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Evaluating Educational Efficiency in Texas Public Schools Utilizing Data Envelopment Analysis

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The public education system has a significant impact on most, if not all American citizens to some degree or another. Parents want to send their children to high-quality schools in order to give them the best opportunities for future success and community members desire great schools in order to attract and staff strong businesses. In addition, the population, in general, aspires to have an educational system that successfully prepares each new generation of students to be good American citizens and fully capable of effectively competing academically with their contemporaries from any other nation in the world (Sims, 2004). Originally, public schools in America were local entities funded with local monies, but the acknowledgment of the great importance of public education is currently reflected in that every state in the nation has a constitutional provision formally assigning responsibility to the state to provide for and support public education (Dayton, 1995).

This responsibility cannot be fulfilled successfully without a significant financial investment (Baker, 2016; Terry et al., 2010). However, Turley (2009) noted both the necessary amount and the potential sources of funding for public education are ongoing topics of great debate across our country. Educators and other school advocates often argue that public school funding is inadequate, particularly in light of ever-increasing student performance standards and district accountability mandates handed down from state legislators (Turley, 2009). Additionally, the significant dependence on property taxes as a primary source for education funding, and the associated disparity of relative property wealth between many school districts has created inequities in funding distributions that have led to numerous legal challenges to the constitutionality of state education funding systems in many states (Barton, 2013; Dayton, 1995; Moore, 2010; Russo, 2010).

Crafting state education funding policies under such circumstances requires policymakers to strike a delicate balance. They must create a mechanism that will generate tax revenues sufficient to adequately provide for a high-quality educational system, collecting from and equitably distributing those revenues to districts with significantly disparate property-wealth levels, while simultaneously remaining accountable to taxpayers who desire as minimal a tax burden as possible (Golebiewski, 2011; Stewart, 2011). Reed (2001) asserted there is often an incongruity between the focus of educational politics, and the mentality of many Americans regarding educational opportunity, particularly relative to mindsets about equality, taxation, and the effectiveness of public education in general as compared to the quality of local schools. While overall perceptions of public education at the national level seem to trend more negatively, many individuals believe their local public schools are generally better than the norm and are willing to place both their children and their tax dollars in the local district (Reed, 2001).

Background

According to the Texas Taxpayers and Research Association (TTARA), Texas has one of the largest public school systems in the United States, leading the nation with more than 1000 school districts in the state, and second only to California in total student enrollment (TTARA, 2014). In the 2015-16 school year, Texas was reported to have a total enrollment of 5,299,728 students, an increase of 1.3% over the previous school year's enrollment, and a cumulative increase of 778,685 students, or 17.2%, over the 2005-06 school year just a decade earlier (Texas Education Agency, 2016d). In that same decade, the percentage of the population of students identified as economically disadvantaged grew by 24.6%, and those participating in Title I programs increased by 23.9%, both subgroups outpacing the significant growth in total student population as a whole (Texas Education Agency, 2016d).

This trend in overall student enrollment growth has been constant and considerable for much longer than the last decade. Terry et al. (2010) noted student enrollment growth in Texas outpaced enrollment increases in the nation as a whole, averaging an increase of 1.84% each year and a total increase of 44.5% in the two decades from the 1998-99 school year to 2008-09. Even if all other financial considerations within public education remained unchanged over the past three decades (which is certainly not the case), the constant growth in student enrollment has necessitated the appropriation of consequential additional funding in order to simply maintain the school systems at an acceptable level (Texas Education Agency, 2016d).

The largest function of the government in Texas is public education, receiving 39% of all the funds allocated from the General Reserve Fund, the state's primary operating funds, and 28% of the state budget as a whole for the 2016-2017 biennium (Legislative Budget Board, 2016). Terry et al. (2010) reported that on average, Texas spends a higher percentage of its total state budget on education (combining both public and higher education) than other states in the nation. Combs (2010) contended the growth of spending for public education in the state of Texas has steadily surpassed student enrollment growth as well as inflation.

Policymakers attempt to be good stewards and frugal with public taxpayer dollars while simultaneously raising expectations for student outcomes that reflect academic excellence in the public school system. As professional educators attempt to meet those challenging standards with a larger number of students and often a smaller number of dollars, the underlying question ultimately becomes, does money really matter in education (Baker, 2016)? Educational professionals and public school advocates often argue that schools simply need more money

(Odden & Picus, 2011). In contrast, political rhetoric often reflects the opinion that governments are spending more and more on public education, but not getting corresponding student performance results (Baker, 2016). As such, many policymakers and business leaders contend that schools merely need to be more efficient with the funding that they do receive and often advocate for greater competition amongst schools leading to suggestions of school choice options such as vouchers or charter schools (Odden & Picus, 2011).

The combination of rising student enrollment and academic expectations of public schools coupled with a growing demand for additional educational funding in a challenging economic climate naturally leads to a search for those schools that are most efficient (Carter, 2012). Efficiency research is appealing to both policymakers and taxpayers alike and should also be of great benefit to educators as well, as it can lead to the identification of those schools that achieve the greatest educational results while minimizing financial input to the extent possible. In theory, practices that contribute to such efficiencies could be replicated in other public schools for the greater good (Odden & Picus, 2011). Hence, the purpose of this study was to determine the efficiency of Texas public school districts and the factors influencing the inefficiency of districts using a model appropriate for evaluating educational institutions and was guided by the following research questions:

1. What non-discretionary factors influence the efficiency of Texas public school districts?
2. What discretionary factors influence the efficiency of Texas public school districts?

Method

This non-experimental, efficiency study was a replication of Carter (2012) who utilized data envelopment analysis (DEA) and regression analysis to evaluate the educational efficiency of 1015 public school districts in the state of Texas. The DEA model was selected for its ability to calculate the efficiency of decision making units (DMU's) such as public school districts with multiple inputs and/or outputs. This study extended and updated the research initially done by Carter (2012) by utilizing outcomes from the current STAAR assessment program in Texas in contrast to the previous TAKS testing system.

DEA originated with Farrell (1957) to measure efficiency by calculating a score for each DMU. DEA is a non-parametric, linear programming method that evaluates the efficiency of decision-making units (DMU) by utilizing linear programming to calculate an efficiency frontier which envelopes the observed outputs of all DMUs being considered (Rassouli-Currier, 2007). This efficiency frontier is created by linear segments which include those points of maximum output relative to given inputs for each DMU, and those DMU are then labeled as efficient (Smith & Street, 2005). The DEA model objectively calculates input and output weights for each DMU, eliminating researcher bias, and thus compares each DMU to other similar DMU's being evaluated and not to statistical averages (Charnes et al., 1978; Lessiter, 2015). DEA improves upon calculating simple ratios of output (production) to input (cost) in that it allows for consideration of multiple and varied inputs and outputs and identifies the most efficient DMU's while targeting specifically where relatively inefficient DMU's can be improved (Sherman & Zhu, 2006). There are two different types of DEA models: the *input-oriented* and *output-oriented* models; the latter of which used for this study strives to maximize outputs given a specific set of inputs and was the model used for the current study (Cooper et al., 2007; Lessiter, 2015).

Population and Participants

This study included data from the entire population of Texas public school districts and was comprised of all school districts that had complete data for the 2014-15 school year, which ultimately included 1015 out of a total of 1024 public school districts. Although charter school districts are public, and as such are monitored and regulated by the state, they are not compelled to comply with all of the same rules and regulations as are typical public schools; therefore, data from charter schools was excluded from this efficiency study. Due to the excessively small size of certain student groups in certain smaller school districts, student assessment data may not be fully reported for confidentiality reasons. Such districts without complete data were also not included in the study.

Measures

Archived and publicly accessible Texas Performance Reporting System (TPRS) data from the 2014-2015 was used for this study, including performance measures on the State of Texas Assessment of Academic Readiness (STAAR) data for each district included in this study. Table one provides an overview of all assessments during the 2014-2015 school year.

Table 1

STAAR Assessments by Grade Level

Grade Level	Assessments
3	Math, Reading
4	Math, Reading, Writing
5	Math, Reading, Science
6	Math, Reading
7	Math, Reading, Writing
8	Math, Reading, Science, Social Studies
9-11 (Only course in which student was enrolled)	End-of-Course Algebra I
	End-of-Course English I

End-of-Course English II

End-of-Course Biology

End-of-Course U.S. History

Output Variable

The dependent variable for this study, 2015 student STAAR percent at Level III: Advanced Standard, all grades in all subjects, represented the percentage of students in each school district who met or exceeded the defined Advanced Standard on STAAR for all subjects tested at each respective grade level. This variable is different, but comparable to the one considered in Carter's (2012) study, which utilized commended performance on TAKS tests. Students who qualify for this level are predicted to be highly successful in the next grade level with little or no academic intervention.

Discretionary Input Variables

The independent variables selected for use in this study were selected based primarily on the similar efficiency study conducted by Carter (2012), and also mirror the research that emerged from the literature review that was previously presented. The data for each of the following input variables can be found directly on the TAPR for each district and was obtained in aggregate from TEA.

Teacher Average Actual Salary. The state of Texas mandates that all classroom teachers and other specified professional educational staff must receive an annual salary not less than the minimum salary schedule as codified in the Texas Education Code §21.402 (2019) and published annually by the Texas Commissioner of Education. However, each school district sets its own professional educator salary schedule, which may be in excess of that minimum scale, as adopted by each local school board of trustees. As a part of the annual publication of the TAPR, TEA reports the average annual salary for teachers in each district for regular duties only, excluding any stipends for extra duties. The average teacher salary across all teachers in each district is reported on the TAPR, along with the average teacher base salaries across the same five stratified groups of teacher experience as listed above. The teacher base average salary was included in this study as a discretionary predictor variable of efficiency.

Teacher Years of Experience. For each year of documented creditable service in an accredited school district (both in and out of the state of Texas), a teacher's service is officially noted on a document referred to as a Teacher Service Record as is required in the Texas Administrative Code (TAC) §153.1021(d). This record is used to justify placement on each district's teacher salary scale, and also used to validate retirement credentials for each teacher at the end of their teaching career. The TAPR records aggregated teacher experience levels in the following stratified groups based on years of teacher experience: beginning teachers in their first year of service, 1-5 years, 6-10 years, 11-20 years, and over 20 years of experience. The average teacher years of experience variable was included in this study as a discretionary predictor variable of efficiency.

Teachers with Master's Degrees. According to the Texas Administrative Code (TAC) §230.11(a), all teachers in Texas are required to have a minimum of a bachelor's degree, and must have completed an approved teacher certification program, either through a university program or an approved alternative certification programs which includes monitored student teaching, and must submit passing scores on comprehensive exams administered by the State Board for Educator Certification (SBEC). Some school districts do encourage, or even may require, their classroom teachers to obtain a master's degree as a condition of employment, but in general, master's degrees are not a requirement for Texas teachers. However, many districts do provide some additional annual financial compensation for those teachers who have completed advanced degrees. TEA includes data annually on the TAPR related to the total number of teachers with bachelor's, master's, and doctorate degrees, and even those teachers with no degree held. For the purpose of this efficiency study, the number of teachers in each district holding a master's degree was included in this study as a discretionary predictor variable of efficiency.

Additional discretionary financial variables taken from the 2014-15 fiscal year from each district's general fund include amounts calculated on a per-student basis from the following budget categories: total operating expenditures, instruction, instruction-related services, instructional leadership, school leadership, student support services, and general administration. TEA tracks actual financial data for every school district in the state and publishes it for public review following verification at the state level of an annual review by independent financial auditors selected by each district. As a result of the time involved in this auditing process, this financial data typically is reported a year behind current academic data at the student level and published as an addendum to the current year TAPR. For the purpose of this study, however, the financial data from the 2014-15 school year was available, and these variables were reported in actual dollar amounts on a per-student basis, and only the expenses from a district's general fund were considered.

All Texas school districts, along with charter schools and education service centers, are governed by a set of financial accounting rules as set forth in the Financial Accountability System Resource Guide (FASRG), which organizes how districts code both revenues and expenditures in district budgets (TEA, 2010). The FASRG groups related operational activities and their corresponding expenditures into units referred to as functions. School districts utilize these functions in order to organize and track resources received and expended in the process of educating students. Where applicable, the specific functions as identified by the FASRG are included with each fiscal variable listed for clarification purposes. All values used in this study were extracted from 2014-2015 Actual Financial data as reported by TEA.

Total Operating Expenditures Per Pupil. One of the financial data points published annually in the TAPR calculates total district expenditures on a per-student basis, indicating the total average cost to educate a student in a particular district. These expenditures reflect expenditures from all functions included in each district's general fund expenditures (TEA, 2010).

Instruction. This variable includes total expenditures directly tied to the instruction of students and related classroom supplies and expenses. This amount is reported as a single amount by TEA, but it is actually a total of function 11 (Instruction) and function 95 (Payments to Juvenile Justice Alternative Education Programs) as defined by the FASRG (TEA, 2010).

Instructional-Related Services. These expenditures represent a sum of two reported functions in a school district's budgeted expenses. Function 12 (Instructional Resources and Media Services) is dedicated to costs associated with libraries and resource centers, and other facilities that deal with instruction media and educational resources. Function 13 (Curriculum Development and Instructional Staff Development) is utilized for assisting instructional staff with planning, developing, and evaluating a variety of learning experiences for students. Costs for in-service trainings and other professional development expenses for instructional staff, such as travel or registration fees, are included in this function (TEA, 2010).

Instructional Leadership. Expenditures related to this variable come from function 21 (Instructional Leadership), and include any expenses for additional staff that provide both general and specific instructional services. Examples include instructional supervisors, special program coordinators, or district administrative staff with specific oversight for instruction. Many smaller school districts may not have expenditures in this function due to a lack of funding available to provide such additional staff (TEA, 2010).

School Leadership. These expenses are organized into function 23 (School Leadership), and largely include costs related to campus principals, assistant principals, and related office staff and administrative costs. Expenses in this function are specific to those individuals tasked with directing and managing a school campus, including the supervision and evaluation of teachers and other campus instructional staff (TEA, 2010).

Student Support Services. This variable encompasses three separate functions, which are reported separately by TEA, and must be totaled. Function 31 (Guidance, Counseling, and Evaluation Services) includes expenses related to guidance, academic, and occupational counselors, assessment and testing coordinators, and psychological services. Function 32 (Social Work Services) encompasses any costs related to the investigation and diagnosis of the social needs of students that may arise out of school, home or community settings. Again, many smaller districts may not have expenses in this function due to a lack of available funds. In addition, Function 33 (Health Services) accounts for any expenses related to the provision of a school nurse or other health services provided by the school district. While these expenses are not directly tied to classroom instruction, they most certainly have an impact on the ability of the instructional staff to do their work effectively with the students in their classrooms (TEA, 2010).

General Administration. Expenditures related to this variable are derived primarily from Function 41, and include expenses related to the oversight and management of the entire district. All expenditures related to the board of trustees, legal fees for the district, and the salary and expenses for the Superintendent and district offices, are included in this function (TEA, 2010). The category also includes expenditures, if applicable, from Function 92, which includes costs associated with the sale or purchase of attendance credits as required for districts with excess wealth per weighted average daily attendance (WADA) under Chapter 41 of the Texas Education Code (TEA, 2010).

Non-Discretionary Input Variables

As previously noted, the independent variables selected for use in this study were selected based primarily on the similar efficiency study conducted by Carter (2012), and also reflect the research that emerged from the literature review. The data for each of the following non-discretionary independent variables can be found directly on the TAPR for each district, and was obtained in aggregate from TEA. Non-discretionary variables were collected for each district from the 2014-15 school year and included the total number of students enrolled, the percentage of non-white students, the percentage of students identified as economically disadvantaged, and the student-to-teacher ratio.

Total Student Enrollment. School district size, based on number of total students, varies greatly across the state of Texas. Simply, this variable identifies the total number of students actually enrolled in a school district in a given year. While districts may have some very limited ability to affect their total student enrollment, this factor was included as a non-discretionary predictor variable of district efficiency.

Percentage of Non-White Students. The TAPR does not specifically report on the total percentage of non-white students in each school district. However, it does report on the percentage of white students for each district, along with percentages for a number of other ethnicities. As the percentage of non-white students was included as a non-discretionary input variable in the original study conducted by Carter (2012) and upon which this current study is modeled, this measure was calculated for each district and included in this study as well.

Economically Disadvantaged. As noted in the review of literature, most research defines this variable by the number of students who both apply for and qualify for free- or reduced-price lunches. The literature related to similar school efficiency research consistently agrees that the percentage of students identified as economically disadvantaged should be included in efficiency studies as a non-discretionary variable. TEA conveniently reports this number for each school district annually on the TAPR, both as a total number of students and as a percentage of the total district.

Number of Students Per Teacher. Texas requires that all public school classrooms in Kindergarten through grade 4 not exceed a maximum student-to-teacher ratio of 22:1, without approval of a special waiver from TEA allowing a larger class size due to specified extenuating circumstances, according to the Texas Education Code (TEC) §25.112. There exists no such maximum class-size requirement for grades 5 and above. TEA reports an average number of students per teacher for each district on the TAPR annually. In spite of the limitations placed on districts related to primary-level class sizes, this number was considered as a discretionary variable and was regressed to evaluate its effect on efficiency.

Procedures

Data related to Texas public school districts was retrieved from the Texas Education Agency, primarily from the TAPR for each district. Complete data for all included variables was available for 1015 school districts. In order to compare similar groups, school districts in this study were categorized according to the designations created by the Texas Education Agency (TEA) for the 2014-15 school year, which included: *Major Urban* (11 districts), *Major Suburban* (79 districts), *Other Central City* (41 districts), *Other Central City Suburban* (163 districts), *Independent Town* (70 districts), *Non-Metropolitan: Fast Growing* (30 districts), *Non-Metropolitan: Stable* (177 districts), and *Rural* (453 districts).

DEA, the analytical method for this study, can be conducted by making assumptions regarding scale (Lessiter, 2015). Charnes et al. (1978) utilized a DEA model which assumed a constant return to scale, as illustrated in the following equation (Sherman & Zhu, 2006):

$$Maximize\ \emptyset o = \frac{\sum_{r=1}^{s} \quad u_r y_{ro}}{\sum_{i=1}^{m} \quad v_i x_{io}} \tag{1}$$

Subject to:

$$\frac{\sum_{r=1}^{s} \quad u_r y_{rj}}{\sum_{i=1}^{m} \quad v_i x_{ij}} \leq 1\ for\ all\ DMUs\ j = 1, \ldots, n \tag{2}$$

$$u_{\ r} \geq 0\ for\ r = 1, \ldots, s;\ , v_{\ i} \geq 0\ for\ all\ i = 1, \ldots, m. \tag{3}$$

Where

θ_o = the efficiency score of the DMU under analysis

n = the number of DMUs under analysis

s = the number of outputs

m = the number of inputs

u_r = weight assigned by DEA to output *r*

v_i = weight assigned by DEA to input *i*

y_{rj} = the measure of output *r* produced by DMU *j*

x_{ij} = the measure of input *i* utilized by DMU *j*

Efficiency calculations in this study were conducted using both the Data Envelopment Analysis (DEA) and the Math Programming add-in programs for Microsoft Excel (Jensen & Bard, 2004). These add-ins were created by Paul Jensen and Jonathan Bard of the Operations Research and Industrial Engineering graduate program in the Cockrell School of Engineering at the University of Texas at Austin and were used with permission.

The equation in the DEA model assigned each district with an efficiency score ranging from 0 to 1, or 0 to 100%. Those DMU's receiving a score of 1 or 100% were considered efficient. However, any score less than 1 or 100% revealed some level of inefficiency in output production for the given set of inputs (Charnes et al., 1978; Lessiter, 2015). For school districts identified as being relatively inefficient, the DEA process identified areas of excess input or shortcomings in output, known as "slack," which prevented the school district from optimizing efficiency (Cooper et al., 2007; Lessiter, 2015). DEA was conducted in two stages. In stage one, an output-oriented DEA model was calculated to obtain efficiency scores for each school district included and the percentage of students scoring at an advanced level on all STAAR tests. Then, utilizing ordinary least squares (OLS) regression, selected variables were regressed against the school district's efficiency scores to determine effects of the variables, if any, on efficiency.

It should be noted the DEA model is designed to measure relative efficiency amongst DMUs, and not necessarily the technical efficiency of each DMU in question (Carter, 2012; Haveman, 2004). As such, each of the school districts in this study that received an efficiency score of 1 or 100% should not be assumed to be entirely efficient, and as such, each can still possibly improve upon actual efficiency. Following the calculation of efficiency scores for each school district utilizing DEA, selected input variables were regressed against the school district's efficiency scores using ordinary least squares (OLS) regression, to determine effects of the variables, if any, on district efficiency.

Finally, Daggett's (2009) *Effectiveness and Efficiency Framework* was utilized to evaluate the various categories of school districts. Daggett's (2009) E/E Framework employs a four-quadrant scheme to identify and promote educational methods that attain high performance outputs with relatively low costs (Quadrant D) while avoiding those which tend toward higher costs and lower performance outputs (Quadrant A). This current study replaced Daggett's (2009) cost measurements with the efficiency ratings obtained through DEA for public school districts in Texas in an effort to identify those that were most and least efficiently utilizing the resources allocated to them with the greatest educational effect.

Daggett's (2009) framework is simple by design, and organizes data into a four-quadrant graphic, where the horizontal axis represents the cost/efficiency, with greater efficiency (lower cost) to the right, and the vertical axis represents the student performance or effectiveness, with greater effectiveness to the top (Daggett, 2009). Daggett's (2009) four quadrants are modified to fit this particular study, and are illustrated as follows:

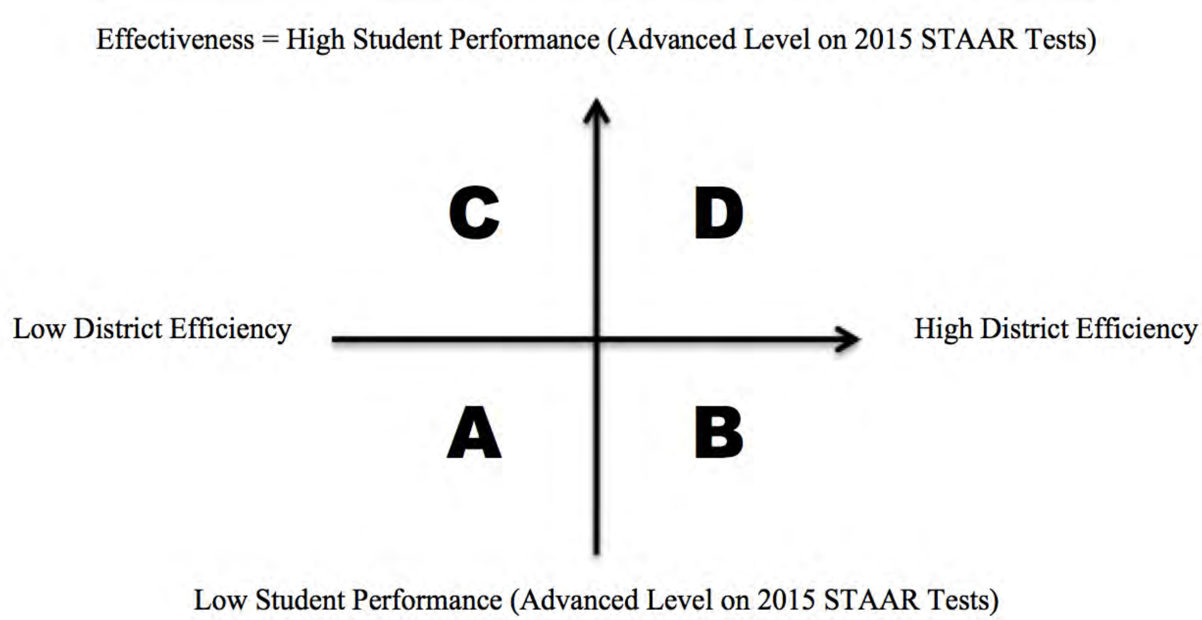
- Quadrant A (bottom left) – represents low district efficiency and low student performance
- Quadrant B (bottom right) – represents high district efficiency and low student performance
- Quadrant C (top left) – represents low district efficiency and high student performance

- Quadrant D (top right) – represents high district efficiency and high student performance

Figure 1 illustrates Daggett's framework that includes the variables for the current study.

Figure 1

Daggett's Modified Effectiveness and Efficiency Framework for STAAR Performance



Note. Modified effectiveness and efficiency framework. From "Effectiveness and Efficiency Framework – A Guide to Focusing Resources to Increase Student Performance," by W. R. Daggett, 2009, Rexford, NY: International Center for Leadership in Education, p. 2. Copyright 2009 by International Center for Leadership in Education. Adapted with permission.

Findings

School districts within each of the eight classification groups of public school districts in Texas utilized by TEA generally tend to be similar in terms of student enrollment numbers. The results displayed in Table 2 show the average student enrollment in each different category of school districts, as well as the largest and smallest actual student enrollment numbers in each classification. Districts within the "Major Urban" category comprise the largest average student enrollment of 89,098 students, with one district having an enrollment of 214,262 students. In contrast, the smallest school district in this study in the "Rural" classification had a total student enrollment of only 29 students, with the average enrollment in that category being only 384 students.

Table 2

Descriptive Statistics for Student Enrollment Data by TEA District Type

District Type	***n***	***M***	***SD***	**Minimum**	**Maximum**
Major Urban	11	89,098	53,228	42,421	214,462
Major Suburban	79	21,513	20,784	1813	112,691
Other Central City	41	20,626	14,001	4211	56,164
Other Central City Suburban	163	4387	4602	869	24,659
Independent Town	70	3647	2454	258	14,411
Non-Metropolitan Fast Growing	30	928	804	325	3787
Non-Metropolitan Stable	177	1652	845	864	6087
Rural	444	384	220	29	857
TOTAL	1015	4913	13,880	29	214,462

The initial results of the DEA suggested that statewide in the 2014-2015 school year, public school districts in Texas operated at an average of 48.3% relative efficiency. Districts categorized as "Non-Metropolitan Fast Growing" were found on average to be the most efficient at 63.6%, while those in the "Independent Town" category were generally found to be the least efficient at 38.6% on average. There were 62 districts statewide (6.1% of all evaluated districts) that were found to have a 100% relative efficiency rating (i.e., efficiency score of 1), and such districts were found in each of the different TEA categories of school districts, with the exception of "Major Urban" and "Independent Town." The lowest relative efficiency score was

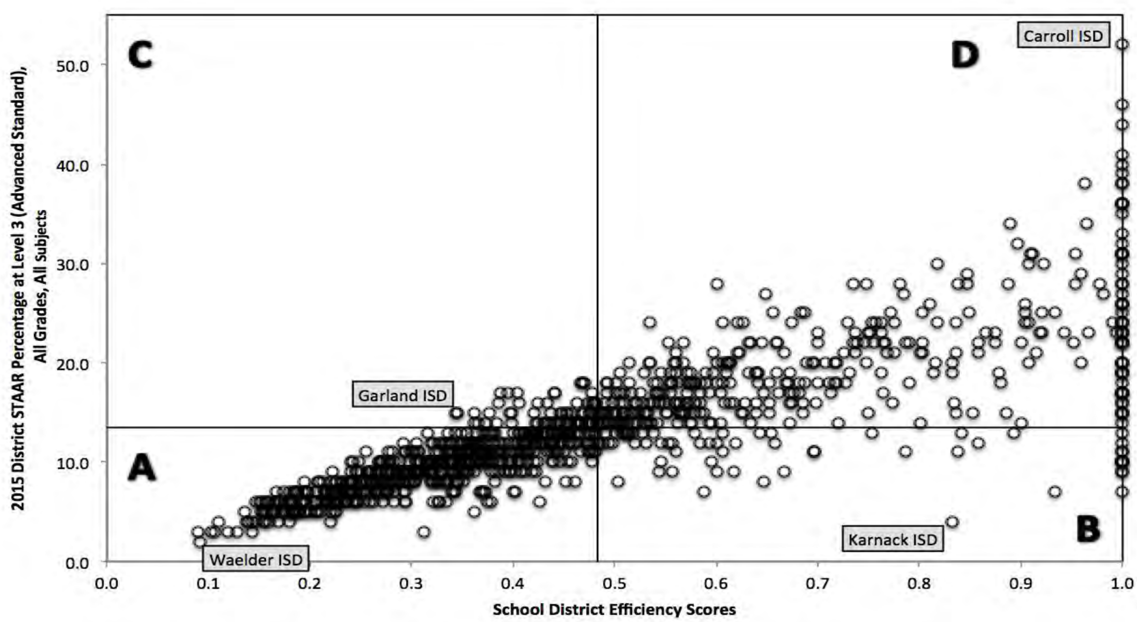
8.9% (e.g., efficiency score of .089), attributed to a school in the "Rural" category. Statewide, there were 14 districts with efficiency scores less than 15% (i.e., efficiency score of 0.15), and 108 districts with scores greater than 85%.

Percentages on *STAAR Percent at Advanced Standard, All Grades, All Subjects*, as reported on the Texas Academic Performance Report (TAPR) for each public school district in the 2014-2015 school year, are plotted on the vertical axis, again corresponding to Daggett's (2009) effectiveness axis. For this study, the horizontal axis was placed at 13.5%, which represents the average of all public school district student achievement percentages in 2014-2015 on this specific performance measure. Correspondingly, districts with percentages plotted above this axis had student STAAR performance levels on this indicator which were above the state average in the 2014-2015 school year.

Figure 2 includes data for the entire population of 1015 Texas public school districts included in this study. Those districts with data points in Quadrant D were found to have above-average student performance levels while operating with above-average efficiency. The 62 districts with 100% relative efficiency ratings are plotted along the far-right border of the graph.

Figure 2

Efficiency Plots for All Texas School Districts



Note. School districts named in the figure were outliers in each of the quadrants.

Slightly more than half (52.5%) of all districts in the study were placed in Quadrant A, which indicates below-average student performance scores and below-average efficiency ratings. However, 34.5% of districts landed in Quadrant D, which indicated above-average effectiveness and efficiency scores.

Findings for Research Question One

Research question one examined “What non-discretionary factors influence the efficiency of Texas public school districts?” For the purpose of examining what effects, if any, the variables selected for this study had on the calculated efficiency of school districts statewide in Texas, an ordinary least squares (OLS) regression was performed. Carter (2012) noted a Tobit regression model had also been utilized in similar studies and yielded similar findings. To that end, a Tobit analysis was also conducted in this study, and those outcomes did confirm the OLS results. Descriptive statistics were calculated to summarize the data for each of the discretionary and non-discretionary independent variables, and the one dependent variable considered in this regression analysis. These descriptive statistics are summarized in Table 3.

Table 3
Descriptive Statistics for Variables Used in District Efficiency Score Analysis
N=1015

Variable	*M*	*SD*
Dependent		
Efficiency	0.483	0.231
Independent, Non-Discretionary		
Total Student Enrollment	4912.891	13,880.098
Percentage of Non-White Students	48.896	26.653
Percentage of Economically Disadvantaged Students	56.550	18.646
Student-to-Teacher Ratio	12.719	2.453
Independent, Discretionary		
Average Years of Teacher Experience	12.406	2.408
Percentage of Teachers with a master's degree	17.202	8.076
Total Instructional Expenditures (per student)	5104.58	1218.018
Average Actual Teacher Salary	45,716.83	4569.259

The chosen non-discretionary independent variables for each of the school districts in this study included total student enrollment, the percentage of non-white students enrolled, the percentage of economically disadvantaged students enrolled, and the ratio of students to teachers in each district. Table 4 presents the results of the OLS regression analysis of independent non-discretionary variables. The dependent variable was the efficiency score for each school district calculated with DEA. The regression analysis was conducted with the full population of 1015 Texas public school districts. The results of this analysis indicated school district efficiency was significantly and positively affected by total student enrollment. Further, the percentages of non-white students and of economically disadvantaged students were found to have a significant negative influence on district efficiency scores. The student-to-teacher ratio was not found to have a significant effect on school district efficiency.

Table 4
Non-Discretionary Variables Used in District Efficiency Score Analysis

Non-Discretionary Variable	Coefficient	Significance
Total Student Enrollment	0.129	0.000*
Percentage of Non-White Students	- 0.173	0.000*
Percentage of Economically Disadvantaged Students	- 0.517	0.000*
Student-to-Teacher Ratio	- 0.050	0.236

*Statistical significance indicated at 0.05.

Findings for Research Question Two

Research question two was, "What discretionary factors influence the efficiency of Texas public school districts?" The dependent variable was again the efficiency score for each school district calculated with DEA. The regression analysis was conducted with the full population of 1015 Texas public school districts. In addition to total expenditures for instruction, the independent variable that reflected total operating expenditures across all functions included in each district's general fund expenditures was also initially considered. This value indicated the total average cost to educate a student in a particular district. An additional model was run to account for errors attributed to collinearity, and it was determined the variables associated with

Total Expenditures and Total Expenditures for Instruction were very highly correlated and were essentially redundant in their measures. As such, the variable for Total Expenditures for Instruction was ultimately selected for regression.

Table 5 summarizes the results of the OLS regression analysis of independent discretionary variables. The results of this analysis indicated school district efficiency was significantly and positively affected by total expenditures for instruction per student. Further, the percentage of teachers with a master's degree was found to have a significant negative influence on district efficiency scores. Neither the average actual teacher salary nor the average years of teacher experience were found to have a significant influence on school district efficiency ratings.

Table 5

Discretionary Variable Used in Efficacy Score Analysis

Discretionary Variable	Coefficient	Significance
Percentage of Teachers with a master's degree	- 0.081	0.002*
Average Years of Teacher Experience	0.029	0.283
Average Actual Teacher Salary	0.008	0.823
Total Expenditures for Instruction (per student)	0.111	0.002*

*Statistical significance indicated at 0.05.

Discussion

The results of this study add to the literature regarding the financing of public schools as well as how effectively public schools expend available resources to successfully educate their students. Further, this study adds literature validating data envelopment analysis as an accurate but relatively simple way to measure school district efficiency (Carter, 2012; Duncombe & Yinger, 2011; Golebiewski, 2011). School district efficiency studies have not been as prevalent as studies related to individual teacher and principal effectiveness, but district-level studies have begun to increase in recent years (Byrd et al., 2011; Carter, 2012).

The policymakers in the state of Texas are not unlike those in other states in the nation, who struggle to find a balance between a desire to minimize the overall tax burden for citizens while attempting to adequately fund public education alongside a plethora of other public services clamoring for a limited amount of public dollars. Many education policymakers and business leaders argue that school districts in the state do not suffer from a lack of funding, but rather a exhibit a significantly inefficient use of the funds received by the school districts (Baker, 2016; Michels, 2015). However, it should be noted this study found that 34.5% of districts in the state of Texas were rated in Quadrant A of the modified E/E Framework, which indicates a higher-than-average level of both student academic performance and efficiency.

It should further be emphasized the single output variable used to calculate efficiency scores in this study was each district's percentage of students in all grade levels attaining the Level III: Advanced Standard, in all STAAR subjects tested in 2015, which remains the highest measured level of student academic performance within the current state assessment system. In order for students to individually meet state graduation standards, or for school districts to be rated as acceptable or higher by state standards, students are only required to meet a lower "Satisfactory Standard" on the STAAR tests, which is being phased in gradually at a lower passing standard than what is required to attain the Level III: Advanced measure. It is reasonable to expect that if this study were replicated using the lower, but acceptable, Satisfactory Standard as the output variable, the percentage of school districts in Quadrant A would increase measurably.

A number of input factors were found to have a significant effect on school district efficiency scores as calculated using DEA. Of the eight input variables that were regressed against calculated efficiency scores, five were found to exert a significant influence—two positively and three negatively. Generally, school districts tended to be rated as more efficient if they had larger student enrollments overall, but smaller percentages of non-white and economically disadvantaged students, as well as if they expended more dollars on a per-student basis for instructional purposes. Notably, three of these four variables were non-discretionary in nature, by definition, beyond the direct control of the school district.

The two discretionary input variables found to exert significant influence on district efficiency scores were instructional expenditures per student (positive influence), and the percentage of teachers with master's degrees (negative influence). While school districts do possess some discretion in the amount of money expended per student for instructional purposes, it should also be reiterated that districts cannot expend funds they do not have (Baker, 2016). As previously stated, simply spending more money on education does not inevitably guarantee better results, but schools which have access to greater revenues can clearly afford to invest in more and better instructional resources than those schools who do not (Dayton, 1995). Carter (2012) found the percentage of teaching staff with master's degrees exerted a significant positive influence on efficiency scores. Contrary to expectation, the results of this study revealed the percentage of teaching staff with master's degrees had a negative influence on overall district efficiency. This could possibly imply that the additional cost paid by districts to professional staff with advanced degrees does not ultimately have a commensurate favorable impact on student academic performance.

It is worthwhile to consider the input variables which were found to not have a significant influence on school district efficiency ratings. Similar to the results in Carter's (2012) study, the student-to-teacher ratio and the average actual teacher salary were not found to affect statewide school district efficiency ratings to a significant extent. Carter (2012) did find the average number of years of teachers' experience exerted a significant, yet negative influence on district efficiency; however, this current study found this variable to also be non-significant regarding efficiency.

This research should be of interest to current and future Texas legislators, specifically regarding the debates referencing the cost and definition of an adequate public school education, the financial and educational merits or detriments of consolidating smaller school districts, and the advantages or disadvantages of school choice and vouchers. This research may assist state legislators and policymakers in moving beyond anecdotal assertions of a lack of efficiency in public school districts toward more accurate and data-driven conclusions. Routinely conducting efficiency evaluations of public school districts could provide valuable longitudinal data leading to improved district efficiency and effectiveness alike, and more effective legislative appropriations of financial resources to public school districts.

School districts that spent more per student for instructional purposes were generally found to be more efficient. However, not all school districts, even those with similar circumstances or demographics, are afforded the same discretion to spend more on instruction due to the significant inequities in the public school funding formulas in Texas (Barton, 2013). Baker (2016) asserted, "When schools have more money, they have greater opportunity to spend productively… when they don't, they can't" (p. ii). Further, school districts with smaller overall student enrollments, or those with larger populations of economically disadvantaged or non-white students will find it more difficult to function efficiently without additional funding to compensate. Thus, legislators should assure that adequate funding is allocated to public schools in general, and specifically to those districts with more challenging, and thus, more expensive-to-educate student populations. At a minimum, public funds should be distributed equitably among school districts, regardless of disparities in local property values, so that each district has an equitable opportunity to operate at high efficiency.

The results of this research should also be of great interest and importance to Texas taxpayers in order to help clearly indicate whether or not their tax dollars are being used effectively and relevantly on students within their own communities. Longitudinal efficiency ratings for school districts could help to inform taxpayers of the stewardship of their local school districts as compared to other similar school districts in the state. However, in order for these relative efficiency ratings to be fair and meaningful, they would need to be reviewed in context with other school district data such as enrollment size, student demographic data, and state revenue allocations per student.

Finally, these findings may have implications for school district practice. This study could aid public school educators and decision-makers as they evaluate how best to allocate and expend diminishing district resources, in order to most efficiently obtain the greatest levels of student performance results. It is clear from the findings that district- and campus-level decision-makers should make every effort to allocate as many available resources as possible directly for instructional purposes in order to improve both effectiveness and efficiency.

Additionally, it is generally expected that larger numbers of teachers with more years of experience, especially when coupled with advanced degrees, will lead to better instructional practices in schools, and thus, to better student academic performance results. While this may very well be the case, these factors have been shown to exert either a negative or a negligible influence on school district efficiency scores. This may be due to the fact that both years of experience and advanced degrees generally contribute to higher average teacher salaries overall, the other non-significant discretionary variable, thus increasing overall costs to districts. Once again, it is possible the additional salary costs (at least for the specified reasons) do not contribute to corresponding gains in student academic performance results. Carter (2012) similarly suggested that districts consider a reevaluation of traditional teacher salary schedules, possibly structuring additional compensation for professional educators based more on documented professional development and growth, as opposed to simply basing salary growth on years of teaching experience.

This district-level efficiency study of public schools in Texas using DEA builds on the research conducted by Carter (2012) and adds to the growing body of research in this area. This study may also assist district-level public educators (such as Superintendents) to more accurately assess the level of efficiency in their own school districts, relative to their fellow districts. This could assist districts identified as being less efficient by providing models of districts with similar demographics and circumstances within the state that have been able to achieve high levels of student performance while minimizing (at least to some degree) the level of input of resources.

Recommendations for Future Research

As previously noted, the single output measure used in this study to calculate district efficiency scores reflected the highest current benchmark for student performance on the STAAR tests. However, students and school districts alike are considered acceptable by the Texas Education Agency at a lower student performance level. It would be valuable to replicate this study using either of these lower, but still acceptable, student performance indicators as the single output variable in the DEA process. It would be expected that school district efficiency scores would generally improve overall, and thus, more districts would be placed in Quadrant D, indicating above average effectiveness and efficiency.

In addition to further investigations to model changes resulting from using different standards, more research is needed to better understand the how and why the variables used in the model affect efficiencies. This should be accomplished using the full array of methodological tools available to have a complete picture of the complex relationships between the various inputs and what could result from minor changes in them. Similarly, it would be valuable to conduct DEA studies in the various district types represented in Texas to evaluate the potential efficiency differences and the input factors that influence them, thus allowing a more targeted approach for becoming more efficient.

Conclusion

This study contributed to the literature by providing a simple, but comprehensive, methodology for ongoing public school efficiency measurement, along with benchmark efficiency scores under the STAAR student assessment program for all public school districts in Texas. With additional study and evaluation, school districts may be able to improve their efficiency ratings by replicating best practices exhibited by comparable school districts. Further, information from this study may be utilized to provide data-driven justification to legislators and policymakers for the investment of additional public resources in specific areas of public education that will provide the greatest educational and financial benefit. Ultimately, such changes would prove to be beneficial for all involved educational stakeholders.

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