

PUBLIC MANAGERS AND COST-EFFECTIVENESS: EVIDENCE FROM TEXAS SCHOOL DISTRICTS

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Abstract

Cost-efficiency and cost-effectiveness are neglected aspects of performance in public administration research. In particular, their relations to managerial behavior are not well understood. This paper uses stochastic frontier analysis, a proven technique from productivity analysis, to fill those gaps. An empirical illustration is given for Texas school districts. Results for the period 1997-2010 confirm modest economies of scale for small schooldistricts, but also indicate diseconomies of scale for the largest districts. Using additional survey data for 2004-2007, we find evidence for a positive impact on cost-effectiveness of performance-related priorities of superintendents, and similar benefits from decentralizing decisions to school principals. The benefits of external networking, although shown in earlier work to be positively related to educational outcomes, do not seem to exceed their costs, however. An unexpected result is the absence of the presumed disciplining force of local tax payers on cost effectiveness. Finally, a stable teacher workforce, already shown before to be beneficial for educational outcomes, also has a positive impact on cost-effectiveness.

1 Introduction

The performance of public organizations is one of the key topics in public administration research (for an overview, see Walker and Boyne 2009). The main focus has been on the process of performance measurement and management and typically challenges the assumptions of 'new public management' and related reforms. A much smaller part of the research effort addresses the determinants of public performance. According to these authors, dimensions of performance receiving not a great deal of attention are: governance and democratic outcomes, equity and cost-effectiveness. Earlier work of Boyne (2003) indicated that around 80% of selected high quality empirical studies concerns quantity and quality of outputs and outcomes, where only 10 percent concerns efficiency and about 4 percent relates to cost-effectiveness. At the same time, the last two decades advanced methods of efficiency and productivity analysis have become widely available (for an overview, see Fried et al. 2008). Although these techniques have also been applied to efficiency analysis in the public sector, often published in economic journals (Kalb 2012 gives an overview for local government efficiency studies), they seem to be absent in public management research. This paper uses these techniques to study the role of public management for cost-effectiveness. Its relevance is not only derived from academic criteria but also from the practitioner's urgent need for results on the cost-effectiveness of public programs. Many governments are cutting budgets on an unprecedented scale after the financial crisis developing in 2008. Reducing budgets and safeguarding the level of essential public services as much as possible, requires thorough knowledge of their cost-effectiveness.

The methodology of the paper closely follows the evidence-based research agenda on public management put forward by, among others, Meier and O'Toole (2009), using large datasets

and quantitative empirical methods. The paper adds new insight by focusing on measures of cost-effectiveness, usually not considered in current public administration research. An empirical illustration is given by studying the cost-effectiveness of Texas schooldistricts, using the database of Meier et al (for details, see O'Toole and Meier 2009). Section 2 outlines the theoretical background of the paper, while section 3 estimates a stochastic cost frontier for Texas schooldistricts based on data for 1997-2010. Section 4 relates costs and outcomes to managerial variables for the shorter period 2004-2007, for which detailed survey data on management are available. Although the approach of our paper is confined to the production side of public education, section 5 discusses some equity issues in the Texas school system, in view of the large state and federal grants to schooldistricts that supplement local tax revenues. Section 6 discusses conclusions and implications.

2 Theoretical background

Current approaches to public sector performance in the context of the evidence-based research agenda typically try to explain program performance as a function of independent variables that measure product or client characteristics, environmental influences and organizational and managerial variables such as the extent of decentralized decision making, the level of external networking by employees or managers, their intrinsic skills and qualities, available resources etc. Cost-effectiveness or efficiency of the institutions or programs involved is typically not considered. Although resources are often included as a control variable (for example, the level of instructional expenditures per student in educational programs), efficiency or cost effectiveness is not addressed separately. This is an important omission, as policy makers

usually are not interested in effectiveness per se – does the program work – but often in the question: how much effect is a program generating for each dollar spent? Or alternatively: is this program the least costly way of achieving given public objectives, or are there less costly alternatives? A typical question in education could be: is it more effective - in terms of educational outcomes - to invest in higher quality teachers or in smaller classes? Both policies can be shown to have an effect, but their cost-effectiveness is not the same. To answer the cost-effectiveness question, a more specific approach is needed. We argue that existing methods from econometrics and operations research (Fried 2008, Coelli 2005) can be used to measure and investigate the cost-effectiveness of public programs or institutions. Methods such as stochastic frontier analysis (SFA) and data envelopment analysis (DEA) determine a virtual frontier of relatively efficient decision making units (compare the solid line in figure 1).

Figure 1 here

The parametric SFA frontier allows for random (measurement) error in the data as well as deviations from the efficiency frontier arising from intrinsic inefficiencies. The non-parametric DEA frontier is completely determined by the existing data, but does not allow for measurement error. Therefore we prefer the more realistic approach of the parametric SFA frontier, although one has to assume a particular functional form. We will use the very convenient translog form (Christensen et al 1973), which expresses the logarithm of costs as a quadratic function of the logarithm of outputs and input prices (such as the prices of labor and purchased goods and services). This allows economies of scale and scope to vary with the level of outputs. For illustrative purposes we give the example of a translog cost function with two

outputs (for instance, regular and special education students) and one price variable (for instance, teacher salaries) as follows:

$$(1) \log C_i = \log C_i^* + v_i + u_i$$

and

$$(2) \log C_i^* =$$

$$b_0 + b_1 \log(q_{1i}) + b_2 (\log(q_{1i}))^2 + b_3 \log(q_{2i}) + b_4 (\log(q_{2i}))^2 + b_5 \log(q_{1i}) \log(q_{2i}) +$$

$$b_6 \log(w_i) + b_7 (\log(w_i))^2 + b_8 \log(q_{1i}) \log(w_i) + b_9 \log(q_{2i}) \log(w_i)$$

with

$\log C_i^*$ minimum costs of unit i (frontier)

q_{1i}, q_{2i} outputs of unit i

w_i input price

v_i random error in costs of unit i

$u_i \geq 0$ cost inefficiency of unit i

b_0, \dots, b_9 parameters to be estimated

Note that by normalizing all variables to unity at their sample means, the coefficients of the loglinear terms can be easily shown to be *cost elasticities* of the corresponding variables at their sample means, i.e. the percentage change in costs when outputs (or prices) change by one percent. This also implies that these coefficients measure (dis)economies of scale. If the

coefficient of a (loglinear) output is smaller than 1, costs increase slower than output, so economies of scale are present at the sample mean; a value larger than 1 means diseconomies of scale. To this basic cost frontier, variables can be added to incorporate other influences on the production technology. In our case, the student mix is very important. It is a well known finding from American educational production literature on primary and secondary public education (for an overview, see Hanushek and Welch 2006)) that for instance low income students require more resources to achieve the same educational outcomes than their more advantaged colleagues. Also, managerial and organizational characteristics can be incorporated in the cost frontier if considered relevant to the educational production technology. To keep the cost frontier estimation manageable and its results easy to interpret, we will add any additional explanatory variables as simple linear additions to the basis structure indicated above, standardized to zero mean and unit standard deviation for the ease of interpretation. This allows the corresponding regression coefficients to be interpreted as the relative change in costs at the sample mean related to one standard deviation of change in the explanatory variables.¹

For our purposes, the most relevant efficiency indicator is cost-efficiency, i.e. minimizing costs for given outputs (or outcomes, in which case we speak of cost-effectiveness). Pure technical efficiency would only optimize the relation between physical inputs, such as the amount of labor or purchased goods and services, and outputs. When considering cost-efficiency, decision

¹ Note that this standardization differs from that implied by the use of beta-coefficients, in which *all* variables are scaled to zero mean and unit standard deviation. We retain the division by the sample mean for the *dependent* variable, as to be able to interpret a change of one standard deviation for the linear independent variables directly in terms of the corresponding relative cost or efficiency change. We also retain the division by the sample mean for the loglinear independent variables to keep the interpretation of regression coefficients as relative changes or cost elasticities at the sample mean.

making units combine physical inputs to minimize costs for given outputs (allocative efficiency), and therefore also have to take into account input prices, such as wages and other prices. The construction of a frontier as described allows for deviations from minimal costs by individual units. These deviations can have a wide range of causes, from political regulation to managerial or professional preferences or inabilities. The distance of actual costs to the efficiency frontier is a measure of the (relative) inefficiency of each individual decision making unit. An efficiency score is calculated for each unit as the proportional decrease in all inputs needed to reach the frontier at given outputs. Depending on the scope of the analysis and available data, assumptions have to be made regarding a possible intertemporal shift of the efficiency frontier, for instance as a result of technological progress. Typically, as a first step, cost-effectiveness or cost-efficiency scores are determined as described, taking into account exogenous factors for a decision making unit relevant for the production structure, such as client characteristics. In a second step, additional explanatory variables, such as organizational and managerial characteristics, are added and the cost frontier is either re-estimated, or those variables are used to explain the efficiency scores obtained in the first step. We prefer the first approach, as it avoids econometric problems associated with two-step estimation². To find a set of relevant variables for explanation of the cost frontier, we will use the public management model developed by Meier and O'Toole (2009) and extensively applied to Texas school districts. We augment their model to take into account specific managerial characteristics related to efficiency or cost-effectiveness. We finally note that the cost frontier approach only addresses

² The two step approach has been criticized as the assumptions on the error term in the first step (random plus typically half-normal inefficiency residuals) are violated in the second step. For details we refer to the contribution of Greene in Fried et al 2008.

the production side of public services. The demand for those services is considered as given. It is well known that on the demand side important distributive questions arise (for primary and secondary education, see Baker et al 2012). Who should have access to public services at what price? Should income and wealth of potential recipients of public programmes play a role? These are questions which are not addressed in our analysis, which confines itself to the production side. A public dollar spent on a poor school district could be valued differently compared to a dollar spent on a rich district, when there are state or federal preferences to equalize educational outcomes between districts. We defer further discussion of these equity issues to section 5.

3 A cost frontier for Texas school districts 1997-2010

We estimate a translog stochastic cost frontier for Texas school districts. Expenditure and student performance data, collected by the Texas Education Agency, are available for 1997-2010 for around 1000 schooldistricts. We leave out chartered schools, as they operate in a quite different institutional context (for a recent efficiency study on chartered schools, see Gronberg et al. 2011). We equate the *cost variable* to district operational expenditures. Inspection of the data reveals that total expenditures per student vary wildly (a factor of 20 between highest and lowest spending per student), not only because of likely bookkeeping errors (see FAST, 2010), but also because of fluctuating capital outlays. As no reliable depreciation data are available, we take operational expenditures as our basic cost variable,

essentially reflecting variable costs.³ About 2/3 of operational expenditures is classified as instructional expenditures, directly related to the activities of teachers and educational aides. Non-instructional expenditures include costs of support staff, operation and maintenance of facilities, as well as costs of central and campus administration. Although the accumulated data in the database of Meier and O'Toole go back to 1993, we only use the data as of 1997. The most important reason is that since 1997 a comparable wage index for non-education college graduates is available, which gives an accurate picture of the differences in cost of living and amenities between Texas schooldistricts (Taylor et al, 2006 and Taylor, private communication). This index provides the possibility to incorporate in the cost frontier a potential exogenous component in (teacher) wage differentials between school districts. The index reflects different regional costs of living and willingness of employers to pay for regional amenities or lack thereof, for example a high crime rate. Although actual teacher wage data are available in the Texas database, they cannot be used as they most likely also reflect important quality differences in the educational or supporting services provided. We assume that these quality differences are reflected in actual wages, but in essentially the same way in every school district. This implies that, after correcting for cost of living differences, labor costs per hour of homogeneous labor of the same quality are essentially the same everywhere and therefore do not show up in the cost frontier. Note that the state of Texas only imposes a minimum wage schedule, allowing wages to adjust to labor market conditions. We have no data to check local

³ After completion of this paper we became aware of a cost function study of Texas school districts, using new data on district capital stocks (Gronberg et al 2011). These authors conclude that cost function studies for Texas are largely insensitive to the exclusion of capital stock measures.

deviations from competitive market conditions⁴. Those deviations would imply either underestimating or overestimating individual school district efficiency in our approach. Given the 13 year period for which financial data are available, we deflate financial variables (expenditures and wages) with the price index of GDP, reflecting the overall costs of purchasing labor and goods and services (Bureau of Economic Analysis 2012). By deflating both costs and wages with this index, we also obey the homogeneity constraint on the price parameters in the cost frontier (implying that the cost frontier should not change when all prices change with the same factor). The price of GDP approximates the price index of non-wage goods and services. We have no indication of large regional variation of those prices.

As our annual *educational outcome variable* we have chosen the number of students that pass the state imposed Texas Assessment of Knowledge and Skills (TAKS) test. Its logarithm LOGQ and squared value LOGQ are used in our frontier estimations. The TAKS-test has to be taken several times during an educational career. It therefore reflects aggregated average performance of students in a schooldistrict. The TAKS-pass rate has been used in many studies as the central, aggregated educational outcome variable (compare O'Toole and Meier, 2009). However, the pass rate as a per capita variable does not reflect the volume of outcomes produced. Therefore we use the product of enrollment and the TAKS pass rate as our central educational outcome variable, i.e. the actual number of students passing relevant TAKS-tests in a given year. As discussed above, we have included a *comparable wage index (CWI)* as explanatory variable to account for exogenous wage differentials between districts. It has been

⁴ We do have some indications of non-competitiveness, as in some of our estimates the comparative wage index is not positively associated with costs. In those cases, the index is deleted as an explanatory variable.

normalized to a sample mean of 1 for each year to be able to disentangle cross-sectional and intertemporal effects. We have incorporated CWI as a single, linear variable, given its small impact on costs. In addition, we have chosen the following explanatory variables, inspired by earlier work and the concise overview of Texas schooldistrict characteristics in the recent Financial Allocation Study for Texas of the Texas Comptroller (FAST, 2010). First, we add the *percentage of special education students* (SPECIAL), as this category of physically or mentally disabled students, requires considerable more resources as regular students. Although the share of special education students in enrollment is only around 10 percent for the average schooldistrict, average spending per special student is two to three times as high as regular per student spending. Second, it is well known that students from disadvantaged, low income families usually require more intensive instruction at school and often lack additional informal educational support at home. Therefore we include the *percentage of low income students* (LOWINC) as an additional explanatory variable that shapes the cost frontier. From the data we infer that this variable has a fairly high correlation ($R = 0.7$) with the percentage of nonwhite (black and hispanic) students. For the current analysis we therefore do not include more detailed student characteristics. Results with the share of non-white students as an independent variable did not reveal large deviations from the structure of the cost frontier presented here. For our analysis of the 1997-2010 data we added a limited number of explanatory managerial variables to model the cost frontier. More detailed managerial characteristics are only available for a limited number of years based on survey data. Inclusion of those variables is deferred to the separate analysis of the period 2004-2007 in section 4. The additional variables used in this section are described and motivated as follows:

- *Percentage of district revenues from local taxes (LOCREV)*. As in many applications of public choice theory to managerial behavior (for a recent review, see Kalb 2010), we hypothesize that a larger dependence on local tax revenues – equivalent with a smaller dependence on state or federal grants - will encourage efficiency and cost effectiveness of public services due to local voter pressure on school boards and school managers.

- *Percentage of instructional expenditures in total operational expenditures (INSTREXP)*. We argue that managers can prioritize direct instructional expenditures at the expense of administrative and supporting expenditures, often assumed to be less effective in ensuring educational outcomes and cost effectiveness. This share is also considered an important indicator of effective districts by the state of Texas (compare FAST 2010).

- *Stability of the teaching workforce (STAB)*, operationalized as the percentage of teachers already employed by the district one year before, calculated as 100 minus the percentage of annual teacher turnover. Consistent results of earlier work on Texas schooldistricts have underlined the positive impact of this variable on educational outcomes. It follows from the notion of management buffering for environmental shocks in the public management model of O'Toole and Meier (2009 and earlier references).

As a first exercise, we consider the pooled data over the whole period as our base for estimation, introducing dummy variables for each year that allow for intertemporal shifts of the cost frontier⁵. Note that the TAKS-test has been modified a number of times during the period

⁵ We have experimented with a panel data approach with fixed effects. Although parameter values change, the general features of the cost frontier are the same. Note that we have introduced dummy variables for each year in our current model, which is equivalent to period fixed effects in a panel data approach.

of analysis, leading to discontinuities in the pass rate, and therefore in our outcome variable, for some years. By invoking dummy variables we assume that the basis structure of the cost frontier in terms of its dependence on relevant variables does not change, but that parallel cost shifts in all schooldistricts can occur over time.

We present separate results for *two subgroups* of schooldistricts. It should be noted that there is a huge variation in school district size, varying from around 20 students in the smallest rural district to around 200,000 students in the largest metropolitan district. The enrollment distribution is also very skewed. The median of the distribution is around 1000 students. Therefore we partition the population of schooldistricts in two, called the 'lower' and 'higher' (enrollment) subgroup, having enrollment below and above the median respectively. In this way we can do justice to structural differences between small and large districts – also borne out by statistical tests - and avoid heteroskedasticity of residuals in the econometric estimations which are the basis of our empirical work. Note that we have deleted the comparable wage index (CWI) in the estimation of the lower subsample, as preliminary estimates indicated a negative sign, probably indicating non-competitive wages or at least the absence of systematic adjustment of wages to cost of living differences.

Descriptive statistics for the period 1997-2010 are given for both subgroups in table 1. We conclude that in particular the average operational expenditures per student differ substantially, with the higher enrollment group having about 18 percent lower expenditures per student than the lower enrollment group, despite 6 percent higher teacher salaries in the larger districts. As the table shows, this is related to a substantial larger class size in the larger

districts. Differences in the percentage low income students and in pass rates are generally small. As far as development over time is concerned (not shown), real expenditures per student (both groups together) increased with 2.6 percent per year. Real teacher salaries have grown with 0.7 percent annually. Note, however, that non-education college graduates earned annually about 1.7 percent more in the period 1997-2010 in real terms, using the comparable wage index mentioned before. Total enrollment as well as our educational outcome proxy increased with about 1 percent per year.

Table 1 here

Table 2 presents estimation results for the two subgroups, based on the pooled data for 1997-2010. We present estimated coefficients (absolute t-values in parentheses) for the variables employed in the cost frontier, obtained through maximum likelihood estimation techniques (LIMDEP package, Greene 2007). The lambda statistic represents the ratio of the standard deviation of the inefficiency term to the standard deviation of the random error term. Sigma denotes the standard deviation of the composite error term (inefficiency plus random error).

Table 2 here

A number of interesting conclusions can be drawn from table 2. At the sample mean in both subgroups the cost frontier shows increasing returns to scale with respect to the outcome variable (i.e. costs increase less rapidly when outcome expands), as implied by regression coefficients of the loglinear outcome variables less than 1. These economies of scale are larger for the lower enrollment group as compared with the higher enrollment group. However, whereas the first group shows economies of scale over the whole range of enrollment values,

the second group shows increasing economies of scale for lower enrollment values, but decreasing economies of scale for higher enrollment values. Figures 2 and 3 present so called ray average costs for the lower and higher enrollment subgroup respectively. Ray average costs show what happens to district operational costs if the outcome variable expands, while other variables are kept at their sample mean. This is the equivalent of unit cost in the case of only one outcome variable. Both ray average costs and outcome are normalized to 1 at their respective means and are indicated in the figures as RAC and RATIO respectively.

Figures 2 and 3 here

As figure 2 shows, there is room for efficiency improvement by increasing the size of the smallest districts, for example by consolidating. This result confirms earlier conclusions for US school districts as summarized in a meta-regression analysis by Colegrave and Giles (2008) based on a large number of studies for different US states. Note that the same picture is obtained when only *instructional* expenditures (directly related to class room activities) are chosen as the cost variable. This tells us that additional transportation costs and maintenance costs for smaller, rural districts do *not* explain large ray average costs. Most likely, a relatively small class size, low pass rates and inefficiencies in teaching or management do explain the results. Despite very high ray average cost for very small districts (up to twice the value for the largest district in this group), inspection of the frequency distribution of the RAC values reveals that 95 percent of the schooldistricts has RAC values not larger than 30 percent above its lowest value for this lower enrollment group. This implies that only modest savings for the group as a whole can be obtained by consolidating districts. Simulations, assuming all districts

to operate at lowest ray average costs, suggest that about 5 percent of total operational expenditures can be saved, not accounting for increased transportation costs. In the higher enrollment group, however, as figure 3 shows, ray average costs, after decreasing first, start rising again around 1.67 times the group mean. This is equivalent to 12,000 students per district, or 910 students per school. Note that this figure is close to the average optimal school size of around 1500 students found by the study of Colegrave and Giles (2008) mentioned earlier. In our analysis, the largest schooldistricts have ray average costs around 20 percent above the group minimum, but 70 percent of the districts has ray average costs less than 10 percent above the group minimum. Simulations suggest overall savings in this subgroup of about 5 percent, assuming all districts to operate on lowest ray average costs by either consolidating smaller or splitting up larger school districts.

Next we discuss the impact of the other explanatory variables on costs, keeping outcomes the same, which is equivalent to the impact on the cost effectiveness of school districts. In all cases the regression coefficients can be interpreted as the relative impact (in percentages: multiply by 100) of one standard deviation change of the explanatory variable on costs at average output levels. By far the largest impact is generated by the percentage of low income students in both enrollment subgroups. An increase of this variable with one standard deviation does increase (marginal) costs, and therefore decreases cost effectiveness, with as much as 12 percent in the lower subgroup and 15 percent in the higher subgroup. The percentage of special education students increases costs with 2.7 percent in the lower subgroup, but with only 0.4 percent in the higher subgroup. Unexpectedly, the percentage of revenues from local taxes, is *not* associated with lower costs or increased cost effectiveness. In the lower subgroup

a standard deviation increase of this variable implies costs to increase with 4.3 percent in the lower subgroup and with 3.1 percent in the higher subgroup. Apparently the expected disciplinary force of voters, who have to pay the local tax burden of public education, is not present or not effective. A possible explanation could be a higher preference for educational spending in more wealthy districts. As section 5 will show, these are also the districts with a higher share of revenues from local taxes. However, increased spending apparently does not translate into better educational outcomes. The same results are obtained with the local tax rate instead of the percentage of locally raised tax revenues. The percentage of instructional expenditures in total operational expenditures is associated with lower costs and higher cost effectiveness; for the lower subgroup we find an impact of 3.0 percent, for the higher subgroup of 3.7 percent. It apparently pays in terms of cost effectiveness to shift resources away from supporting activities to direct instructional activities. The stability variable is also associated with lower costs and higher cost effectiveness; in the lower subgroup it has a 3.0 percent impact, in the higher subgroup 1.4 percent. This confirms the benefits of a relatively stable organization, as demonstrated repeatedly by O'Toole and Meier (2009 and earlier work), in particular for the smaller schooldistricts. We finally note that additional efficiency gains are to be expected if school districts move closer to the cost frontier. However, as we have incorporated many relevant characteristics in the frontier itself, the average schooldistrict already operates closely to the frontier. In the lower subgroup we even find that the distance to the frontier is completely dominated by random error, i.e. the inefficiency term is not different from zero. In the higher subgroup the average efficiency score is as high as 89 percent, indicating some room for additional efficiency gains on top of the possibilities discussed above.

Finally, some conclusions can be drawn on the time dependence of the cost frontier based on the regression coefficients of the dummy variables introduced for each year. As shown in the appendix with full estimation results, apart from some erratic behavior in 2003-2005 due to the redefined TAKS-test, the cost frontier shows a net upward shift between 1997 and 2010. For the lower subgroup this implies an average annual cost increase - or productivity decrease - of 1.6 percent for the smaller group, and 1.1 percent for the higher subgroup. As mentioned earlier, about 0.7 percentpoint can be attributed to the time trend in real teacher wages. The remaining part is not explained by the current model. It should be noted, however, that in the period 2005-2010 coefficients do not to change much, implying the absence of autonomous or unexplained productivity changes.

4 Explaining cost effectiveness of Texas school districts 2004-2007

As our ambition is to relate costs and cost effectiveness to managerial variables, we decided to work with a smaller dataset, combining expenditure and performance data with managerial variables from bi-annual superintendent surveys. We repeat our estimation of a stochastic cost frontier for 2004-2007 and incorporate organizational and managerial variables in the cost frontier. As in the analysis of the 1997-2010 data, we partition the data in two subgroups having enrollment lower or higher than 1000 students, which is close to the median of enrollment in the complete dataset. In our choice of relevant explanatory variables we have benefitted from the extensive dataset prepared by Meier et al for the period 2004-2007. It enriches financial and student data from the Texas Education Agency with data from bi-annual surveys of superintendents of schooldistricts. We refer to O'Toole and Meier (2009) for details.

Apart from their variables on networking, human capital and general management quality, we have constructed variables on managerial priorities directly related to efficiency and budget matters. Unfortunately, relevant survey questions are often included only for one year. We have extrapolated the relevant survey answers for a particular schooldistrict to the other three years included in the analysis, i.e. assuming the corresponding managerial characteristics did not change significantly in the four year period concerned. However, as response rates for the surveys are typically in the order of 60%, and responding schooldistricts are not necessarily the same in every survey, the number of valid cases quickly decreases. Our final sample contains 340 cases in our 'lower' subsample and 509 cases in our 'higher' subsample. The following variables have been included in our frontier estimation:

As in our analysis in the previous paragraph we employ the outcome proxy Q, percentage of special education students SPECIAL, percentage of low income students LOWINC, percentage of local tax revenues LOCREV, percentage of instructional expenditures INSTREXP, the stability parameter STAB, as well as dummy variables for the years 2005, 2006 and 2007.

Additional managerial variables have been added and operationalized as follows, starting with five managerial variables previously used by O'Toole and Meier (2009) and followed by five additional variables more specifically related to managerial priority for efficiency and budget matters:

- *Superintendent district experience* (EMPDIST, years of employment with the district, from survey)

- *Superintendent networking* (NETW, factorscore as calculated by O'Toole and Meier, derived from survey responses on the intensity of networking with local business leaders, other superintendents, state legislators and the Texas Education Agency)
- *Superintendent contacts with the School Board* (TSB, intensity of contacts from survey)
- *Superintendent assessment of district human capital* (HUMCAP, factorscore as calculated by O'Toole and Meier, derived from survey responses on - among others - the quality of teachers, professional development and principal's management skills)
- *Superintendent management quality* (MQUAL, factorscore as calculated by O'Toole and Meier, derived from the residual of a wage equation explaining superintendent salaries)

In addition, we employed dummy variables, more specifically related to the management of budgets or efficiency:

- *Superintendent time spent on budget and financial management* (DBUDGET)⁶
- *Superintendent time spent on contracting and procurement* (DCONTRACT)⁷
- *Superintendent use of performance data for efficiency improvement* (DPERF)⁸
- *Superintendent priority for efficiency improvement* (DEFF)⁹
- *Superintendent view on principal's discretion in decisionmaking* (DDISCR)¹⁰

⁶ Respondents could indicate time spent on budget and financial management in 6 categories: (1)never (2)yearly (3)monthly (4)weekly (5)more than once a week (6)daily. Dummy variable=1 for responses in category 6.

⁷ Respondents could indicate time spent on contracting and procurement in 6 categories: (1)never (2)yearly (3)monthly (4)weekly (5)more than once a week (6)daily. Dummy variable=1 for responses in category 5 or 6.

⁸ Respondents could indicate the use of performance data to improve efficiency in 4 categories: (1)never (2)not frequently (3) frequently (4) very frequently. Dummy variable =1 for responses in category 4.

⁹ Respondents could rank the importance of increased efficiency in 7 categories: from (1)most important to (7)least important. Dummy variable=1 for responses in categories 1 or 2.

¹⁰ Respondents could indicate their agreement with the statement: 'I give my principals a great deal of discretion in making decisions' in four categories: (1)strongly disagree (2)tend do disagree (3)tend to agree (4) strongly agree. Dummy variable =1 for responses in category 4.

We have added the last variable, although not directly related to efficiency and budget matters, since decentralized decisionmaking is often argued to be an important condition for more efficient and effective public services (as in the New Public Management approach as documented by Pollitt and Bouckaert (2004)).

Table 3 presents descriptive statistics of the employed variables. We note that the general profile of the subsamples resembles that of the subgroups in the 1997-2010 analysis. We have also compared the subsamples with the full schooldistrict population of 2004-2007 on a number of key variables. Sample and population values differ only a few percent, with the exception of average enrollment in the higher subsample, which is about 16 percent higher than the population average.

Table 3 here

We have estimated a similar cost frontier as in our previous analysis for 1997-2010. Results are given in table 4.

Table 4 here

Despite a substantially reduced number of cases, we obtain similar results for the dependence on educational outcomes as measured by our proxy of the number of students passing annual TAKS-tests. For the lower enrollment subsample economies of scale dominate, while for the higher subsample again a U-shaped ray average cost curve is obtained. The optimum district size turns out to be higher than before, around 35,000 students per district. Note, however, that in our subsample larger districts are overrepresented. The impact of the percentage of low

income students is almost identical, but the impact of special students has changed. The impact on costs is now insignificant (higher sample) or slightly negative (lower sample). Note that as our educational outcome variable incorporates both enrollment and passing rates, differences in passing rates between regular and special education students (on which we do not have separate information) could explain these results: higher costs per student can be compensated by higher passing rates. More locally raised tax revenues are again associated with higher costs in both subsamples, while personnel stability is associated with lower costs as before. The share of instructional expenditures does not have a significant impact in this analysis for the lower enrollment sample.

Of the five variables directly or indirectly related to superintendent priority for budget and efficiency matters, two show a significant impact in the expected direction for both subsamples. Superintendents' intensive use of performance data to improve efficiency turns out to be associated with less costs and therefore higher cost effectiveness. The same holds for superintendents granting their principals relatively large freedom to take decisions. The impact seems to be somewhat smaller (3 and 2 percent respectively) for the larger districts as compared with the smaller districts (5 and 4 percent respectively). The result on effective performance management by superintendents is an interesting finding in view of the recent literature on performance management (for example, Moynihan, 2008). This literature demonstrates the limited use of performance information at the state and federal level. At the same time, however, empirical evidence on the impact of actual, albeit limited, use of this instrument on measured performance is lacking. Our analysis suggests at least some potential for performance management at the level of school districts. This seems consistent with the

recommendation of Moynihan to focus on performance management at lower (agency) levels. A significant positive effect on performance of decentralizing decisions to lower management has also been found by Moynihan and Pandey 2005. In their research, although based on self-assessed performance, decentralizing decisions and clarity of goals stand out as the most important managerial determinants of performance.

The more general managerial variables introduced by O'Toole and Meier to explain student pass rates, however, do *not* show a significant impact on costs, given educational outcomes. One exception is the significant but positive impact of networking on costs for the lower subsample. This suggests that for smaller districts external networking, although possibly beneficial to educational outcomes as found by O'Toole and Meier (2009), incurs more costs than benefits warrant, implying a net cost increase or lower cost-effectiveness. As in the previous analysis, school districts operate quite close to the cost frontier, with average efficiency scores of 84 and 90 percent in the lower and higher subsample respectively.

5. Equity considerations

Although our analysis focusses on the production side of public education in Texas, it is worthwhile to look at some equity issues related to the distribution of public resources over school districts. First, the availability of sufficient revenues determines the production possibilities of schooldistricts. There is a huge variation in the local tax base of schooldistricts, reflecting large regional differences in income and wealth. The existence of large transfers from state and federal government to school districts, in particular in less wealthy areas, are evidence of political preferences for equalizing available resources for education per student. We have

chosen 2010 to get the most recent picture of expenditures and revenues for poor and rich schooldistricts in Texas. We define rich and poor districts by the first and fourth quartile of districts, sorting districts by the percentage of low income students in ascending order. Table 5 gives the descriptive statistics for a number of key variables for both subgroups.

Table 5 here

From table 5 we infer the following marked differences between the subgroups. The schooldistricts in poor areas generate only about a quarter of school revenues from local taxes, while the districts in rich areas generate about half of their income from local taxes. State and federal grants make up for the difference: they generate almost 70 percent of total revenues in districts in poor areas, but only 40 percent of total revenues in districts in rich areas. Note that, consistent with other analyses (Baker 2012), the redistributive effects of state transfers on the total level of state and local tax revenues is regressive in Texas: poor districts receive about 5% less revenues per student than rich districts from those two sources combined. Less well known, however, is the fact that for Texas schools the transfers of the federal government (almost three times as large - per student - for poor districts as compared with rich districts and generating 14 percent of total revenues for poor districts) more than compensate for this difference. The net result is that, combining all sources of revenues (including local and regional non-tax revenues), poor districts generate slightly larger (around 1.5 percent) revenues per student than rich districts. The difference is even more pronounced for operational expenditures, our central variable for resources spent: poor districts spent about 11 percent more per student than rich districts. Most likely, poor districts spend relatively less on non-

operational expenditures such as investment in buildings. Note that other key variables are comparable between both subgroups, except of course one important variable: the TAKS-test pass rate. We already discussed the much lower pass rates in low income districts, and the large impact of the percentage low income students on educational costs. We conclude that also in Texas large state and federal transfers to schooldistricts have an equalizing effect on the resources per student in primary and secondary education, without completely compensating for the relatively large need for resources in the poor districts, however. It should be noted that, given the intrinsic cost differences between poor and rich districts as a result of their different student populations, no significant differences in efficiency scores with respect to the frontier between those groups have been found.

6. Conclusions and implications

From the research reported here a number of conclusions and directions for further research can be derived.

First, we have demonstrated the feasibility of a cost function approach to analyze the determinants of efficiency and cost-effectiveness, which are generally neglected dimensions of performance in public administration research. Second, we have generated additional insight into the impact of management on primary and secondary education in Texas with new techniques applied to an existing database.

Using data on the period 1997-2010, we confirmed modest economies of scale in the operation of small Texas school districts and diseconomies of scale for the largest districts, using an educational outcome variable incorporating both student enrollment and pass rates on the

state-wide TAKS-test. In future research, it would be interesting to relate these results to both local political choices and state aid policy. As in many countries, politicians struggle with the costs of supplying good quality education and other public services in less populated rural areas. We also demonstrated the benefits of a stable workforce, already documented for educational outcomes as such, for cost-effectiveness. But how this mechanism exactly works, is still largely unknown and could be an interesting area for future research. An unexpected result is the apparent absence of the disciplinary force of local taxpayers on the cost-effectiveness of schooldistricts, despite the fact that they earn 25 to 50 percent of their revenues from local taxes. Further research should go into more detail by modeling local choices for public education, the influence of school boards and election procedures, determinants of state support, etc.

Using additional survey data for the period 2004-2007, we have added to the understanding of the impact of managerial practices on the performance of public education, which could be relevant for other public services as well. We have found a positive impact on cost-effectiveness of superintendent's priorities for performance management, as well as similar benefits from the decentralization of decisions to school principals. Also here, further research could refine those results by collecting more systematic, multiyear data on management practices. We found that the more general managerial variables, used by O'Toole et al to explain pass rates, usually do *not* have an impact on cost-effectiveness. However, external networking, found to be positively associated with educational outcomes in earlier work, does increase costs for given outcomes and therefore decreases cost-effectiveness, at least for the small school districts. Perhaps external networking reduces available time for alternative, more

productive applications. Finally, we note that the process of wage determination in school districts is not very well understood. Future research could shed more light on the relation between managerial and teacher characteristics and actual wages. In this way the implicit or explicit price tag of many managerial activities could be revealed and compared with the benefits for educational outcomes and cost-effectiveness. We think we know that teacher experience, a stable work environment and good managers are important for performance, but what are the costs of obtaining and sustaining them? These are major challenges for future public management research, in public education and beyond.

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TABLES AND FIGURES

Table 1. Variable means for two subgroups of schooldistricts 1997—2010

Variable	Lower enrollment subgroup (N=7072) Variable mean	Higher enrollment subgroup (N=6680) Variable mean
Operational expenditures per student(\$)	9241	7537
Enrollment	454	8172
Number of schools per district	2.38	13.2
Percentage low income students (LOWINC)	51.1	49.8
Percentage students passing TAKS test	74.0	72.6
Percentage special education students (SPECIAL)	14.1	12.2
Teacher salary (\$)	41527	44144
Student-teacher ratio	11.2	14.2
Percentage local revenues (LOCREV)	39.7	44.7
Percentage instructional expenditures (INSTREXP)	56.1	56.3
Stability teacher workforce (STAB)	82.7	84.6

Table 2. Cost frontier estimation results 1997-2010

Variable	Parameters Lower subgroup (N=7072)	Parameters Higher subgroup (N=6680)
constant	-0.19 (0.13)	-0.35 (55)
LOGQ	0.92 (196)	0.97 (526)
LOGQ2	0.036 (11)	0.026 (24)
CWI	-	0.019 (9.3)
LOWINC	0.12 (43)	0.15 (69)
SPECIAL	0.027 (11)	0.0038 (2.1)
LOCREV	0.043 (16)	0.031 (16)
INSTREXP	-0.030 (11)	-0.037 (18)
STAB	-0.030 (12)	-0.014 (7.9)
DUMMY VARIABLES: SEE APPENDIX		
LAMBDA	0	1.52
SIGMA	0.20	0.17

Absolute t-values in parentheses; bold printed: significant with p=0.05

Table 3. Variable means for two subsamples of schooldistricts 2004-2007

Variable	Lower subgroup (N=340) Variable mean	Higher subgroup (N=509) Variable mean
ENROLLMENT	473	7245
PASS RATE	67.4	68.6
LOWINC	54.5	48.3
SPECIAL	14.4	12.2
LOCREV	38.2	45.1
INSTREXP	56.4	57.1
STAB	83.4	84.3
DBUDGET	0.62	0.36
DCONTRA	0.18	0.13
DEFF	0.26	0.20
DPERF	0.29	0.41
DDISCR	0.53	0.53
NETW	0.0076	0.0373
MQUAL	-0.057	0.026
TSB	4.39	4.70
HUMCAP	-0.0059	0.136
EMPDIST	9.68	11.4

Table 4. Cost frontier estimation results 2004-2007

Variable	Parameters Lower subgroup (N=340)	Parameters Higher subgroup (N=509)
CONSTANT	-0.043 (1.6)	0.086 (5.7)
LOGQ	0.92 (41)	0.97 (526)
LOGQ2	0.045 (2.1)	0.026 (24)
LOWINC	0.13 (11)	0.15 (69)
SPECIAL	-0.028 (3.0)	0.0038 (2.1)
LOCREV	0.040 (3.5)	0.031 (16)
INSTREXP	-0.0075 (0.71)	-0.037 (18)
STAB	-0.035 (3.6)	-0.014 (7.9)
DBUDGET	0.011 (0.5)	-0.003 (0.2)
DCONTRA	-0.026 (1.0)	-0.004 (0.2)
DEFF	-0.035 (1.6)	0.01 (0.9)
DPERF	-0.049 (2.3)	-0.032 (2.9)
DDISCR	-0.042 (2.0)	-0.023 (2.0)
NETW	0.030 (3.2)	-0.01 (1.7)
MQUAL	0.0003 (0.03)	0.011 (1.7)
TSB	0.047 (0.5)	-0.003 (0.4)
HUMCAP	-0.0003 (0.03)	-0.009 (1.3)
EMPDIST	0.011(0.01)	-0.001(0.2)
DUMMY 2005	0.075(3.0)	0.043(2.8)
DUMMY 2006	-0.033(1.3)	-0.060(3.8)
DUMMY 2007	-0.038(1.4)	-0.097(6.0)
LAMBDA	2.23	1.52
SIGMA	0.25	0.17

Absolute t-values in parentheses; bold printed: significant with p=0.05

Table 5. Variable means for schooldistricts in rich and poor areas (2010)

Variable	LOWINC < 0.15 (N=241) Variable mean	LOWINC > 57.7 (N=241) Variable mean
Percentage low income students	31.2	81.9
Percentage black or Hispanic students	35.2	81.0
Enrollment	5675	5300
Percentage special education students	8.56	8.64
TAKS-pass rate	85.4	69.3
Total revenues per student (\$)	9822	9972
- Local tax revenues per student (\$)	5283 (53.8 %)	2677 (26.8 %)
- State revenues per student (\$)	3361 (34.2 %)	5563 (55.8 %)
- Federal revenues per student (\$)	535 (5.45 %)	1380 (13.8 %)
- Other local and regional revenues per student (\$)	643 (6.55 %)	352 (3.53 %)
Operational expenditures per student (\$)	7821	8702

FIGURES

Figure 1. Example of a cost frontier

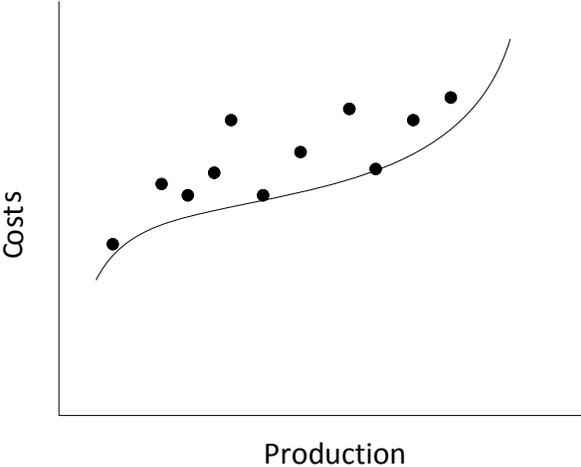


Figure 2. Ray average costs for the Lower enrollment subgroup

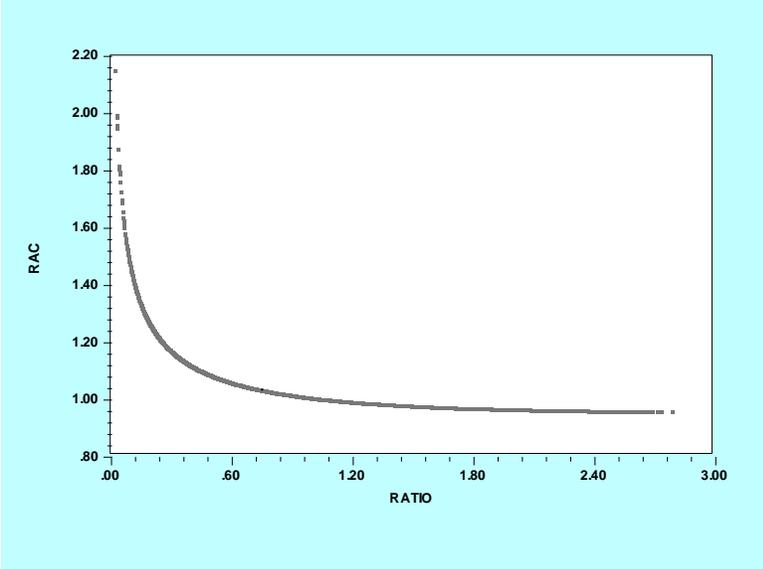
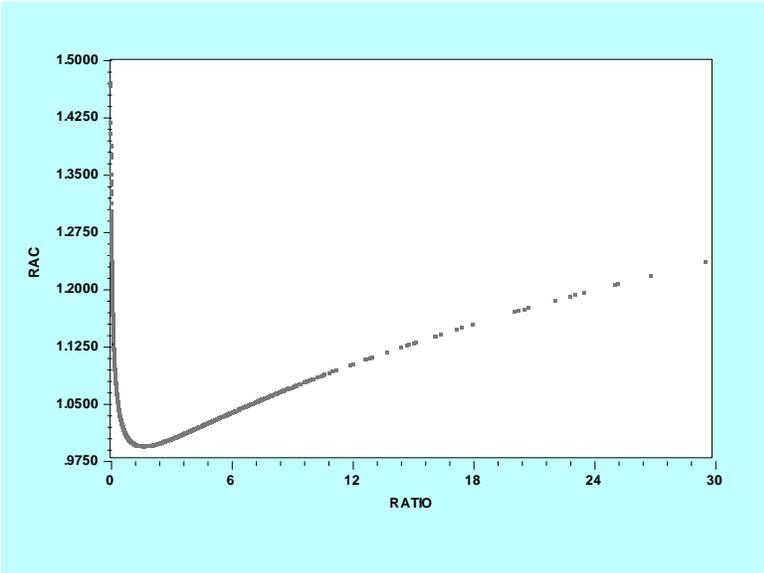


Figure 3. Ray average costs for the Higher enrollment subgroup



APPENDIX

Full cost frontier estimation results 1997-2010

Variable	Parameters Lower subgroup (N=7072)	Parameters Higher subgroup (N=6680)
constant	-0.19 (0.13)	-0.35 (55)
LOGQ	0.92 (196)	0.97 (526)
LOGQ2	0.036 (11)	0.026 (24)
CWI	-	0.019 (9.3)
LOWINC	0.12 (43)	0.15 (69)
SPECIAL	0.027 (11)	0.0038 (2.1)
LOCREV	0.043 (16)	0.031 (16)
INSTREXP	-0.030 (11)	-0.037 (18)
STAB	-0.030 (12)	-0.014 (7.9)
DUMMY 1998	-0.003 (0.2)	-0.004 (0.5)
DUMMY 1999	-0.003 (0.2)	-0.01 (1.3)
DUMMY 2000	0.047 (3.9)	0.051 (6.2)
DUMMY 2001	0.033 (2.8)	0.033 (4.0)
DUMMY 2002	0.021 (1.7)	0.017 (2.0)
DUMMY 2003	0.61 (50)	0.60 (71)
DUMMY 2004	0.31 (26)	0.32 (39)
DUMMY 2005	0.38 (32)	0.37 (44)
DUMMY 2006	0.28 (23)	0.25 (30)
DUMMY 2007	0.26 (21)	0.22 (27)
DUMMY 2008	0.28 (22)	0.23 (27)
DUMMY 2009	0.31 (25)	0.26 (31)
DUMMY 2010	0.23 (17)	0.16 (17)
LAMBDA	0	1.52
SIGMA	0.20	0.17

Absolute t-values in parentheses; bold printed: significant with p=0.05