MONEY AND MANAGERS: DO THEY MATTER? TEXAS SCHOOL DISTRICTS REVISITED

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Abstract

Cost-efficiency and cost-effectiveness are neglected aspects of public sector performance in public administration research. This paper introduces stochastic frontier analysis, a well known technique from productivity analysis, into public management research, to fill those gaps. An empirical illustration is given for Texas school districts, using the well developed database set up by Meier et al in the last decade. The results show substantial economies of scale for many small schooldistricts, but also diseconomies of scale for districts enrolling more than 12,000 students, after correcting for the share of low income students and using an output variable that incorporates pass rates from the state wide TAKS-test. We find evidence for the positive impact of performance-related priorities of top managers on cost effectiveness, and similar benefits from decentralizing decisions to lower management. An unexpected result is the absence of the disciplining force of local taxpayers on cost effectiveness. We find a positive impact on cost effectiveness from a stable teacher workforce, already demonstrated earlier to be beneficial for educational outcomes. The benefits of external networking, although shown to be positively related to educational outcomes in earlier work, do not to seem to exceed their costs, however. Indications for future research, in particularly aimed at increasing knowledge on the implicit and explicit price of managerial activities, are given.

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 and outcomes of 'new public management' and related reforms. A smaller part of the research effort addresses the determinants of public performance; however often without calculating the size of impacts on public management. In particular, the dimension of cost-efficiency (can outputs be produced at less cost?) or cost-effectiveness (can outcomes be provided at less cost?) is usually overlooked. 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 (Boyne, 2003). 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 and Coelli et al (2005) for more empirical work). This paper aims at partly filling the indicated gap. 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 currently are cutting budgets on an unprecedented scale after the world-wide financial and economic crisis. 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 performance 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 and efficiency, usually not considered in current public administration research. An empirical illustration is given by studying the efficiency and cost-effectiveness of Texas schooldistricts, using the well-developed database of Meier et al (O'Toole and Meier, 2009). Paragraph 2 outlines the theoretical background of the paper, while par. 3 estimates a stochastic cost frontier for Texas schooldistricts based on data for 1997-2010. Par. 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, par. 5 discusses some equity issues in the Texas school system, acknowledging the large state and federal grants to local school districts that supplement local tax revenues. Par.6 concludes with a discussion and suggestions for further research.

2 Theoretical considerations

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 the given public objectives, or are their less costly alternatives? A typical question in education could be: is it more effective - in terms of student achievement - to invest in higher quality teachers or in smaller classes? Both measures can be shown to have some 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 can be used to measure and investigate the cost-effectiveness of public programs or institutions (for an overview, see Fried et al, 2008). 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 systematic 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) $\log C_i^* =$
$b0 + b1*\log(q1_i) + b2*(\log(q1_i))^2 + b3*\log(q2_i) + b4*(\log(q2_i))^2 + b5*\log(q1_i)*\log(q2_i) +$
$b6*\log(w_i) + b7*(\log(w_i))^2 + b8*\log(q1_i)*\log(w_i)* + b9*\log(q2_i)*\log(w_i)$

with

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

$q1_i$, $q2_i$ 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

b0,…., b9 parameters to be estimated

Note that by normalizing all variables to unity at their sample means, the coefficients of the linear 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. To this basis 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 make the cost frontier estimation 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. The latter allows the corresponding regression coefficients to be interpreted as the relative change in costs at their sample mean related to one standard deviation of change in the explanatory variables.[i]

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 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 decision making unit. In practice, 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 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 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 the two-step estimation[ii]. In practice, our approach implies estimating the impact of all relevant variables at the same time. 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 that can be related to efficiency and cost effectiveness. We finally note that the cost frontier approach only addresses the production side of public services. The demand of those services is considered as given. It is well known that on the demand side important distributive questions arise. 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. However, we do realize the importance of the distribution of available public resource for, among others, public education. Therefore a paragraph is included on the distribution of expenditures and revenues for Texas school districts in 2010, differentiated by the level of low income students. This should shed some light on the actual redistribution of resources in the Texas school district system, which is an essential feature of the current system of public primary and secondary education in Texas and in fact all other US states. It also serves to demonstrate that there are no important implicit constraints on the level of expenditures due to unavailability of resources.

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. We equate the *cost variable* to district operational expenditures. Inspection of the data reveals that total expenditures 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. 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 directly 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 deviations from competitive market conditions[iii]. 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 costs and wages with this index, we also obey the homogeneity constraint on the cost frontier parameters, assuming that 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 passed the state imposed TAKS-test (its logarithm LOGQ and squared value LOGQ used in our frontier estimation). The TAKS-test has to be taken several times during an educational career in a schooldistrict. It therefore reflects aggregated multiyear performance of a schooldistrict.The TAKS-pass rate is already used in many studies as the central, aggregated educational outcome variable (compare O'Toole and Meier, 2009). However, it does not reflect the volume of instructing and supporting activities necessary to produce educational outcomes. Therefore we prefer to use the product of enrollment and the TAKS(passed)rate as our central outcome variable, i.e. the actual number of students passing a TAKS-test in a given year. As discussed above, we have included a *comparable wage index* as explanatpory variable. It has been normalized to a sample mean of 1 for each year to be able to disentangle cross-sectional and intertemporal effects. We have chosen the following output-related 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 available 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 to 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 par.4. The additional variables used here are described and motivated as follows:

- *Percentage of district revenues from local taxes* (LOCREV). As in many politico-economic analyses, we hypothesize that a larger dependence on local tax revenue will foster efficiency and cost effectiveness of public services due to voter pressure.

- *Percentage of instructional expenditures* in total operational expenditures (INSTR). 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 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 the year before, calculated as 100 minus the percentage of annual teacher turnover. Consistent results of earlier work on Texas schooldistricts have underlined the importance of this variable. It also 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 frontier[iv]. Note that the TAKS-test has been modified a number of times during the period 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 halves, 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 in the estimation of the lower subsample, as preliminary estimates indicated a consistently negative sign, probably indicating non-competitive wages or at least the absence of significant adjustments of wages to cost of living differences.

Descriptive statistics for the period 1997-2010 are given in table 1. We conclude that in particular the average operational expenditures per student differ substantially, with the higher enrollment group having almost 25 percent lower expenditures per student than the lower enrollment group, despite 13 percent higher teacher salaries in the larger districts. As the table shows, this is related to a substantial larger class size in those districts. Differences in the percentage low income students and in pass rates are much smaller and amount to less than a few percentage points on average. Within group deviations, however, are much larger. 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 means the cost frontier shows increasing returns to scale with respect to the outcome variable, signalled by a regression coefficient values less than 1. These economies of scale are larger for the small enrollment group. However, whereas the first group shows economies of scale over the whole range of enrollment values, the second group shows constant returns to scale around 12,000 students, and 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 output or outcome expands, while other variables are kept at their sample means. This is the equivalent of unit cost in the case of one outcome variable. Both outcome and ray average costs are normalized to 1 at their sample means (indicated in the figures as RENROLL and RAC respectively). As the figures show, there seems to be room for efficiency improvement by consolidating the smallest districts. Note that for the small enrollment subgroup 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 the large ray average costs. Most likely, a relatively small class size and low pass rates do explain the results. Despite high ray average cost for the smallest districts (up to twice the value for the largest district in this group) the steep descent of the curve implies that only modest savings for the group as a whole can be obtained by consolidating districts. Simulations, pinning all districts at the lowest value of ray average costs, suggest that about 5 percent on total operational expenditures can be saved, not accounting for increased transportation costs. Figure 3 shows that in the high enrollment group ray average costs again start to rise around 1.67 times the group mean, corresponding with about 12,000 students. The largest schooldistricts have ray average costs around 20 percent above the group minimum. Possible explanations are increasing costs of coordination in very large organizations. Simulations suggest overall savings around 5 percent, if all districts are operating on lowest ray average costs by either consolidating smaller or splitting up larger school districts.

Figures 2 and 3 here

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 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. Contrary to expectations, the percentage of locally raised revenues is not associated with lower costs or increased cost effectiveness. In the lower subgroup costs increase with 4.3 percent, in the higher subgroup with 3.1 percent. Apparently the expected disciplinary force of voters, who have to pay the local tax burden of public education, is not present or not effective. We do find the same results if we replace the percentage of locally raised revenues by the local tax rate. Again, higher tax rates seem to lead to more, but less efficient spending. 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 Meier and O'Toole (2009 and earlier work). 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 89 percent, indicating some room for additional efficiency gains on top of the possibilities discussed before.

Finally, some conclusions can be drawn on the time dependence of the cost frontier based on the regression coefficents 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 of 1.6 percent for the smaller group, and 1.1 percent for the higher subgroup. As mentioned earlier, about 0.7 percent 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 that in the period 2005-2010 coefficients tend not to change much, implying the absence of autonomous cost changes.

4 Explaning 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 ánd available 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, index 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. index, 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, index 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)[v]
- *Superintendent time spent on contracting and procurement* (DCONTRACT)[vi]
- *Superintendent use of performance data for efficiency improvement* (DPERF)[vii]
- *Superintendent priority for efficiency improvement* (DEFF)[viii]
- *Superintendent view on principal's discretion in decisionmaking* (DDISCR)[ix]

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 student passing the TAKS-test. For the lower 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. Note, however, that our subsample overrepresents the larger districts. 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). Locally raised revenues are again associated with higher cost in both subsamples, while personnel stability is associated with lower costs also here. The share of instructional expenditures does not have a significant impact in this analysis.

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 respectievely). The more general managerial variables introduced by O'Toole and Meier to explain student pass rates, do not show a significant impact on costs, however. One exception is the significant and 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 those benefits warrant, implying a net cost increase. As in the previous analysis, school districts operate quite close to the 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 worth wile 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 already referred to the increased share of state and federal funds in school district revenues in par. 2, but in this paragraph we give more detailed information on the actual revenues and expenditures of school districts differentiated by their share of low income students. We have choosen 2010 to get the most recent picture, and construct subsamples each containing the 25 percent schooldistricts with the lowest and the highest percentage of low income students respectively. Tabel 5 gives the results

Table 5 here

From table 5 we conclude that the subgroup of Texas school districts with the highest percentage of low income students (which are also the poorest districts in terms of local income and wealth) shows some remarkable differences with the other subgroup. 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. The net result is not only that districts in poor areas are effectively compensated for their lack of fiscal capacity but also that those districts on average spend 10 percent more per student than districts in rich areas. Note that other key variables are comparable between both subgroups, except 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 important state and federa l transfers to schooldistricts effectively equalize available resources per student in primary and secondary education. That also means that our analysis,solely focusing on the production side, most likely is not hampered by implicit constraints on the level of expenditures as a result of the impossibility to raise sufficient revenues.

6. Discussion

From the research reported here a number of conclusions and directions for further research can be derived. First, we think we have demonstrated the feasibility of a cost function approach to analyze cost efficiency and cost effectiveness as important, but neglected, dimensions of public sector performance. Second, we have generated additional insight into public primary and secondary education in Texas with new techniques using a well developed existing database. In particular we have demonstrated substantial economies of scale in the operation of Texas school districts, after correcting for student mix, including the share of low income students, and accounting for both the number of students and their educational performance as measured by pass rates on the TAKS-test. In future research, it would be interesting to relate these outcomes 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 have added to the understanding of the impact of managerial activities and characteristics on the performance of public education, which could be relevant for other public services as well. We have found a positive impact of superintendent's priorities for performance management on cost effectiveness, as well as similar benefits from decentralization of top management decisions. Also here, further research could refine those results by collecting more systematic, multiyear data on management activities and preferences. We 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 receive 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. We found some evidence that external networking, although found to be positively associated with educational outcomes in earlier work, is reducing cost effectiveness. Note, however, 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 tend to conclude more generally that educational outcomes, such as pass or graduation rates, seem to depend less directly on available financial resources, but on the quality of inputs and their use by experienced teachers and effective managers. 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($)	9241	7537
Enrollment	454	8172
Percentage low income students (LOWINC)	51.1	49.8
Percentage students passing TAKS test	74.0	72.6
Percentage special education students (SPECIAL)	14.1	12.2
Teacher salary ($)	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		
LOGQ	**0.92 (196)**	**0.97(526)**
LOGQ2	**0.036 (11)**	**0.026 (24)**
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	**2.2**	**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
Percentage local tax revenues	53.4	26.8
Percentage state revenues	34.8	56.0
Percentage federal revenues	5.43	13.7
Operational expenditures per student ($)	7821	8702

FIGURES

Figure 1. Example of a cost frontier

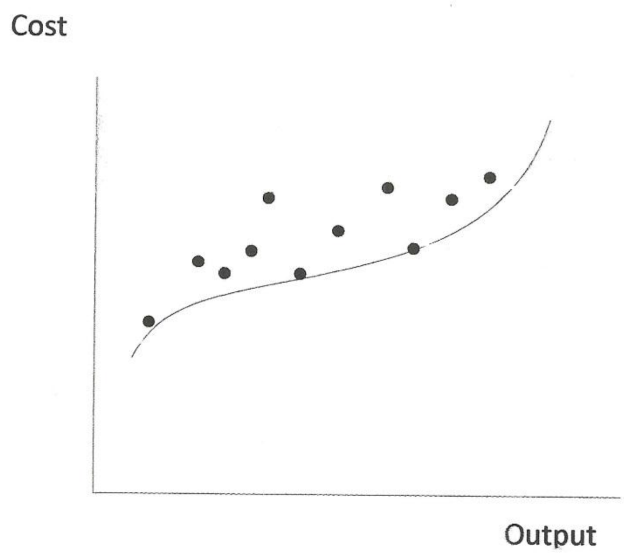


Figure 2. Ray average costs for the Lower subgroup

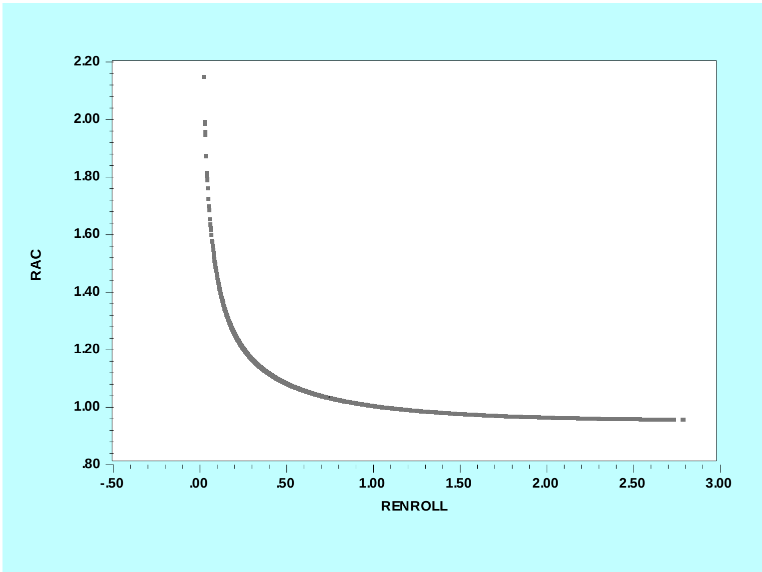
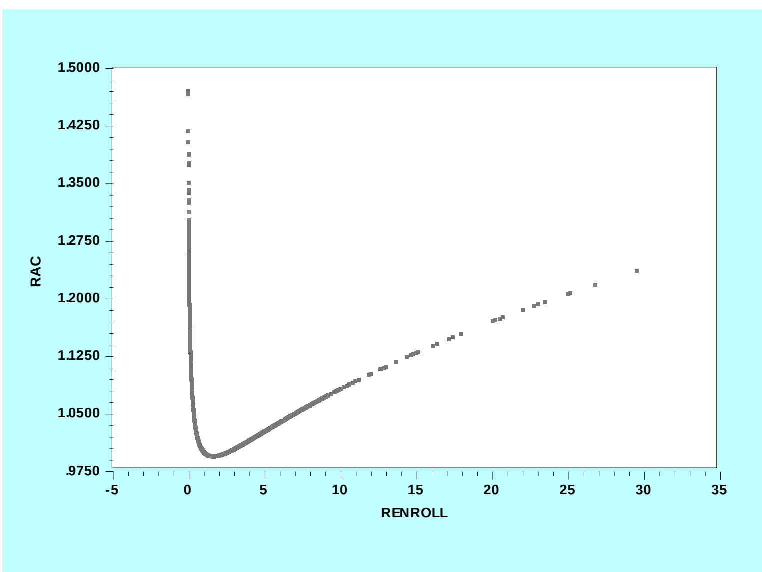


Figure 3. Ray average costs for the Higher subgroup



ENDNOTES

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[i] 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, in order 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.

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

[iii] We do have some indications of non-competitivenes, 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.

[iv] 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 already introduced dummy variables for each year in our current model, which is equivalent with period fixed effects in a panel data approach.

[v] 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.

[vi] 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.

[vii] 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.

[viii] Re 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.

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

[ix] 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.

APPENDIX

Full cost frontier estimation results 1997-2010

Variable	**Parameters Lower subgroup (N=7072)**	**Parameters Higher subgroup (N=6680)**
constant		
LOGQ	**0.92 (196)**	**0.97 (526)**
LOGQ2	**0.036 (11)**	**0.026 (24)**
CWI	**-**	**0.019 (9)**
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	**.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