the salary residual. Finally Table 9 presents the results when both residual measures are used. These tables provide the coefficient estimates, t-statistic, R-square and sample size for the quality measure when it is regressed on different dependent variables.

Looking at Table 8, major differences associated with using the DEA residual are a lack of significance in explaining Black pass rates, significant results on percentage tested and a positive significant result on dropout rate. These differences are also present in Table 9 when both variables are used in each of these models. The results are similar to those associated with TAAS pass rate. The DEA inefficiency residual does a better job of explaining overall variance in each of the output measures and exhibits much less sampling variation in each case. These differences while somewhat problematic may be

[6] Meier and O'Toole do not include parental and community support, and student attendance variables in these models which could be because of the high number of missing values in these 3 variables (the survey had a response rate of only 57 percent which would significantly reduce the N). When they include these variables in the regressions, the results are similar except on Black TAAS scores.

capturing important differences in sub-populations. For example, in most of the school districts the proportion of black students is quite small and may be the single major contribution to the dropout rate. Similarly, non-black students make up the vast majority of test takers in the vast majority of schools. Thus one possible explanation for these differences is that the DEA residual may be picking up different sub-population experiences in different ways.

Differential DEA Inefficiency Residuals

Our analysis suggests that DEA residuals are a significant indicator of management quality. However, they are not the only factor determining managerial quality and isolating the effects of efficiency (or inefficiency) is problematic. To illustrate this point, we ran the same models using residuals derived from the DEA analysis based on 9 inputs and 6 outputs.[7] When using these DEA residuals along with salary residuals in the various output regressions, for most part, there is concurrence amongst the two results. Most of the discrepancies between the two residuals occur in a difference in direction; the affected variables are generally statistically insignificant though. For example, there is a switch from a positive to a negative relationship between class attendance and DEA inefficiency residual when the second set of DEA residuals is used. However, there is no change in the significance of the relationship when we use either. Another example in the same vein is the difference in the direction of relationship between teacher experience and DEA inefficiency residual. The initial DEA residuals are negatively related to teacher experience, whereas the second set of residuals is positively related to teacher experience; however, both are insignificant. Except for a few instances,

[7] The tables from the analyses involving residuals based on 9 inputs and 6 outputs are not included in the paper. However, the tables can be obtained from the authors.

the regression analyses that include one or the other DEA residual with the salary residual provide similar results.

IMPLICATIONS OF FINDINGS

The approach demonstrated in this paper builds directly upon the work of Meier and O'Toole (2002). First we develop a residual approach to measuring managerial contributions to output, secondly we attempt to ascertain the quality of the measure through a series of applications to production models. The results are mixed. First there is evidence that a DEA efficiency or inefficiency measure contains additional and unique information on management quality. This information potentially reflects the aggregate effects of management throughout the system and is not limited to top-level management contained in the salary residual measure generated from a model of superintendent salary. The statistical evidence presented here suggests that when the DEA measure is included in the production equation these additional effects are underlined and suggest two additional important points. First, failure to include a measure of efficiency (including embedded elements of management quality) misspecifies the production equation leading to an overstatement on the effects of top-level management. This point is actually clear in the work of Duncombe and Yinger (1997). Second, this result also suggests it might be possible to further disaggregate a system wide measure of management quality from other aspects of efficiency. It should be noted though that DEA efficiency scores are not a direct measure of management quality. DEA efficiency is a relative measure that is constrained by the set of cases used. Samples of populations can cause serious problems if very high efficiency cases are outside the sample. In addition, like the salary residual

measure, DEA inefficiency residuals can include other factors beyond management, leading to a similar "messy" measure subject to specification issues.

The actual attempt to generate and evaluate a DEA residual measure, while promising, remains problematic. First model specification of both the DEA inputs and outputs and the model of explanation for the results are problematic. Different DEA specifications led to very different results from empirical estimation of the explanations. Surprisingly, though, the two residual measures performed somewhat similarly when evaluated over a number of output models. Secondly, evaluation of the DEA residuals did not generate completely consistent results with our expectations for a measure of management quality. For example, the relationship to dropout rate was positive not negative.

CONCLUSIONS

The main research question addressed in this study concerns how we might improve our understanding of how to measure management quality with respect to its effects on public performance outcomes. Based on the assumption that management quality is integral to the efficient conversion of resources to educational outcomes, this research uses DEA as a tool to assess management quality. The results suggest this measurement strategy does indeed capture at least some important aspects of management quality not previously accounted for.

As with the salary residual approach pioneered by Meier and O'Toole (2002), it must be noted that this approach provides a partial measure of management quality. Results suggest the DEA approach contributes importantly to improving model specification and provide direction for future research. Future work using stochastic

frontier modeling may address some of the measurement problems inherent to DEA approaches. And, decomposition of the DEA efficiency score into those components that measure management quality and other factors is an important next step.

In closing, a DEA approach to measuring public management quality holds promise for fields outside the realm of public education. Its flexibility with regard to the various types of inputs and outputs it is able to account for may facilitate its application to health, public safety, city management and other arenas.

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Table 1: Descriptive Statistics

Variable	N	Mean	Std Dev	Min	Max
TAAS pass rate (apass)	5104	73.92	12.58	14.30	100.00
Class attendance (atten)	5106	95.86	0.94	85.00	98.90
Average ACT score (avgact)	4238	19.84	1.62	13.70	26.10
Average SAT score (avgsat)	3511	931.20	89.07	594.00	1296.00
Percent black superintendent (blksup)	5098	0.01	0.10	0.00	1.00
Black pass (bpass)	2968	55.38	17.92	0.00	100.00
Community support (dci)	2661	3.88	0.83	1.00	5.00
Parental involvement (dpi)	2656	3.32	0.93	1.00	5.00
Dropout (dropout)	5010	1.17	1.14	0.00	11.10
Superintendent's with PhDs (drsup)	5098	0.24	0.43	0.00	1.00
Female superintendent (femsup)	5098	0.09	0.28	0.00	1.00
Hispanic superintendent (hispsup)	5098	0.06	0.24	0.00	1.00
Latino pass (hpass)	4530	63.91	15.84	0.00	100.00
Logged budget (lbud)	5105	15.62	1.37	11.49	20.87
Logged superintendent salary (lnpay)	5056	11.12	0.27	9.95	12.23
Low income pass (lowpass)	5064	64.65	14.28	0.00	100.00
Logged revenues (lrevp)	5105	8.68	0.22	7.15	10.40
Logged tax rate (ltax)	5106	0.34	0.12	0.00	0.78
Percent above 1100 (plpass)	5105	69.40	10.67	33.16	98.16
Percent tested (ptested)	4591	63.44	16.26	0.00	100.00
Superintendent age (supage)	5038	50.94	6.46	25.82	73.92
Superintendent experience (supexp)	5098	24.08	8.29	0.00	48.00
Superintendent tenure (supten)	5098	6.66	8.03	0.00	42.00
Anglo pass (wpass)	5025	80.78	10.33	0.00	100.00
Black students (xbst)	5106	8.13	12.19	0.00	86.00
Hispanic students (xhst)	5106	26.69	26.75	0.00	100.00
Low income students (xlow)	5106	46.42	19.04	0.00	100.00
Teacher certification (xperm)	5106	3.96	4.83	0.00	47.20
Per-pupil instructional exp (xpst)	5105	3173.94	810.08	202.00	10916.00
Class size (xstear)	5106	13.11	2.56	3.40	57.40
Teacher salaries (xtsal)	5105	30415.57	2991.41	18932.00	49187.00

Table 2: The effect of management on TAAS pass rate (Meier and O'Toole)

Variable	Slope	t-score	Slope	t-score
Residuals	0.8685	7.57	0.4282	2.78
Teachers salaries	0.0007	8.90	0.0007	6.92
Instruction spending	-0.0005	-2.11	-0.0008	-2.60
Black students	-0.2599	-23.07	-0.1729	-11.44
Latino students	-0.1146	-15.25	-0.1166	-12.29
Low-income students	-0.1838	-18.09	-0.1025	-7.74
Class size	-0.5874	-7.48	-0.1987	-2.03
Teacher experience	0.1633	2.33	0.0745	0.83
Non-certified teachers	-0.1712	-7.04	-0.1323	-4.11
Parental support			0.5362	2.69
Community support			0.9881	4.58
Student attendance			3.6738	20.03
R^2	0.596		0.6445	
Standard error	7.96		7.13	
F	570.36		298.08	
N	5019		2623	

Table 3a: The effect of management on TAAS pass rate with DEA inefficiency

Variable	Slope	t-score	Slope	t-score
inefficiency	-9.2783	-53.76	-8.4166	-34.92
teachers salaries	0.0009	14.94	0.0009	10.86
instruction spending	0.0003	1.66	-0.0005	-1.86
Black students	-0.1098	-11.67	-0.0619	-4.83
Latino students	0.0245	3.76	0.0103	1.20
Low-income students	-0.1069	-13.02	-0.0514	-4.66
Class size	-0.2880	-4.56	-0.2883	-3.57
Teacher experience	-0.1094	-2.00	-0.1838	-2.49
Non-certified teachers	-0.1066	-5.47	-0.0921	-3.49
Parental support			0.5538	3.38
Community support			0.7149	4.01
Student attendance			2.1516	13.66
R^2	0.7383		0.757	
Standard error	6.43		5.91	
F	1107.9		517.71	
N	5102		2655	

Table 3b: The effect of management on TAAS pass rate with inefficiency and residual

Variable	Slope	t-score	Slope	t-score
inefficiency	-9.3087	-52.34	-8.39	-34.24
residuals	0.0097	0.10	-0.10	-0.76
teachers salaries	0.0009	14.49	0.00	10.82
instruction spending	0.0004	2.14	0.00	-1.77
Black students	-0.1092	-11.49	-0.06	-4.66
Latino students	0.0268	4.04	0.01	1.07
Low-income students	-0.1083	-13.05	-0.05	-4.55
Class size	-0.2762	-4.35	-0.28	-3.44
Teacher experience	-0.1323	-2.34	-0.21	-2.74
Non-certified teachers	-0.1140	-5.82	-0.10	-3.56
Parental support			0.58	3.50
Community support			0.70	3.87
Student attendance			2.15	13.57
R^2	0.7389		0.7547	
Standard error	6.4		5.93	
F	1015.14		475.56	
N	5019		2623	

Table 4a: Tobit Model of Inefficiency (1/DEA) based on 6 inputs and 2 outputs

Variable	Slope	Std. Error	Chi-Square	P-Value
Intercept	-4.522	0.443	104.18	<..0001
Log of Revenue/Pupil	1.066	0.047	517.25	<.0001
Log Tax Rate	0.676	0.058	134.20	<.0001
Superintendent Experience	0.001	0.001	2.44	0.1184
Percent Teachers with Certificates	0.003	0.002	3.80	0.0514
Student Teacher Ratio	0.058	0.004	179.70	<.0001
Total Enrollment	0.000	0.000	60.80	<.0001
Total Pass Rate	-0.047	0.001	6531.77	<.0001
Scale	0.505	0.005		
N=5168				

Table 4b: Tobit Model of Inefficiency (1/DEA) based on 9 inputs and 6 outputs

Variable	Slope	Std. Error	Chi-Square	P-Value
Intercept	2.711	0.089	924.73	<..0001
Log of Revenue/Pupil	-0.132	0.010	195.54	<.0001
Log Tax Rate	0.015	0.011	1.76	0.1840
Superintendent Experience	0.001	0.000	13.57	0.0002
Percent Teachers with Certificates	-0.001	0.000	3.29	0.0695
Student Teacher Ratio	-0.019	0.001	500.12	<.0001
Total Enrollment	0.000	0.000	25.50	<.0001
Total Pass Rate	-0.002	0.000	321.75	<.0001
Scale	0.095	0.001		
N=5107				

Table 5a: The effect of management on TAAS pass rate with DEA inefficiency residuals (6 inputs and 2 outputs)

Variable	Slope	t-score	Slope	t-score
DEA Inefficiency Residuals (resid0)	3.0241	11.58	2.9779	8.70
Teacher Salaries (xtsal)	0.0007	9.73	0.0007	6.58
Instruction Spending (xpst)	-0.0001	-0.60	-0.0001	-0.28
% Black students (xbst)	-0.2654	-23.78	-0.1838	-12.35
% Latino students (xhst)	-0.1454	-18.77	-0.1460	-14.94
% Low-income students (xlow)	-0.1855	-18.57	-0.1064	-8.19
Class size (xstear)	-0.4888	-6.25	-0.0102	-0.10
Teacher Experience (xtexp)	-0.0204	-0.30	0.0155	0.18
% Teacher Certification (xperm)	-0.1421	-5.89	-0.1035	-3.28
Parental Support (dpi)			0.5870	3.00
Community Support (dcs)			0.9207	4.34
% Student Attendance (atten)			3.7117	20.73
R-Square	0.5969		0.6522	
Standard Error	7.99		7.08	
F-Statistic	589.33		315.4	
N	5167		2683	

Table 5b: The effect of management on TAAS pass rate with DEA inefficiency residuals (9 inputs and 6 outputs)

Variable	Slope	t-score	Slope	t-score
DEA Inefficiency Residuals (resid0)	5.6851	4.44	4.5698	2.75.
Teacher Salaries (xtsal)	0.0007	9.89	0.0007	6.87
Instruction Spending (xpst)	-0.0002	-0.85	-0.0001	-0.30
% Black students (xbst)	-0.2446	-21.82	-0.1554	-10.49
% Latino students (xhst)	-0.1111	-14.70	-0.1087	-11.52
% Low-income students (xlow)	-0.2042	-19.27	-0.1291	-9.36
Class size (xstear)	-0.5574	-7.02	-0.0836	-0.87
Teacher Experience (xtexp)	0.0556	0.82	0.1353	1.55
% Teacher Certification (xperm)	-0.1572	-6.51	-0.1054	-3.33
Parental Support (dpi)			1.0006	4.75
Community Support (dcs)			0.4766	2.45
% Student Attendance (atten)			3.6652	20.42
R-Square	0.6008		0.6586	
Standard Error	7.889		6.993	
F-Statistic	589.48		318.1	
N	5106		2656	

Table 6: The effect of management on TAAS pass rate with DEA inefficiency residuals and salary residuals

Variable	Slope	t-score	Slope	t-score
DEA inefficiency residuals (resid0)	3.4284	12.97	3.1070	9.03
Salary residuals	1.0293	9.07	0.5570	3.65
teachers salaries	0.0006	7.96	0.0006	6.05
instruction spending	-0.0002	-0.70	-0.0003	-0.87
Black students	-0.2694	-24.26	-0.1865	-12.47
Latino students	-0.1456	-18.74	-0.1441	-14.66
Low-income students	-0.1851	-18.52	-0.1092	-8.36
Class size	-0.4828	-6.21	-0.0366	-0.37
Teacher experience	0.1566	2.27	0.0879	0.99
Non-certified teachers	-0.1495	-6.23	-0.1118	-3.51
Parental support			0.5310	2.71
Community support			0.9338	4.39
Student Attendance			3.6171	20.01
R-Square	0.6090		0.6551	
Standard Error	7.83		7.03	
F-Statistic	559.35		294.01	
N	5019		2623	

Table 7: Management Quality (Salary Residuals) and other performance measures

Dependent Variable	Slope	t-score	R2	N
Latino pass	0.4840	2.51	0.38	4459
Black pass	0.7131	2.70	0.38	2919
Anglo pass	0.8569	7.47	0.42	4947
Low income pass	0.8851	6.03	0.50	4988
Average ACT score	0.0809	3.85	0.36	4179
Average SAT score	3.1831	2.83	0.49	3459
Percentage above 1100	0.6660	4.27	0.29	4604
Percentage tested	0.0208	0.09	0.12	4525
Dropout	-0.1253	-8.21	0.16	4933
Class attendance	0.0868	7.47	0.24	5019

Table 8: Management Quality (DEA inefficiency residuals) and other performance measures

Dependent Variable	Slope	t-score	R-Square	N
Latino pass	1.9478	4.28	0.3826	4576
Black pass	0.4254	0.58	0.3829	2985
Anglo pass	4.0357	14.78	0.4287	5088
Low income pass	3.0539	9.09	0.5062	5130
Average ACT score	0.1369	2.57	0.3623	4275
Average SAT score	10.6540	3.62	0.4957	3539
Percentage above 1100	1.1748	3.11	0.2847	4711
Percentage tested	4.1253	7.14	0.1337	4631
Dropout	0.1371	3.79	0.1439	5059
Class attendance	0.0392	1.44	0.2243	5167

Table 9: Management Quality (DEA inefficiency and salary residuals) and other performance measures

	DEA Inefficiency Residuals		Salary Residuals	
Dependent Variable	*Slope*	*t-score*	*Slope*	*t-score*
Latino pass	2.3339	4.97	0.5834	3.02
Black pass	0.3948	0.53	0.7202	2.72
Anglo pass	4.4373	16.09	1.0604	9.43
Low income pass	3.5163	10.29	1.0422	7.14
Average ACT score	0.1459	2.69	0.0841	4.00
Average SAT score	10.9581	3.63	3.3742	3.01
Percentage above 1100	1.2932	3.36	0.6976	4.47
Percentage tested	4.2733	7.24	0.1396	0.58
Dropout	0.1063	2.89	-0.1208	-7.87
Class attendance	0.0607	2.23	0.0896	7.67