DATA ENVELOPMENT ANALYSIS: MEASURMENT OF

EDUCATIONAL EFFICIENCY IN TEXAS

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The purpose of this study was to examine the efficiency of Texas public school districts through Data Envelopment Analysis. The Data Envelopment Analysis estimation method calculated and assigned efficiency scores to each of the 931 school districts considered in the study. The efficiency scores were utilized in two phases. First, the school district efficiency scores were combined with school district student achievement to evaluate effectiveness with efficiency. A framework was constructed to graph the scores on an x-axis of student achievement scores and a y-axis of efficiency scores to further illustrate the data. The framework was evaluated with the full statewide sample and with school districts categorized into similar peer groups.

Then, using variables selected from related scholarly literature, a regression analysis identified which factors impacted school district efficiency statewide. The non-discretionary variables included in the study were total student enrollment, the percentage of non-white students and the percentage of economically disadvantaged students. The discretionary variables selected included the teacher-to-student ratio, teachers' average years of experience, the percentage of teachers with master's degrees and the average teacher base salary.

Amongst the seven factors selected for regression analysis, five statistically significant variables were identified as impacting statewide school district efficiency. All three non-discretionary variables were identified as statistically significant on efficiency and included total student enrollment, the percentage of non-white students and the percentage of economically disadvantaged students. Two discretionary factors showed statistically significant effects on

efficiency which included teachers' average years of experience and the percentage of teachers with master's degrees. The teacher-to-student ratio and the average teacher base salary were ineffective in predicting efficiency.

This study contributed to the understanding on educational efficiency. Data Envelopment Analysis has been employed mainly in the private sector to analyze efficiency in economics and business organizations. This study added to the educational research on selecting Data Envelopment Analysis as a primary estimation method for analyzing the efficiency of school systems.

ACKNOWLEDGEMENTS

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CHAPTER 1

INTRODUCTION

Texas public school allocations have risen consistently from the inception of public

education in Texas until the 2008-2009 school year. In fact, beginning with the 1998-1999

school year, Texas spending on public education rose 95.3% over the following decade.

However, over the same decade, enrollment in Texas public schools increased 20%, a

considerably smaller rate of increase than spending (Combs, 2010). The inconsistency between

slight enrollment increases and substantial spending increases naturally issues a call for

efficiency research, especially considering that in the present economic climate, spending

increases will likely cease for the foreseeable future. Therefore, this study examined public

school efficiency research with a model created for examining schools.

Educational Expenditures

Educational expenditures which predict student achievement deserve the greatest

allocation of resources available in education in order to most efficiently steward tax coffers by

providing a quality education to public school students. Countless studies and publications of

research gleaned inspiration from an outdated interest in deciphering whether school

expenditures answer the question; does money matter in education? (Picus, 1997). Researchers

now recognize that the debate over education lies in how efficiently and effectively public

schools utilize their resources (Ruggiero & Vitaliano, 1999). The current body of research

transforms the former question into a more timely consideration; where does the money matter

most in education? School districts across the country confront an economy with dwindling

resources requiring school officials to find strategies that maintain high standards with low

expenditures. During times of high expectations, school district must strategically spend limited funds (Odden & Picus, 2011).

Elementary and secondary school disbursements totaled $650 billion in the United States for the school year 2009-2010, a peak of educational spending for the federal government. Since that time, the public education budget has been adversely affected by a problematic economy. As a result of the fiscal downturn, the 2011-2012 federal allocation for public school education reflected a decrease in funding of about $125 billion. (National Center for Education Statistics, 2010). Over time, policy makers have consistently added resources to schools in an effort to improve quality (Hanushek, 2003.) The school years following the economic downturn began an era of school budget cuts and deficits (Picus & Odden, 2011). Public school entities in the United States are experiencing the effects of a weakened economy and decreasing budgets without a reduction in enrollment.

Public school enrollment at the elementary and secondary school levels is projected to increase by 7% for elementary students and 4% for secondary students between the school years 2010 and 2019, creating a record enrollment for each successive school year (National Center for Education Statistics, 2010). As school funding limitations increase burdens on a growing number of students in public education, measuring the efficiency of school systems emerges as a subject of paramount concern. The fiscal downturn in the United States' economy requires states and school districts within states to educate more students with fewer resources of funding but added financial pressure (Picus & Odden, 2011).

The economic instability and reduction in public school funding currently requires school officials to decide how to allocate funding in terms that will result in increased student performance. During difficult financial periods in the past, schools continued to receive

additional funding although the school districts contended that the reduced amounts would compromise their endeavors to improve student achievement (Picus & Odden, 2011). School districts have historically found means to compensate for short-term financial difficulties and small fiscal deficits. Currently, school districts are cutting budgets to programs and services which have not traditionally suffered in the past.

For example, in Texas the school year 2011-2012 brought the dismay of parents and students when their school districts faced stifling budget cuts. Because of the budgeting shortages, with no immediately foreseeable reconciliation of funding, school districts have resorted to cutting programs and personnel perceived as having the least effect on student achievement. In a football obsessed state, Dallas ISD, the state's second largest school system, eliminated the entire seventh grade football program for the 2011-12 school year (Haag, 2011). During the same school year, Keller ISD, a school district of over 33,000 students, implemented a pay-to-ride bus system as a means of reducing transportation funding (Keller ISD, 2011). As homeowners' property tax values have declined, the school districts largest funding source, local property tax, lessened (Picus & Odden, 2011). Ironically, while taxpayers balk at the reduction in activities and service, taxpayers also suffer from economic woes such as reduced property values, which have caused some of these reductions. The task at hand for school districts to reinstate and recover effective programs and services suffered by funding loss is a challenge; improving efficiency and maximizing impact of limited funding where the most results will be achieved for stakeholders becomes the goal.

Efficiency in public schools becomes increasingly crucial with every school year. In Texas, property taxes comprise the greatest allocation of funds for public schools, since Texas does not levy a state income tax. Hanushek (2003) points out that the actual performance of

individual students did not dictate the expenditure distribution, but instead rather the wealth and income of the community determines the expenditures. Texas citizens often equate their elevated property tax expense to a tuition payment when raising school age children. Public education greatly influences local government spending (Combs, 2010). Local property taxes comprised 36.7% of public school education dollars for the 2008-2009 school year (Combs, 2010). Due to the structure of the funding system, Texas public schools undergo public scrutiny and criticism with regards to expenditures. Because of tax revenue allocation for education, Texas citizens submit their investments (local property taxes) with expectation that these investments will yield the desired return: high levels of student achievement.

Definitively, local tax payers expect local school districts to earn high accountability ratings. School districts earn accountability ratings as a result of state assessment scores. The accountability ratings received by school districts directly influence the property values within the districts' boundaries. High student academic performance achieved at a minimum of cost to taxpayers provides valuable examples of school district efficiency (Combs, 2010). The most recognizable and celebrated student achievement scores come from scores on state mandated assessments.

The Texas Education Agency implements the assessment of public school students' knowledge and skills under obligation of state law. Texas employs a statewide assessment system to measure student achievement which delegates the administration of assessments in Texas public schools. Assessments include reading and mathematics in all grade levels from third through eleventh grades with additional testing as follows:

- Grades 4 and 7 – Writing
- Grade 5 – Science

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- Grades 6 and 9 – No additional testing

- Grades 8, 10 and 11 – Science and Social Studies

Since its inception, the assessment has survived under numerous titles including the Texas Assessment of Basic Skills (TABS), the Texas Educational Assessment of Minimum Skills (TEAMS), the Texas Assessment of Academic Skills (TAAS) and for the past several years, Texas Assessment of Knowledge and Skills (TAKS). TAKS evaluates students beginning in grades 3 through 11. These tests cost taxpayers millions of dollars annually. A report released by the Texas Comptroller of Public Accounts Susan Combs's office revealed that in the 2008-2009 school year, districts spent nearly $37 million on testing materials, not including the expenses of staff preparations and administration of the assessments (Combs, 2010). State mandated assessments will continue to be earmarked in school budgets as long as the state of Texas provides public school funding.

Texas School Funding

According to Texas Comptroller's office school funding currently accounts for about 43.7% of the state's general fund. K-12 schools receive over twice the portion that Medicaid is provided. Combining Texas public and higher education together in the 2010-2011 biennium represented over 60% of the state's general revenue spending, by far the largest category of state expenditures (Combs, 2010).

At the district level, the general fund provides a financial description of expenditures. The general fund for every school district is itemized on the Academic Excellence Indicator System (AEIS) report available through the Texas Education Agency's website. The general fund outlines expenditures which include but are not limited instruction, leadership, facilities,

and transportation. This distinct section of the AEIS report details the information which adds up to provide the total amount spent by the school district to educate the students. The total operating expenditure per student has increased 63% since the 1998-1999 school year (Combs, 2010).

To positively affect the quality of education, the state government imposed a requirement on school districts directly related to the general funds. In 2005, Texas Governor Rick Perry instituted an executive order termed the "65% Solution" (Hoppe, 2005). This order mandated all Texas public school districts to redistribute their budgets allocating a minimum of 65% of expenditures towards classroom instruction. Clearly, Governor Perry acted with intentions to influence school district efficiency as established in the following statement from the *Dallas Morning News* in July 2005, "The action I take today will mean more financial accountability for taxpayers, more efficiency in school spending and more money directed to the classroom so that more children achieve." Governor Perry's order indicates an expenditure variables' predictive measure in that greater classroom allocation must lead to greater student achievement.

In 2008, the national and state economic climate declined considerably. Hence, in 2011, Governor Perry called a special session of the Texas legislature in order to address the state's budget, intentionally focusing on the state's education budget. During the special session, Texas lawmakers passed a bill cutting $4 billion from the public school education budget (Vertuno, 2011). Whether earmarking additional funds towards education or decreasing educational spending, measuring the efficiency of school systems becomes essential. The school districts in Texas averaged a per pupil annual expenditure of $11,567 in 2008-2009 (Combs, 2010). School districts that have grown accustomed to increasing budgets in the past presently face dilemmas regarding drastic budget cuts. In terms of school efficiency, the most efficient school districts

will not incur a decrease in student achievement outputs as a result of decreased inputs of expenditures.

Efficiency Measurement

Efficiency embodies the ratio of expending the least amount of time, effort or money on the development of an acceptable product or accomplishing a goal. Measuring public school efficiency has emerged as a popular topic of current research. Researchers have documented cases of measuring public school efficiency with varying results including the claim that money does not matter, implying no "strong evidence" linking per pupil expenditures and efficiency (Chakraborty and Poggio, 2008, p.228). The vast majority of the research available on the subject of state public school efficiency contradicts this view and indicates several common variable predictors. As previously mentioned, the research concentration has undergone transference to determine how to utilize resources to ensure organizations perform efficiently. A critical aspect of this quantitative study rests in the estimation methods utilized to measure efficiency.

An informative definition of technical efficiency states, "the maximum equiproprotionate reduction in all inputs consistent with the production of observed output" (Ruggiero and Vitaliano, 1999, p. 322). The measured subject attains a perfect technical efficiency score of 1 when inputs may not be reduced any further without affecting the outputs. The technical efficiency measurement tools include data envelopment analysis (DEA) (Smith & Street, 2005).

Data envelopment analysis was developed as a method designed to measure the relative efficiency of decision making units (DMU). Farrell (1957) established modern empirical efficiency measurement with the procedure of calculating a technical efficiency score for every

observed DMU. Two decades later, Charnes, Cooper and Rhodes (1981) pioneered DEA as a programming technique designed to compare the DMU efficiency scores. DEA creates a frontier of efficiency comprised of all observed efficiency scores. The DMUs that incur the most efficient scores emerge to create the frontier, thereby enveloping all the other remaining scores.

Depending on the study and analysis in question, a designated DMU may be an organization, company, or, in the case of this study, a school district. This study focuses on the technical efficiency of Texas public school districts. DEA delineates an organization such as a school district as efficient under the circumstances that it produces the same amount of output as another school district with similar characteristics yet employs less input (Smith & Street, 2005).

Rassouli-Currier (2007) utilized efficiencies generated by DEA as dependent variables in a second stage with Tobit regression to assess the effects of variables not included in the first stage on technical efficiency. Since the efficiency estimates from the first stage are between 0 and 1, data is censored, and therefore Tobit regression, rather than OLS, is the appropriate method of estimation.

DEA has previously been utilized in studies intended to measure public school systems' efficiency in several states. This study focuses on the condition of public school districts' efficiency in the state of Texas.

Theoretical Framework

Daggett's (2009) effectiveness and efficiency framework provides the theoretical framework for this study. This framework was created with the intent of assisting educators in determining cost (efficiency), defining student performance (effectiveness), and constructing the comparison of cost to performance. The effectiveness and efficiency framework analysis of data

can be employed in making data-driven decisions through the evaluation of resource allocations

invested to provide cost-efficient, effective practices and procedures that improve student

achievement outcomes. Daggett's (2009) framework includes determining the cost of initiatives

and the resulting student performance.

Figure 1 presents Daggett's (2009) four quadrant framework.

Effectiveness = High Student Performance

C   D

High Cost ——————————————→Efficiency
                                    = Low Cost

A   B

Low Student Performance
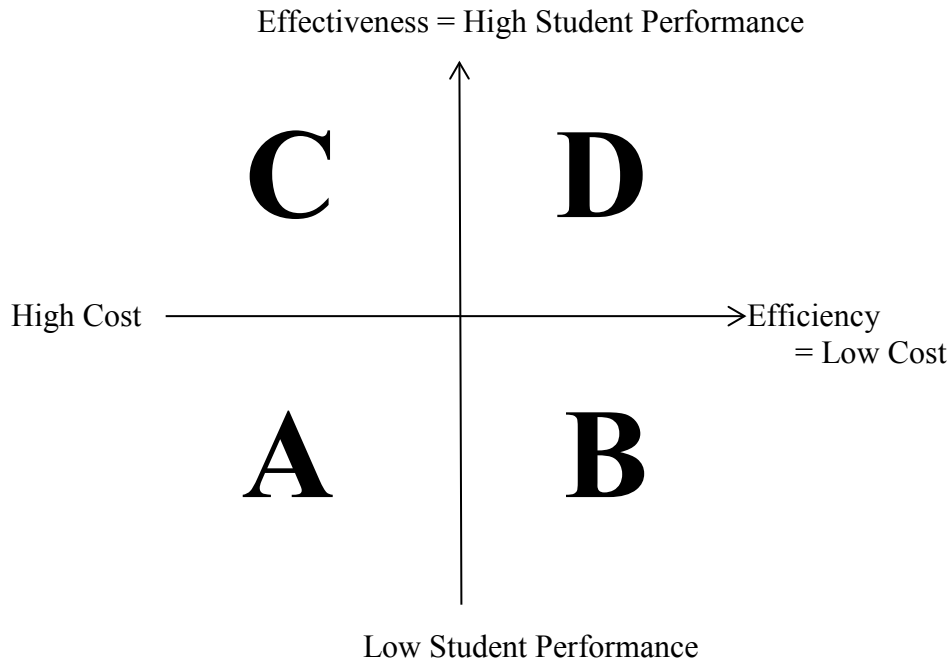
Figure 1. Effectiveness and efficiency framework.

- The horizontal line denotes cost of initiatives, or efficiency.

- The vertical line represents student performance, or effectiveness, of an initiative.

- Quadrant A – represents high cost and low student performance

- Quadrant B – represents low cost and low student performance

- Quadrant C – represents high cost and high student performance

- Quadrant D – represents low cost and high student performance

    Daggett (2009) described the framework as intentionally simple. While the present study

includes more complex analysis, the theory of the analysis and purpose of the results correspond.

This study is intended to compare the Texas public school districts that are effective and efficient operating with relatively low cost, producing high student performance.

Problem Statement

The research problem for this study is based upon declining school district funds and increased student enrollment and focuses on the critical need to assess the efficiency of Texas public school districts using information from the Academic Excellence Indicator System, a database implemented and maintained by the Texas Education Agency. DEA results in predictors of efficiency and inefficiency in Texas public school districts.

Purpose of the Study

The purpose of this study is two-fold: 1) to determine the efficiency of Texas public school systems and 2) to determine the causes of inefficiency.

Research Questions

The following research questions guide the current study:

1. Which non-discretionary factors influence efficiency among Texas public school districts?

2. Which discretionary factors significantly contribute to efficiency among Texas public school districts?

Definition of Terms

Academic Excellence Indicator System (AEIS). A Texas Education Agency database that stores data from school districts pertaining to staff, students, finances, operations, and organizational records.

Accountability rating. A designation assigned by the Texas Education Agency to a school district and schools within the district. The ratings of concern in this paper were developed in 2007 by the state to signify performance on Texas state assessments. The calculations to determine accountability ratings include test scores, completion rates, dropout rates and attendance records. The nomenclatures for these ratings are as follows in order from the highest credential to the lowest for the first four listed:

- Exemplary

- Recognized

- Academically Acceptable

- Academically Unacceptable

- Not Rated: Other

- Not Rated: Data Integrity Issues

Central administration. The costs associated with district level administrative support.

Data envelopment analysis (DEA). A method of measuring technical efficiency that uses efficiency scores to form a boundary or barrier comprised of the most efficient scores. The boundary encompasses all other scores, enveloping the data set.

Decision making unit (DMU). The subject of observation for determining technical efficiency expressed with a label. For this study, each DMU is a Texas public school district, such as Kaufman ISD.

Economically disadvantaged. School efficiency studies and scholarly literature incorporate the number of economically disadvantaged students. The standard assigning variable is student qualification for free lunch or reduced lunch prices. Such qualification requires parents to complete paperwork attesting to their household income.

Expenditures per pupil. For every Texas public school district, AEIS records an average number of dollars spent in each school year on an average student. This dollar amount indicates the average cost to the school district to educate a student. The average expenditure per pupil has increased every school year, indicating a willingness to further invest in the education of students.

Instruction. This variable includes expenditures directly related to the instruction of students and the classroom.

Instructional leadership. Instructional Leadership refers to funds directly used for managing, directing, supervising and providing leadership for staff who provide general and specific instructional services.

Instructional-related services. These expenditures/expenses are directly and exclusively used for resource centers, establishing and maintaining libraries and other major facilities dealing with educational resources and media. This function includes expenditures used directly and exclusively for curriculum, in-service training, and other staff development for instructional-related personnel functions. Examples include travel and substitute teachers used during training sessions.

School leadership. This function covers activities that have as their purpose directing, managing, and supervising schools, i.e., campus principal's office and related costs.

Student enrollment. This variable represents the actual number of students enrolled in the school district from all grade levels including grades which do not take TAKS.

Student percentage passing TAKS. The dependent variable in this study reflects the percentage of assessments passed by all students on all assessments for each school district on

the Texas Assessment of Knowledge and Skills (TAKS). Students in grades 3 – 11 participate in TAKS.

Students per teacher. This predictor ratio indicates an average number of students for any given teacher in the district. It bears noting that in Texas public school districts for all grades kindergarten through fourth grade, class sizes may not exceed 22 students per class without obtaining a special waiver granted from TEA. Class sizes for grade 5 and older do not have a state mandate for ratios per teacher. Consequently, all things being equal in the state's elementary schools, the calculation is derived from the average of number of students per teacher in grades 5 through 12.

Student support services. Student Support Services contains three main budgeting areas: guidance, counseling, and evaluation services. Those activities have as their purpose assessing and testing pupils' abilities, aptitudes, and interests; counseling pupils with respect to career and educational opportunities; and helping them establish realistic goals. Social Work Services encompasses those activities related to promoting and improving school attendance of students. Health Services embraces the area of responsibility to provide health services, which are not a part of direct instruction.

Teacher annual salary. The teacher annual salary is a calculation of average annual salary for teachers in the school district. TEA reports indicate that the minimum teacher's salary for a teacher with zero years of teaching experience remained at $27,320 for three school years under consideration in this study. School district officials often use the term "beginning teacher salary" as a recruiting tool. In certain areas, school districts compete to offer the highest salary to newly certified teachers. Conversely, financially impoverished school districts lack the means to compensate teachers with more than the TEA allowed minimum.

Teachers with master's degrees. Teachers who hold master's degrees are generally offered higher salaries. Obtaining teacher certification in Texas requires first earning a bachelor's degree and completing an approved teacher certification program that includes student teaching. Teachers normally must complete graduate school earning a master's degree in order to earn principal certification in an effort to move into a school administrator role. This variable represents the percentage of teachers in a school district holding a master's degree.

Teacher's years of experience. Beginning with the first year of teaching, every Texas public school teacher has a record of service. Every teacher service record is an official TEA document that verifies every year a person has taught in Texas public schools. TEA recognizes other teaching years from out-of-state schools and in other designated capacities with specific documentation. This variable describes the average number of documented teaching years for any teacher in the district.

Technical efficiency. A score ranging from 0 to 1 indicating the ratio of output gleaned from inputs. A score of 1 equals absolute efficiency.

Texas Assessment of Knowledge and Skills (TAKS). The Texas statewide assessment system involving students in grades 3 – 11 from 2003 until 2011. TAKS results contribute to schools' accountability ratings.

Texas Education Agency (TEA). The state of Texas's governing body of education. According to the agencies website, the TEA is the administrative unit for primary and secondary public education. Agency responsibilities include:

- Managing the textbook adoption process
- Overseeing development of the statewide curriculum
- Administering the statewide assessment program

- Administering a data collection system on public school students, staff, and finances

- Rating school districts under the statewide accountability system

- Operating research and information programs

- Monitoring for compliance with federal guidelines

- Serving as a fiscal agent for the distribution of state and federal funds

Total operating expenditures by function (2009-2010). Actual total operating expenditures are grouped by function of expense. Actual operating expenditures for groups of function categories are expressed as a percent of actual total operating expenditures. The values in the Per Student column, on an AEIS report, show actual operating expenditures by function divided by the total number of 2009-2010 students in membership. Per student operating expenditures are shown for total operating expenditures and for various groupings of operating categories. Note that the number shown, on an AEIS reports, is not the amount actually spent on each and every student, but rather a per-student average of the total. Function categories are:

- Instruction

- Instructional-related services

- Instructional leadership

- School leadership

- School services-student

- Student transportation

- Food services

- Cocurricular activities

- Central administration

- Plant maintenance and operations

- Security and monitoring services

- Data processing services

Assumptions

It is assumed that all data reported by Texas public school districts to the Texas Education Agency is accurate. The data accessed from the Texas AEIS is assumed to be accurate. The variable data provided by the United States Department of Labor: Bureau of Labor Statistics is assumed to be correct.

Limitations

The data accessed for use in this study is from publically accessible databases maintained by the TEA through their websites. Data for this paper represents state and school district specific categories pertaining to personnel, students, and finances. The United States government data on county employment rates in Texas is publically accessible through its website.

Significance of the Study

The significance of this study included analyzing information in order to cause improvement of efficiency in Texas public school districts. This paper provides information for every school district in the state of Texas to examine its level of efficiency and determine fiscally sound strategies for funding allocation, which will lead to a maximum student achievement for a given amount of financial input. Additionally, this study will contribute to the growing body of scholarly literature utilizing data envelopment analysis as a valuable estimation method for analyzing public education efficiency.

Organization of the Study

The organization of this study consists of five chapters. The introduction of the paper, Chapter 1, provides general information, the problem statement, the purpose of the study, definitions of terms, assumptions and limitations of the research and data as well as the significance and organization of the study. The review contained in Chapter 2 offers pertinent information from applicable research with data and literature regarding the subject of the study. Chapter 3 details the research methodology. Chapter 4 compiles the results and analysis of the data derived from the research. The results of the study and further research recommendations are presented in Chapter 5.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

The two dominate issues facing public school districts include 1) improving student performance and 2) operating with diminishing financial resources (Daggett, 2009). The body of research regarding public education efficiency grows in response to an economic climate that constricts financial allocations. School district officials prioritize researched information to guide subsequent actions; they regard data as an instrument of information to impact judgment. According to Byrd, Daggett, Silver and Williams (2011), "Making data driven decision has been the push for both districts and state departments" (p. 1). Educators and taxpayers continue to gain more appreciation for establishing the amount of educational value derived from educational investments as economic resources become increasingly stringent and budgets become scrutinized beyond historical measures. The efforts to measure technical efficiency in schools and school systems have increased accompanied by a jolt in per pupil expenditures raises questions on appropriate spending and research to provide valid conclusions.

For decades, researchers have studied the relationship between educational appropriations and student achievement throughout differing economic environments. During the 1990s as educated baby boomers sent their children to school, the flourishing United States economy provided more than adequate school funding. In 1998-99, Picus questioned the outcome of spending additional education funding in California. The thriving economic condition at the time allowed for full state coffers. Mismanagement of funding in the form of heedless spending sometimes resulted. This level of prosperity began a great decline in 2008.

The subsequent decline of the economy provoked national and state reductions in school funding causing a paradigm shift of influence regarding subjects of school efficiency research which continues. Researchers attempt to quantify the ultimate resourceful methods of educational budgeting and spending. Subsequently, Picus and others revisit educational funding in questioning, "Is it reasonable to ask schools to continue to raise student performance and improve teaching with no additional money, and in some cases with less?" (Odden and Picus, 2011, p.42).

Daggett's (2009) effectiveness and efficiency framework, the theoretical basis of this study, questions all initiatives which appear in Quadrant A and conversely requires consideration for initiatives in Quadrant D. In 2009, Daggett clarified the effectiveness and efficiency framework with further descriptions as displayed in Figure 2.

High Student Performance

	High Cost High Performance	Low Cost High Performance	
	C	**D**	
High Cost			Low Cost
	A	**B**	
	High Cost Low Performance	Low Cost Low Performance	

Low Student Performance
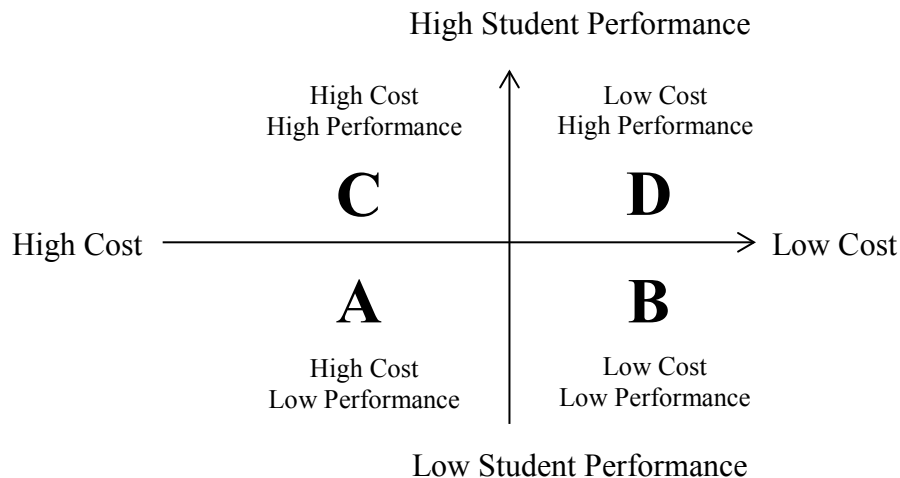
Figure 2. Effectiveness and efficiency framework, descriptive.

The effectiveness and efficiency framework's design proposes to determine the location on the quadrant model for any given school initiative under analysis. The current study analyzes the effectiveness and efficiency of Texas public school districts. School districts with high costs

and low performance, (Quadrant A) are questioned unlike efficacious school districts with low cost and high performance, (Quadrant D).

Production Function Efficiency

Production functions emulate an explained output as a function of input levels (Duncombe & Yinger, 2011). Farrell (1957) introduced the decision making unit (DMU) as a component of a whole system. Farrell founded empirical efficiency measurement based on computing an efficiency score comprised of inputs and outputs. A DMU operating at a technical efficiency (TE) of 1 denotes maximum efficiency. This perfect efficiency exists when none of the inputs can be reduced without sacrifice to the preferred production output. Farrell originally operated his theory on data concerning farms using only cash receipts as the sole output (Stone, 2002).

Production functions which incorporate inputs related to financial allocations may be referred to in scholarly literature as cost functions. An extensive number of school finance and general economic efficiency studies focus on production function analyses in an effort to relate inputs to outputs (Picus, 2000). Educational cost functions are generally comprised of student performance on state assessments as outputs explained as a function of several financial inputs such as expenditures per pupil or teacher salaries. Education and other public services have been analyzed extensively using production and cost functions (Duncombe & Yinger, 2011).

As in other disciplines, production and cost function models reign as a standard, traditional method for measuring efficiency. Hanushek's (1989) education production function research suggested no definite relationship between spending and student achievement. In direct response to Hanushek's (1989) claim that increasing educational spending did not necessarily

increase student achievement, Greenwald, Hedges and Laine (1996) compiled a meta-analysis of studies on education production functions comprised of various educational inputs and student achievement. The production function meta-analysis conclusions found specific resources that positively relate to student outcomes, suggesting that increasing school spending significantly impacts gains in student performance in the areas of teacher education, teacher/pupil ratios, and school size.

Duncombe and Yinger (2011) studied education cost functions for the state of Missouri. The conclusions drawn from their research clearly imply a relational cause between spending and learning, offering education cost functions as the best available methodology for ensuring consistency between a state's educational accountability system and its education finance system. Production functions provide the foundational building blocks for estimating efficiency with the estimation methods employed in this study.

<div align="center">Data Envelopment Analysis</div>

To date, DEA exists in the scholarly literature as a predominant method to measure organizational efficiency. DEA involves the creation of efficiency scores based on input variables and outputs or production functions. These plotted efficiency scores reveal an efficiency frontier comprised of scores representing greatest efficiency. The efficiency scores' frontier serves to envelop all of the other data points, which occur as measures of less efficient scores. Each observed score is compared against the best practice frontier to determine its relative status (Chakrabory, & Poggio, 2008). DEA continues to gain recognition as a premier method of measuring efficiency.

The foundational components of DEA were derived from Farrell's work in the 1950s (Farrell, 1957). Charnes, Cooper and Rhodes (1981) approached the frontier estimation model with a linear programming procedure leading to the development of DEA. William W. Cooper, a member of the group of authors to first publish the use of DEA, authored linear programming and quantitative research texts with and without Charnes beginning in the 1950s. After the development of DEA, Cooper later collaborated with various colleagues to furnish scholars with textbooks (Cooper, Sieford and Tone, 2007; Cooper, Seiford and Zhu, 2004) and additional publications of research incorporating DEA as the foremost measurement efficiency method.

DEA calculates a frontier developed from the data comprised of the production function or efficiency scores of the DMUs indicating the greatest efficiency of the given data set. The efficient frontier connects with at least one point and possibly more yet forcing points not on the line to occur below it (Cooper, Sieford & Tone, 2007). Judging by the relative location from the efficient frontier of the points representing the other DMUs, determinations for increasing efficiency can occur. Data envelopment analysis described the nature of the method: the appearance of the data being *enveloped* by the frontier as if captured by a barrier.

Just a few years after the development of DEA, the same publication to offer the pioneering research published a paper measuring the efficiency of a school district in Texas. *Management Science* offered a study by Bessent, A., Bessent W., Kennington and Reagan (1982) which applied DEA to measuring productivity of the elementary schools in the Houston Independent School District.

For these purposes, the paper presented 167 individual elementary schools in the district as the DMUs of DEA and offered further tutorial information and instructions on the understanding and applications for DEA in measuring school efficiency. This study offered the

school district a pilot testing of DEA that produced sufficiently interesting results causing the superintendent to distribute the data to area superintendents and school principals (Bessent, et. al. 1982).

According to the analysis, 89 schools operated efficiently while 78 utilized their resources inefficiently. Similar studies involving schools and school districts followed this landmark use of these two technical efficiency estimation methods. In fact, the data from several states' school districts have since been investigated in similar manners.

DEA's specific attributes and crucial benefits include its distinction as a non-parametric method with the ability to manipulate multiple inputs and multiple outputs (Ruggiero, 2007). Further, DEA identifies the inputs and outputs influencing inefficiency (Kantabutra, 2009). DEA offers an empirically deduced frontier of efficiency based on the efficiency scores of each DMU. DMUs are the central focus points of a DEA study and encompass all manner of entities, from United States business schools (Sexton & Comunale, 2009) to hospitals in Germany (Felder & Schmitt, 2004). Rassouli-Currier (2007) described a frontier function as a bounding function of a maximum output or the minimum cost against which inefficiency or the relative size of one-sided deviations can be estimated

Data envelopment analysis methods or slight variations thereof, gained notoriety and deference from those aiming to measure educational efficiency. An article published in the Peabody Journal of Education (Rolle, 2004) showed that public educational organizations enlist a trio of nontraditional methods to measure levels of economic efficiency. The author listed DEA as one of the three methods recommended for future research in educational productivity research.

Ruggerio and Vitaliano's (1999) study approached the same data set of public school districts in New York state with the application of both DEA and regression analysis methods. The New York study revealed that the three largest school districts were among the most efficient which seems unorthodox. The 1999 study presented separate public school districts in the state of New York as the DMUs similar to this paper's DMUs, separate public school districts in Texas.

Contradictory to Ruggiero and Vitlaiano's (1999) claim of uniqueness, a study published in 1994 evaluated the efficiency of schools in the United Kingdom (Thanassoulis & Dunstan, 1994) using both DEA and regression analysis. Secondary schools, with students aging 11-15 years old, served as the DMUs for the research. The authors provided a simple, yet definitive comparison between DEA and regression. They described DEA as a method estimating optimal performance and regression providing an average of performance (Thanassoulis & Dunstan, 1994). Additionally, this paper pointed out that DEA delivered examples of efficiency for use of comparison for improvement. The study found DEA especially relevant to school improvement in that the possibility existed to isolate schools operating with the greatest efficiency and offering these schools to others as the exemplar model to emulate.

In the same paper, Thanassoulis and Dunstan (1994) offered the advantages of analyzing school data with DEA over traditional regression analysis:

> DEA offers distinct advantages over regression analysis as a source of information that will guide schools to improved performance. DEA is a "boundary" method so it estimates targets with reference to best performance for given values of the contextual variables. Regression analysis estimates targets with reference to average rather than best performance possible. (p. 1248)

Actually, Thanoassoulis proposed a comparison of ordinary least squares regression analysis and DEA in a 1993 publication. Using a set of hypothetical hospital data, the researcher

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explained that the estimation accuracy belonged to DEA while regression's stability of accuracy supersedes DEA (Thanassoulis, 1993).

More recently, another study utilizing a DEA surfaced as a presentation at the International Atlantic Economic Society Conference in Germany in 2006. Kansas public school districts became the subject of this paper similar to those studying New York. Here the researchers presented the results of an efficiency measurement of Kansas public school districts (Chakraborty and Poggio, 2008). The Kansas schools paper provided another substantial illustration regarding the value of efficiency measurement using DEA.

In 2007, Ruggiero solely authored a study measuring efficiency of school districts in Ohio for the purpose of determining adequate spending. 607 Ohio school districts became DMUs with school year 2000 data. DEA analysis provided the results with focus on measuring the cost of an adequate education corresponding to the state of Ohio's outcome targets (Ruggiero, 2007).

Another study specifically targeting DEA and regression analysis on common public school data comes from Rassouli-Currier in 2007 published in the *Journal of Economics*. The paper presents techniques for the measurement of efficiency of schools in Oklahoma.

Chakraborty (2009) reported Rassouli-Currier's (2007) study specifically as a model that addressed inefficiency effects that has rarely assessed productive efficiency in education production function literature. The author disagreed with Currier's decision to use the socioeconomic variables as inputs for measuring production. Chakraborty claims the socioeconomic variables should most effectively be used as variables for measuring inefficiency. Kansas school districts were the subjects of Chakraborty's (2008) study of public education efficiency and effects of inefficiency.

In the approach to efficiency measurement, Rassouli-Currier (2007) used both a parametric regression analysis, and non-parametric DEA, methods to produce a conclusion on determinants of inefficiency through analysis of efficiency scores. The literature rendered the use of DEA and regression to estimate public school efficiency inspired this study to provide further results, information and literature for Texas public schools taking into account the responsible use of DEA and regression analysis on school district data.

Texas public secondary school data has been used to illustrate applications of DEA and statistical regression (Arnold, Bardham, Cooper, & Kumbhakar, 1996). While the results of the study produced valuable information for educational policy stakeholders, the purpose of the paper tests focused the illustration of DEA and statistical approaches such as ordinary least swquares (OLS) regressions rather than the exercise of using the data to improve the efficiency schools. Of particular interest and focus in this study were the performances of the variables in predicting with statistical significance the efficient and inefficient school districts in Texas.

Similarities in the Literature

Throughout the reviewed literature, researchers selected grades three through eleven for the measurement of student achievement through testing results with slight variation on exact grade levels (Chakrabory & Poggio, 2008; Rassouli-Currier, 2007; Ruggiero, 2007; Ruggiero & Vitaliano, 1999). The assessment data from these grade levels concentrated mainly on reading and math scores. Test scores from children younger than third grade, especially the very young, were routinely excluded in these studies due to the lack of consistent, reliable data.

Expenditures per pupil varied due to the range of years during which the studies occurred and the states funding allocations. This variable occurred universally in school finance studies as

an imperative aspect of determining efficiency and a factor of concern for taxpayers who fill the coffers. The mean per student expenditure for each data set ranged from around $5,500 to over $10,000. This range represented the ability of some school systems to double the financial efforts of others; all schools attempted to achieve the same basic product; satisfactory test scores on basic skills.

During the 2007-2008 school year alone, the least expenditure per student occurred in the state of Utah at $5,978 while New Jersey spent the most per pupil with $17,620 (United States Department of Education, 2009) in elementary and secondary public schools. This range of expenditures nearly tripled. Referencing the Digest of Education, Texas spent $8,350 per pupil in public elementary and secondary schools.

The literature of school efficiency studies revealed numerous other similar inputs taken into account when considering factors affecting test scores. Specifically, the majority of school efficiency studies included variables pertaining especially to the attributes of teachers and students. Though the common teacher inputs vary by minute details and different designations, the most shared teacher related inputs consisted of:

1. Teachers' annual salary

2. Teachers' number of years of experience

3. Teachers with advanced degrees

4. Ratios of teachers and students

Inputs related to student characteristics and qualities did not appear in the data sets as consistently as did the teacher driven variables with the exception of the number of students enrolled and those eligible for free or reduced lunch which were unfailingly selected as input variables.

Other important inputs considered in school efficiency studies include calculations for the numbers of non-white, special education and limited English speaking students. These inputs, referred to as the socioeconomic variables, did not fall under the expenditures controlled by the school systems. The general consensus was that the number of student categorized by these variables dramatically impact school budget resources with regard to amounts received from state and federal funds.

One of Hanushek's (1986) studies on educational efficiency compiled 147 studies into a comparison of the production function of common input factors on the student performance output. After pooling all the public school studies, the author listed the variables utilized in all 147 studies. Hanushek confirmed the previously discovered inputs as most common in the comprehensive survey conducted and lists the variables using generic terms in the following order:

1. Teacher/pupil ratio

2. Teacher education

3. Teacher experience

4. Teacher salary

5. Expenditures/pupil

Each of the factors enumerated above have undergone analysis throughout educational research that intended to determine the contribution of each on student learning. Teacher variables have been exhaustedly studied and pointed out as a potential factor of great school budget reform, especially teacher salaries. Economists and researchers endorsed incentive based teacher compensation in alignment with student achievement (Petrilli & Roza, 2011). In fact, after Hanushek (1989) offered the absence of association between spending and student learning,

he proposed linking monetary incentives for school personnel to student performance in order to attain substantial school improvement.

Teacher education levels often arose as a factor in student achievement research. A more recent study on panel data from Texas schools, which Hanushek co-authored, asserted that a teacher's skills showed no improvement with a master's degree (Rivkin, Hanushek, & Kain, 2005), indirectly implying the same stagnation in student performance. The National Council on Teacher Quality (NCTQ) released findings from a commissioned meta-analysis comprised 102 statistical tests on all teacher education studies since 1993. NCTQ (2010) claimed that 90% of these tests report that teachers who possessed advanced degrees either did not impact student achievement significantly or actually negatively impact student performance. West Virginia schools were analyzed with similar questions for investigation. Wilkins (2002) found no consistent effect on student achievement by teacher advanced training, teacher experience or per pupil expenditures.

Expenditures per pupil continue to rise causing further scrutiny. In Tennessee school systems, Bibb (2009) revealed no significant relationship between per pupil expenditures and ACT scores or student scores from a state writing assessment. A study focusing on school in West Virginia contemplated per pupil expenditure as a simplistic research variable moniker which did not adequately explain the complex processes required to arrive at the figure (Wilkins, 2002). Not surprisingly, the West Virginia students receiving more dollars for education showed no higher scores on the Stanford Achievement Test.

Aside from variables related directly to students and teachers, some studies considered factors regarding administrative funding such as administrator salaries. Throughout the documentation of education efficiency studies, factors regarding administrative functions varied

greatly in worth. This paper pertained to Texas public schools that utilized the factors

determined effective in previous studies and which accurately reflect the current practices in

Texas public education.

Subsidizing the Literature's Similar Variables

Since the 1969-70 school year, the United States declared expenditures per pupil in

elementary and secondary schools of $751 in unadjusted dollars. For the 2007-2008 school year

the nation allocated $10, 297 per student, a total of almost 14 times as much as 40 years prior

(United States Department of Education, 2009). Over the same 40 years, Texas has increased the

money spent per pupil in elementary and secondary public schools by more than 15 times. For

the 1969-70 school year, the expense of $551 was incurred per public school student and raised

to $8,350 for the 2007-2008 school year, all reported without adjustments to the dollar (United

States Department of Education, 2009).

According to the Academic Excellence Indicator System (AEIS), a resource of Texas

public school data prepared by the Texas Education Agency, three of the consistent teacher input

variables from the literature include 1) the averages for years of experience, 2) advanced college

degrees and 3) teacher-to-student ratios, undergo changes of any significance throughout the five

school years from 2005-2010.

Only one of the teacher inputs consistently found in the studies altered noticeably which

is the teachers' average annual salary. Texas teachers earned an average of $41,744 during the

2005-2006 school year. Five years later for the 2009-10 school year, that average salary grew

over 15% to $48,263 (Texas Education Agency, 2010) which generally equates to a cost of

living increase of 3% per year.

In keeping with the literature of school efficiency measurement, one of the two consistent student-related input variables described student enrollment figures in various forms and terms. The Texas public school total student enrollment grew 7% in five years from the 2005-2006 to the 2009-2010 school years. AEIS documents reported enrollment at over 4.8 million students in Texas public schools. The most current records designate Texas public school students now represent almost 11% of entire population of students enrolled in public schools in the United States.

The supplementary student related input variable evaluated in all studies included expenditure per pupil calculation which theoretically indicated an average of the money spent on the average student. In Texas, for the 2009-10 school year, the expenditure per pupil totaled $8,572 indicating greater allotments for each student than has ever been disbursed (Combs, 2010). For the most recent five year period, 2006-2010, Texas increased the total amount of money spent per student by 18%.

Efficiency in Education

Educational productivity was addressed in a 750-page document from Coleman (1966) often referred to as the Coleman study entitled *Equality of Educational Opportunity*. This research asserted that greater student expenditures did not generate increase student academic achievement. However, socioeconomic status was shown to affect student performance, in addition to other demographic categories. Coleman's production function analysis heightened interest related to measuring the effectiveness of specific resource allocation on student achievement, especially approaching the data analysis as an input-output affiliation. The

Coleman report inspired many economic studies of efficiency, educational production, and cost structure (Rassouli-Currier, 2007).

Several years later Jencks (1972) strengthened the Coleman report's findings presenting the argument that educational outcomes are not influenced significantly by funding amounts. Jencks ascertained certain uncontrollable traits of the students impacted their academic outcomes significantly more than the money spent on them. As a rule, more dollars age generally allocated to specialized programs addressing specific educational issues resulting in additional expenses per pupil.

A decade later, the United States government commissioned an investigation of the state of education in America. *A Nation at Risk: The Imperative for Educational Reform* was compiled by the newly established National Commission on Excellence in Education (1983). Although the federal government appointed this committee and demanded this research, states provide the majority of appropriations for public schools. States therefore encumber the accountability of educational productivity, and following this report, imposed numerous legislative modifications to the educational system and budget.

A Nation at Risk brought school efficiency the public's attention, not just educators and politicians but additionally activists groups and lay persons the last of which actually provides the monetary resources for state education mainly through property taxes. As a result, the political implications began to emerge in the states' court systems.

The Supreme Court of Kentucky decided on a landmark school efficiency case in 1989, Rose v. Council for Better Education. The Court rendered a judgment against the Kentucky General Assembly because evidence contended that the state did not "provide an efficient system of common schools throughout the state" as mandated by the state constitution. In the decision

presented by Chief Justice Stephens, the Court refrained from directly criticizing the attempts of the General Assembly. Yet the Court resolved that Kentucky did not have an efficient school system, and that no legislation had been enacted to provide one.

Landmark Legislation Affecting Texas Public School Funding

In 1984, in the year following the release of *A Nation at Risk*, a suit filed against the Texas Commissioner of Education, Dr. William N. Kirby, by the Mexican American Legal Defense and Educational Fund (MALDEF) claimed that the state discriminates against students in low socioeconomic school districts by failing to provide these students with an efficient, free public school education. MALDEF filed on behalf of San Antonio's Edgewood ISD on May 23, 1984.

About one month later on June 30, 1984, the Texas legislature passed House Bill 72 affording more allocations to poorer school districts, raising teacher pay, and various other policies to improve student academic achievement. At this early stage of focus on school efficiency, MALDEF and the state argued other filings and appeals for the next few years until October 2, 1989 when the Texas Supreme Court unanimously favored the Edgewood Plaintiffs by ordering the legislature to execute an equitable school funding system by the 1990-1991 school year. The ruling declared that the current system was not efficient.

Three additional Edgewood cases arose and progressed through the year 1995 resulting in drastic and ground breaking actions by the Texas legislature. Edgewood I forced the efficiency issue behind *A Nation at Risk.* The Texas legislature responded to the next three Edgewood cases with the following condensed and highlighted descriptions of legislation:

1. Senate Bill 1 – Gave more authority to local school districts; allowed for open-enrollment charter schools

2. Senate Bill 351 – Consolidated over 1,000 school districts into less than 200 for the purposes of tax collection and redistribution of resources. This law was later overturned and did not meet with voter approval.

3. Senate Bill 7 – "Robin Hood" – Tax wealthy school districts submitted school funds to the state government to be redistributed to poorer school districts. This piece of legislation guaranteed a ceiling on the property tax rate of $1.50 per $100 of property valuation for school funding.

The Edgewood litigations instigated landmark state government decisions, laws, and special legislative sessions. Furthermore, these cases raised awareness of school efficiency at the state level. Afterward the Edgewood lawsuits, the West Orange-Cove case arose in the courts. The West Orange-Cove Consolidated Independent School District led a lawsuit including 47 districts regarding the $1.50 property tax cap. The Texas Supreme Court voted in favor of the plaintiffs by a vote of seven to one with one judge not participating in the decision. The Court rendered constitutional standards, among others, requiring:

> efficiency (the system must use resources to produce results with little waste) adequacy (the system must accomplish a general diffusion of knowledge), and suitability (the system must be structured, operated, and funded so that it can accomplish its purpose for all Texas Children). (Texas Association of School Boards Legal Services, 2005)

In 1999, the Texas Education Agency developed a financial accountability system for Texas School Districts entitled "The School Financial Integrity Rating System of Texas," or School FIRST. Following the West Orange-Cove cases, in 2006, performance under School FIRST was added as a consideration for accreditation, along with academic performance (Taylor, 2011). The accreditation label on districts influenced more levels of school administrators to

consider financial responsibility and efficiency. Spending the money wisely became as important as making the grade. Texas educators focus resources to improve students' state assessment scores.

Mandatory Assessments in Texas

In 1980, Texas public schools administered a state wide standardized assessment system stemming from decisions by the 1979 Texas Legislature which felt pressure from accusations that high school graduates did not possess basic skills necessary to function in society and to provide valuable contributions. The administration of criterion-referenced assessments occurred in Texas schools for mathematics, reading, and writing. The Texas Assessment of Basic Skills (TABS) tested third, fifth and ninth grade students.

Texas Legislatures following 1979 periodically called for alterations and updates to the state wide assessment which includes various acronyms. Curriculum began as generic basic skills which evolved into a more formal arrangement in the 1980s, presented as Essential Elements, or EEs, and represented educational and curricular non-negotiables. School administrators and their staff would face a new challenge of a state assessment linked directly to state curriculum. The Texas Educational Assessment of Minimum Skills (TEAMS) replaced TABS and sought to assess the students' knowledge of the Essential Elements in first, third, fifth, seventh, ninth and eleventh grades.

During the latter part of the 1980s, Texas assessments were redesigned a third time to include an accountability component for schools that included ratings. The addition of ratings was a monumental change for Texas school systems. The state curriculum standards broadened in size and scope from the basic Essential Elements into the rigorous Texas Essential Knowledge

and Skills (TEKS). To accompany new curriculum standards and the implementation of an accountability module, The Texas Education Agency created the Texas Assessment of Academic Skills (TAAS) and administered the assessment initially in 1990. Students in third, fourth, fifth, sixth, seventh, eighth and tenth grades were assessed with some added passing standards at specific grade levels.

The TAAS endured for the longest time period of all Texas state school assessments to date and was administered until the spring of 2003. The 76th session of the Texas Legislature passed Senate Bill 103 in 1999 mandating an updated statewide assessment instrument. The TAAS replacement was a more rigorous measurement instrument, the Texas Assessment of Knowledge and Skills (TAKS), which continued to test the TEKS. Higher student outcomes established for TAKS required a higher level of mastery of the curriculum standards and impacted the state accountability performance standards for students and schools.

Throughout the revisions, the Texas exams have existed as a calculation of students' knowledge of the state's curriculum of the corresponding time (Cruse & Twing, 2000). The Texas Education Agency has overseen the creation, implementation and storage of testing results data for all the statewide assessments. Figure 3 represents a timeline of Texas public school assessments.


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┌─────────────────────────────────────────────────────────────────────────┐
│         Timeline of Texas Public School Assessments                        │
│                                                                             │
│      1980         1985          1990            2003           2012         │
│       |            |             |               |              |      →    │
│      TABS       TEAMS          TAAS            TAKS          STAAR           │
│                                                                             │
│   TABS: Texas Assessment of Basic Skills                                   │
│   TEAMS: Texas Educational Assessment of Minimum Skills                    │
│   TAAS: Texas Assessment of Academic Skills                                │
│   TAKS: Texas Assessment of Knowledge and Skills                           │
│   STAAR: State of Texas Assessments of Academic Readiness                  │
└─────────────────────────────────────────────────────────────────────────┘
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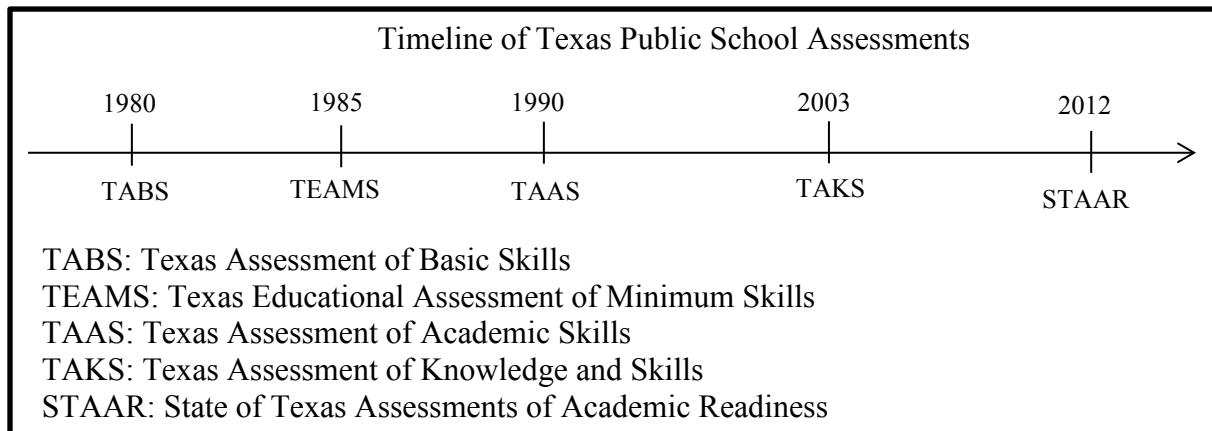
Figure 3. Timeline of Texas public school assessments.

At the time of this study, the schools prepare for the State of Texas Assessments of Academic Readiness (STAAR). TEA states that the new assessments test the same subjects and grades as TAKS with exceptions in high school. The grade specific TAKS tests will be replaced with end-of-course assessments for several specific courses such as Algebra I, Chemistry and Physics. TEA claims STAAR contains a greater emphasis on alignment to college and career readiness (Texas Education Agency, 2011). The data analyzed in this study reflects TAKS results as compiled and stored by TEA.

TAKS Implications on Tax Payers

TAKS and taxes connect Texas residents to the school district and vice versa. The structure of a public school district's operating budget depends on the property taxes collected from owners of property located within the school district boundaries. For the United States in general, Hanushek (2003) implicates the diversity of school funding levels corresponding to the wealth and income of the community. Community wealth rather than student performance dictated allocation distribution. Not surprisingly, communities with considerable amounts of school funding and high student achievement create desirable school districts.

Property values and property tax rates vary considerably depending upon the school district's academic rating from TEA. Statewide, local property taxes comprised 36.7% of Texas public school funding with bonds and other local funds subsidize another 18.2% (Combs, 2010). School districts that establish and maintain a tradition of educational success via top tier TEA ratings enjoy reputations as superior places to live. Texas' most sought after school districts combine the supply and demand dynamic with real estate rule number one: location, location,

location. In this context, an exclusive location often receives that designation as a product of the exceptional, traditionally highly rated school district.

Five Standard Rating Labels are assigned to each school campus based on TAKS data. The four customary labels - Exemplary, Recognized, Academically Acceptable and Academically Unacceptable - are assigned to campuses serving grades 1-12 with at least one TAKS test result (in any subject) in the accountability subset (Texas Education Agency, 2011). "Not Rated" represents a campus that at least one of the following criteria:

- No students enrolled in grades higher than kindergarten

- Insufficient data to rate due to no TAKS results in the accountability subset

- Insufficient data to rate through Special Analysis due to very small numbers of TAKS results in the accountability subset

- Designated Juvenile Justice Alternative Education Program (JJAEP) or a designated Disciplinary Alternative Education Program (DAEP). (Texas Education Agency Department of Assessment, Accountability, and Data Quality Division of Performance Reporting, 2011)

Texas public school districts generally have few campuses qualifying for a "Not Rated" label. Therefore, the school districts' ratings as a whole come from the campuses' individual ratings. Campus ratings designate subdivisions of real estate prices in a school district large enough to have more than one of any given grade-designated campus such as a school district operating three high schools with numerous middle and elementary campuses. School zones, campus boundaries, and the associated TEA ratings prescribe the demographic for the area by affecting the real estate economy. Similar socioeconomic environments form within the confines

of the campus zones. Research mentioned in this paper suggests socioeconomic variables impact student outcomes (Chakraborty, 2009; Cooper, Seiford, & Zhu, 2004; Rassouli-Currier, 2007).

Schools' Outlay for Outcomes

As accountability, rewards, and repercussions intensified throughout the history of Texas testing, educators' desire to improve scores results in greater expenditures on new programs. Naturally, some programs involved additional time for tutorials and remedial instruction, adding to their costs. Duncombe and Yinger (2011) call for the recognition of the difference between costs and spending, alleging that some districts do not necessarily spend money efficiently resulting in an inflated cost to produce student achievement outcomes.

A brief written for a state policymaker audience encouraged state officials to agree to the reality that the ultimate school budget control rests with the districts, not the states (Petrilli & Roza, 2011). Nonetheless, educators at all levels follow and even contribute to the swinging pendulum of change or jumping aboard the current bandwagon of the latest programs claiming to be research-based. Of course, educators allocating costs are required to acquire "research-based" options for spending due to the legal ramifications set forth in the No Child Left Behind Act of 2001 (NCLB). The level of research conducted to validate products masqueraded as fact by a mass of vendors when it served primarily as marketing purposes.

The decision makers assigning the allocated per student expenditures, almost exclusively educators, normally have little to no expertise on efficiency measurement. With rare exception, school district administrators rise through the ranks of the school system and do not generally develop a researcher's or economist's skill set for effectively managing money. Another group of powerful school district decision makers, school board members, represent a myriad of

professions, levels of education, opinions, and special interests. After all, school board members are elected officials representing not only their constituents, but often their own children attend the school district which may lead to subjective decision making. In fact, Herbert J. Walberg, from the University of Illinois at Chicago offered this perspective in 2004 regarding the competency of school district policy and decision makers to spend money economically on educational programs:

> School board members and most educators lack education and experience in accountability, evaluation and methods of psychometrics and statistics that would enable them to choose effective efficient programs and weed out others. Though these tasks should be central to leaders aiming to measure, evaluate and improve learning, they are neglected. Consequently, popular programs are often chosen by fad and reputation rather than by a careful review of evidence of their results and costs. (Walberg, 2004, p.13)

Determining the most efficient use of school resources necessitated studying the effects of multiple independent variables on educational production outcomes. Ruggiero authored a chapter in *Handbook on Data Analysis* (2004), edited by DEA founding researcher Cooper as well as Seiford and Zhu. In his chapter, Performance Evaluation in Education, Ruggiero alleged socioeconomic conditions account for the greatest influence on the data. Rassouli-Currier's (2007) Oklahoma schools paper reports socioeconomic factors as the key elements for determining inefficiency. Socioeconomic factors significantly influenced student achievement scores as determined by Chakraborty (2009) in the study analyzing Kansas school districts.

The aforementioned study of efficiency of New York public schools by Ruggiero and Vitaliano (1999) argued that schools paying higher teacher salaries operated less efficiently and those with more poverty performed more efficiently. The authors suggested poorer schools economize their resources due to budget constraints. The topic of school inefficiency was mentioned in the final paragraph of the New York study as important for research in the future.

Ruggiero's DEA analysis of Ohio schools (2007) revealed a solution for improvement that involves not increasing revenue but instead restructuring the budget to differentiate resources. In the conclusion of the analysis, Ruggiero offered that increasing funding was not the answer but instead an organizational funding system with an increase in district accountability would discourage inefficiency.

Financial Allocation Study for Texas

In 2010, The Texas Comptroller of Public Accounts, Susan Combs, conducted a study entitled *Financial Allocation Study for Texas (FAST)*, in response to lawmakers who commissioned the undertaking with the Texas Legislature's House Bill 3 in 2009. This bill assigned the Comptroller to identify the Texas public schools districts and campuses that operate with cost efficiency and produce high student performance (Combs, 2010). The executive summary published includes a rating system for school districts which indicates by number of stars academic growth realized by cost-effective practices. As detailed in the FAST report:

- A five-star district has a composite [academic] progress rating between 80 and 99 and a spending index of "Very Low"

- A one-star district has a composite [academic] progress rating below 20 and a spending index of "Very High" (Combs, 2010, p. 6)

Simply, school districts who earn a five-star rating seem to account for the greatest academic growth for the least amount of money while a district with one star imposes the least amount of education yet spends the most. The absolutes of this system appear straightforward, yet middle ground ratings offer inconclusive results. For example, a school district appears average with a three star rating. A three star rating may be bestowed upon a district with extreme

spending as long as exceptional academic progress is achieved. Likewise, a three star average rating can indicate a school district with nominal academic progress and minimal expenditures (Combs, 2010). Neither of these extreme scenarios indicates an average school district.

The FAST approach compared groups based on similar elements of educational costs including area incomes, student characteristics and district size establishing "fiscal peers" (p.6) of school districts (Combs, 2010). Within these groups districts relationally earned the star ratings. Therefore, no attempt of an alignment of all districts collectively exists from the FAST findings. Still, the FAST report included information and analyses of great importance for Texas public school stakeholders.

Summary

Attempts to analyze Texas public school efficiency, to consolidate resources, and to reduce spending will likely continue and intensify in part due to a deficient economic recovery. Additionally, school district officials will cross-reference student needs, taxpayer demands, and the likelihood and amounts of available funding. Public school efficiency studies will continue to evolve by applying statistical measurement methods to public school data.

The literature confirms both DEA and regression analysis as effective, valuable measures of organizational technical efficiency including school systems. Smith and Street (2005) denote DEA and regression as "off-the-shelf" (p.401) statistical tools for measuring organizational efficiency at the urging of policy makers eager to investigate the efficiency of public service organizations. The studies published on measuring school district efficiency with these techniques, and others, contain a repetition of variables examined.

Common input and output variables throughout the previous school efficiency studies confirm the independent and dependent variable choices incorporated in this paper. For example, the quantitative value of the variables such as teacher pay depend greatly on the school district in question, yet the literature consistently, construes teacher pay as a contributing factor in a school system's evidence of efficiently expending resources (Picus, 2000). During the 2008-2009 school year, almost 60% of Texas public school districts' spending was apportioned to payroll costs of $32.5 billion (Combs, 2010). Texas public school districts' efficiency continues to be the subject of all manner of literature ranging from quantitative research to opinion laden editorials primarily due to the funding reduction effecting government aided organizations and the reliance on the property taxes of the community at large.

This analysis will contribute, as a resource, further to the literature regarding the effectiveness of DEA and regression in measuring the efficiency of public school education. Utilizing DEA and OLS regression serves to confirm efficiency predictors enabling school districts to allocate assets based on variables that produce student achievement.

The empirical literature clearly outlines the decline of educational funding, increasing the need to use school resources logically. Not since the Great Depression have schools been faced with such certainty repeated annual budget cuts (Petrilli & Roza, 2011). The school systems' financial difficulties may be traced and studied from the beginning of the first economic decline of the new millennium, but forecasting an end to the hardships is another matter entirely. Feasibly, neither economists nor school officials will accurately predict the severity of future fiscal disparities.

As researchers further delve into the school budgets trends since 2008, and effective strategies to govern educational spending, some offer warnings to state and district officials.

Reducing the portions of state and federal fiscal distributions further constricts local school officials' options of innovating solutions to new financial problems, yet school districts must continue to follow and fund laws, mandates, policies and outdated programs and practices instituted by state and federal governments (Petrilli & Roza, 2011).

This study will utilize recognized estimation methods to assess the efficiency of Texas public school districts deciphering variables which contribute to greater efficiency. The information gleaned from the analyses will provide a resource to stakeholders in making data-driven decisions regarding school funding and spending.

CHAPTER 3

METHOD

Purpose of the Study

The purpose of this quantitative study is to measure the efficiency of Texas public school districts. Specifically, this study intends to compare the results generated from data envelopment analysis (DEA) and regression analysis to determine which variables predict efficiency in school districts. The current study examined 931 independent school districts (ISDs) in Texas that provided complete data sets.

Participants

For the purposes of determining like groups for comparison, the school districts were categorized utilizing a system developed by the Texas Education Agency (TEA) for the 2009 – 2010 school year. TEA described the categories as follows:

- Major urban (10 districts). A district is classified as major urban if: (a) it is located in a county with a population of at least 750,000; (b) its enrollment is the largest in the county or at least 75% of the largest district enrollment in the county; and (c) at least 35% of enrolled students are economically disadvantaged. A student is reported as economically disadvantaged if he or she is eligible for free or reduced-price meals under the National School Lunch and Child Nutrition Program. Example: Austin ISD is in Travis County, which has a population of 1,025,127. Austin ISD's enrollment of 84,245 students is the largest enrollment in the county, and at least 35% of the enrolled students are economically disadvantaged.

- Major Suburban (78 districts). A district is classified as major suburban if: (a) it does not meet the criteria for classification as major urban; (b) it is contiguous to a major urban district; and (c) its enrollment is at least 3% that of the contiguous major urban district or at least 4,500 students. A district also is classified as major suburban if: (a) it does not meet the criteria for classification as major urban; (b) it is not contiguous to a major urban district; (c) it is located in the same county as a major urban district; and (d) its enrollment is at least 15% that of the nearest major urban district in the county or at least 4,500 students. Examples: 1) Castleberry ISD is in Tarrant County, which has a population of 1,798,838, but it does not meet the criteria for classification as major urban. Castleberry ISD is contiguous to Fort Worth ISD, a major urban district, and its enrollment of 3,590 students is greater than 3% that of Fort Worth

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ISD. 2) Goose Creek CISD is in Harris County, which has a population of 4,083,368 and contains at least one district classified as major urban. Goose Creek CISD does not meet the criteria for classification as major urban, nor is it contiguous to a major urban district. Although Goose Creek CISD's enrollment of 20,819 students is less than 15% that of Houston ISD, the nearest major urban district in Harris County, it exceeds 4,500 students.

- Other Central City (39 districts). A district is classified as other central city if: (a) it does not meet the criteria for classification in either of the previous subcategories; (b) it is not contiguous to a major urban district; (c) it is located in a county with a population of between 100,000 and 749,999; and (d) its enrollment is the largest in the county or at least 75% of the largest district enrollment in the county. Examples: 1) Brownsville ISD is in Cameron County, which has a population 398,624. Brownsville ISD does not meet the criteria for classification in either of the previous subcategories, and it is not contiguous to a major urban district. Brownsville ISD's enrollment of 49,080 students is the largest in the county. 2) McAllen ISD is in Hidalgo County, which has a population of 747,512. McAllen ISD does not meet the criteria for classification in either of the previous subcategories, and it is not contiguous to a major urban district. Although McAllen ISD's enrollment of 25,101 students is not the largest in the county, it is greater than 75% of the largest district enrollment in the county.

- Other Central City Suburban (153 districts). A district is classified as other central city suburban if: (a) it does not meet the criteria for classification in any of the previous subcategories; (b) it is located in a county with a population of between 100,000 and 749,999; and (c) its enrollment is at least 15% of the largest district enrollment in the county. A district also is other central city suburban if: (a) it does not meet the criteria for classification in any of the previous subcategories; (b) it is contiguous to another central city district; (c) its enrollment is greater than 3% that of the contiguous other central city district; and (d) its enrollment exceeds the median district enrollment of 765 students for the state. Examples: 1) Harlingen is in Cameron County, which has a population of 398,624. Harlingen CISD does not meet the criteria for classification in any of the previous subcategories. Its enrollment of 18,142 students is greater than 15% of the largest district enrollment in the county. 2) Port Arthur ISD is in Jefferson County, which has a population of 247,047. Port Arthur ISD does not meet the criteria for classification in any of the previous subcategories. Port Arthur ISD is contiguous to Beaumont ISD, another central city district that also is the largest district in the county. Port Arthur ISD's enrollment of 9,047 students is greater than 3% that of Beaumont ISD and exceeds the median district enrollment for the state of 765 students.

- Independent Town (71 districts). A district is classified as independent town if: (a) it does not meet the criteria for classification in any of the previous subcategories; (b) it is located in a county with a population of 25,000 to 99,999; and (c) its enrollment is the largest in the county or greater than 75% of the largest district enrollment in the county. Examples: 1) Victoria ISD is in Victoria County, which has a population of 88,230. Victoria ISD does not meet the criteria for classification in any of the previous subcategories. Its enrollment of 13,680 students is the largest in the county.

2) Winnsboro ISD is in Wood County, which has a population of 43,289. Winnsboro ISD does not meet the criteria for classification in any of the previous subcategories. Its enrollment of 1,410 students is greater than 75% of the largest district enrollment in the county.

- Non-Metropolitan: Fast Growing (18 districts). A district is classified as non-metropolitan: fast growing if: (a) it does not meet the criteria for classification in any of the previous subcategories; (b) it has an enrollment of at least 300 students; and (c) its enrollment has increased by at least 20% over the past five years. Example: 1) Jarrell ISD is in Williamson County, which has a population of 416,326. Jarrell ISD does not meet the criteria for classification in any of the previous subcategories. Jarrell ISD has an enrollment of 915 students, and its enrollment has increased by more than 20% over the past five years.

- Non-Metropolitan: Stable (227 districts). A district is classified as non-metropolitan: stable if: (a) it does not meet the criteria for classification in any of the previous subcategories; and (b) its enrollment exceeds the median district enrollment for the state. Example: 1) Snyder ISD is in Scurry County, which has a population of 16,223. Snyder ISD does not meet the criteria for classification in any of the previous subcategories. Its enrollment of 2,715 students exceeds the median district enrollment for the state of 765 students.

- Rural (335 districts). A district is classified as rural if it does not meet the criteria for classification in any of the previous subcategories. A rural district has either: (a) an enrollment of between 300 and the median district enrollment for the state and an enrollment growth rate over the past five years of less than 20%; or (b) an enrollment of less than 300 students. Examples: 1) Valley View ISD is in Cooke County, which has a population of 40,338. Valley View ISD has an enrollment of 641 students and an enrollment growth rate over the past five years of less than 20%. 2) Mount Calm ISD is in Hill County, which has a population of 36,256. Although Mount Calm ISD has an enrollment growth rate over the past five years of more than 20%, its current enrollment is only 154 students. (Texas Education Agency, n.d.)

Teacher Salary Index

With over 1,000 school districts in the country's second largest land-area state, Texas varies in all assessable quality of life elements ranging from weather to wealth. Consequently, the value of a dollar spent is Dallas ISD may or may not be have the same purchasing power in Del Rio ISD. This study will consider the fluctuating dollar in school districts by examining teacher salaries. Based on the model from Haveman (2004), the teacher salary index (TSI) was calculated to compare the cost of education in a variety of school districts. The teacher salary

index displayed an estimated cost of a school district to employ a group of teachers compared to the state average cost of employing the same group. First, an ordinary least squares regression equation will be utilized to calculate a teacher salary index. The following variables were regressed:

- Intercept

- Average teacher years of experience

- Percent of teachers with a master's degree

- Enrollment

- Percent minority

- Non-dropout rate

- Limited English proficiency

- Unemployment rate

- Income (general fund total)

- Percent free and reduced lunches

- 3rd grade math score

- 3rd grade reading score

- 5th grade math score

- 5th grade reading score

- 8th grade math score

- 8th grade reading score

- 10th grade writing score

- Adjusted R^2 (Haveman, 2004)

The TEA website provided all the school district data including assessments scores, student, teacher and district financial information. One factor from the original Haveman (2004) TSI model, the 10th grade writings scores were replaced with the most replicable factor available in Texas, 10th grade scores on the English language arts assessment. TEA does not administer a specific writing test to 10th grade students. According to the research performed by Haveman (2004), 10th grade writing was selected to incorporate a high school level assessment in the model.

The defined local unemployment rates were unique to each county. The county unemployment rate figures were publically accessed through the website supported by the United States Department of Labor: Bureau of Labor and Statistics. Summing the regression of the coefficients and the value of the listed variables produced a predicted salary for each school district. The predicted salary indicated the average salary a school district would be required to offer an average teacher with average outcomes, education, and experience.

Variables Examined

For efficiency analysis, the 2009-2010 school year was selected to provide the latest complete data available. The variables examined were extracted from the AEIS on each school district analyzed in this study.

Dependent Variable

2010 student TAKS commended performance, all students, all tests. The dependent variable in the current study reflected the percentage of students in each school district who earned commended performance on Texas Assessment of Knowledge and Skills (TAKS) in

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2010. Students in Grades 3 – 11 participated in TAKS. Table 1 identifies which TAKS were administered to the grade levels.

Table 1

TAKS Grade Levels and Assessments

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	Math Reading
10	Math English Language Arts Science Social Studies
11	Math English Language Arts Science Social Studies

Math TAKS was administered to all tested grade levels. Reading was likewise administered in grades 3-11 though the nomenclature changed at the high school level to English language arts and incorporated higher level literacy skills.

Independent Variables

The independent variables chosen for this study emerged from the literature review previously depicted in this paper.

Expenditures per pupil. For every Texas public school district, AEIS records an average number of dollars spent in each school year on any given student. This dollar amount indicates the average cost to the school district to educate a student. Expenditures per pupil have increased every school year indicating a willingness to further invest in the education of students.

Teacher base average salary. The average annual base salary for teachers in the school district determines this variable. TEA determines the base average salary by using the salaries for all teachers in the district which excludes any stipends for extra duties. TEA records base salary averages for beginning teachers, teachers with master's degrees and teachers with doctorate degrees. The teacher base average salary was incorporated in the current study as a discretionary predictor variable of efficiency.

Teacher's years of experience. Beginning with the first year of teaching, every Texas public school teacher begins a record of service. Every Teacher Service Record is an official TEA document which verifies every year a person has taught in Texas public schools. TEA recognizes other teaching years from out-of-states schools and in other designated capacities with specific documentation. This variable describes the average number of documented teaching years for any teacher in the district. AEIS reports display the years of teacher service in

qualifying school districts with the following monikers: Beginning Teachers, which indicates teachers in the first year of service, 1-5 Years' Experience, 6-10 Years' Experience, 11-20 Years' Experience, Over 20 Years' Experience. The average number of years of teachers' experience was integrated in the current study as a discretionary predictor variable of efficiency.

Teachers with master's degrees. Obtaining teacher certification in Texas requires first earning a bachelor's degree and completing an approved teacher certification program that includes student teaching. Masters degrees are not required to retain a teacher position in Texas public schools. Even so, districts do generally offer a salary schedule with higher salaries to teachers who hold masters degrees. Teachers often attend graduate school in order to earn principal certification in an effort to move into a school administrator role. This discretionary variable represents the cumulative total of teachers in the school district with master's degrees and was regressed to evaluate effect on efficiency.

Students-per-teacher ratio. This predictor ratio indicates an average number of students for any given teacher in the district. It bears noting that in Texas public school districts for all grades kindergarten through fourth grade, class sizes may not exceed 22 students per class without obtaining a special waiver granted from TEA. Class sizes for grade 5 and older do not have a state mandate for ratios per teacher. Consequently, all things being equal in the state's elementary schools, the calculation is derived from the average of number of students per teacher in grades 5 through 12. This ratio was considered a discretionary variable despite the state mandate minimums for the elementary grade levels.

Total student enrollment. This variable represents the actual number of students enrolled in the school district. Student enrollment was studied as a non-discretionary factor in predicting efficiency.

Economically disadvantaged. School efficiency studies and scholarly literature incorporate the number of economically disadvantaged students in studies as a non-discretionary variable. Further, most researchers similarly describe this variable as students who qualify for free lunch or reduced lunch prices. Such qualification requires parents to complete paperwork attesting to their household income.

Fiscal Variables

The fiscal variables to be examined are reported in actual dollar amounts and were extracted as per pupil expenditures, not general total figures. The finance related variables are categorized from the general funds of school districts. The fiscal variables listed below are specific to Texas public schools with regards to requirements for reporting, nomenclature and general use.

Instruction. This variable includes expenditures directly related to the instruction of students and the classroom.

Instructional-related services. These expenditures/expenses are directly and exclusively used for resource centers, establishing and maintaining libraries and other major facilities dealing with educational resources and media. This function includes those expenditures used directly and exclusively for curriculum, in-service training and other staff development for instructional related personnel functions. Examples include travel and substitutes used during training sessions.

Instructional leadership. Instructional Leadership refers to funds directly used for managing, directing, supervising and providing leadership for staff who provide general and specific instructional services.

School leadership. This function covers those activities, which have as their purpose directing, managing, and supervising schools, i.e., campus principal's office and related costs.

Student support services. Student Support Services contains three main budgeting areas. Guidance, counseling and evaluation services incorporates those activities, which have as their purpose assessing and testing pupils' abilities, aptitudes, and interests; counseling pupils with respect to career and educational opportunities, and helping them establish realistic goals. Social Work Services encompasses those activities related to promoting and improving school attendance of students. Health Services embraces the area of responsibility to provide health services, which are not a part of direct instruction.

Total general fund. This variable represents the total dollar amount from the school district General Fund. This total revenue amount was one of the factors used to calculate the Teacher Salary Index.

Procedure

Texas public school data was accessed through the TEA, and from the AEIS. All public school district data under consideration in this study encompassed academic, student, staff and financial information for the 2009-2010 school year. The data which was used to create AEIS reports was submitted to TEA by each school district.

The reporting system through which school districts submit the data required by TEA is the Public Education Information Management System (PEIMS). PEIMS includes all data requested and received by TEA about public education, including student demographic and academic performance, personnel, financial records, and organizational information (Texas Education Agency). School districts routinely employ personnel specifically charged with

reporting the districts' data to PEIMS in the specified timely manner with accuracy. TEA accesses PEIMS data to create AEIS reports, the state's accountability system, and snapshots which offers a statewide educational overview for a given school year. Additionally, data stored in the PEIMS database provides information for standard TEA reports including geographic information, student and staff reports. PEIMS is the state's foremost source for public school data.

AEIS data on each variable was retrieved from TEA for all Texas public school districts examined in the study for the 2009-2010 academic year including variables focused on students, staff and finances. Erroneous entries and data which did not contribute to this study were extracted from the data set. Complete data for all variables was available for 931 school districts, with no charter school districts counted in the data set. In addition, districts' budget and human resource data was assembled to provide a record of the 2009-2010 school year of expenditures and human resource information.

The data retrieved that related to student outcomes provided the singular dependent variable, the percentage of students earning commended performance on the TAKS test in 2010. Data that represented the total number of students enrolled in the school districts was utilized as the only non-discretionary student variable. The percentages of non-white students and economically disadvantaged students were the two socio economic, non-discretionary student factors embedded in the data set. Another non-discretionary variable, students to teacher ratio was examined for effect on efficiency.

School district data that focused on teachers were all discretionary measures. The factors included the average base teacher salary, the number of average years of teachers' experience, and the total number of teachers with master's degrees.

Financial expenditures that occurred during the 2009-2010 school year were derived from the general fund of each school district. Financial variables encompassed instruction, instructional-related services, instructional leadership, school leadership, student support services, central administration and the total of each school district's general fund. Additionally

The research design utilizes DEA and regression analysis on the selected variables. DEA, a deterministic and non-parametric method, assigned an efficiency score to each school district with a range of .1 to 1. Regression analysis on the selected variables calculated the influence of the variables on statewide efficiency. The framework based on Daggett's (2009) model was employed to study efficiency and effectiveness of school district categories.

Data Analysis

DEA evaluates the efficiency of decision-making units (DMU), and exists as a linear programming-based technique. Using DEA to estimate efficiency allows for data that involves numerous inputs and outputs to be expressed in different units. In addition, the efficiency frontier created by DEA compares decision making units relative to each other and combinations of DMUs. Navigating from the DEA efficiency frontier to other DMUs not creating the frontier provides information indicative of possible efficiency improvement.

The model applied in this study consists of an input- and output-oriented DEA model where efficiency is calculated to determine the most amount of output that may be produced using the least amount of input. In Figure 4 Charnes, Cooper, and Rhodes (1981) introduced the following formulation as a standard form of DEA.

$$\text{(1)} \quad Max\left\{ \theta_0 = \frac{\sum_i \mu_i y_{i0}}{\sum_j v_j x_{j0}} \right\}$$

$$Subject\ to:$$

$$\text{(2)} \quad \frac{\sum_i \mu_i y_{ik}}{\sum_j v_j x_{jk}} \leq 1 \ for\ all\ DMUs\ k=1,2,\dots,n$$

$$\text{(3)} \quad \mu_i \geq 0$$

$$\text{(4)} \quad v_j \geq 0$$

Figure 4. Standard DEA formulation.

Where

θ_0 = the efficiency score of the DMU under analysis

n = number of DMUs under analysis

I = number of outputs

J = number of inputs

Y_k = {Y_{1k}, Y_{2k},…, Y_{ik},...,Y_{lk} is the vector of outputs for DMU k with y_{ik} being the value of output for DMU k.

X_k = {X_{1k}, X_{2k},…, X_{jk},…,X_{lk} is the vector of inputs for DMU k with x_{ik} being the value of input j for DMU k;

μ and v the vector on multipliers respectively set on Y_k and X_k = the respective weights for output i and for input j;

Given a set of J decision making units, the model determines for each DMU_0 the optimal set of input weights $\{v_{io}\}_{i-l}$ and output weights $\{\mu_{r0}\}_{r-l}$ that maximizes its efficiency score e_o.

Despite the popularity of using DEA to measure efficiency, the method does have inherent disadvantages. While DEA provides an efficiency frontier indicating the most efficient DMUs, it does not provide calculations to address absolute efficiency. DEA creates efficiency measurements comparatively and not a finite calculation indicating the distance to maximum, or technical efficiency. DEA's usefulness can be disturbed by statistical noise while regression analysis captures measurement error.

Consider the production function for *n* DMUs and K inputs in

$$y_i = \alpha + \underset{k=K}{\Sigma} \beta_k \ x_{ik} + e_i \ \text{I} = 1..n \quad \text{K inputs}$$

where y is output, x_{ik} are inputs, and e_i is the residual for DMU_i. The residual, e_i, captures all the measurement error, noise and any inefficiency in this model. Regression analysis attempts to decompose the error term into inefficiency and noise components for each DMU as shown below:

$$\text{In } y_i = \alpha + \overset{k=K}{\underset{k=1}{\Sigma}} \beta_k \ x_{ik} + [v_i - u_i] \quad i = 1 \ldots n$$

Finally, the error term is decomposed into two components, namely v_i and u_i, where *v*, an identically distributed conventional two-sided error term with zero mean, measures random noise and *u*, an identically distributed one-sided error term with a non-zero mean, measures inefficiency. Thus, technical efficiency (TE), a term indicating that no increase of inputs will result in increased outputs, may be determined by the formula.

$$TE_i = \frac{y_i}{\exp(x_i\beta + v_i)} = \frac{\exp(x_i\beta + v_i - u_i)}{\exp(x_i\beta + v_i)} = \exp(-u_i)$$

DEA was conducted in two stages. In stage one, an input and an output oriented DEA model will be calculated to obtain efficiency scores for each school district included and the percentage of students passing all TAKS.

Then, utilizing OLS regression selected variables were regressed against the school districts' efficiency scores to determine effects on efficiency.

Summary

This study determined educational efficiency of 931 public school districts in the state of Texas using data envelopment analysis and regression analysis. Variables commonly researched in the scholarly literature as well as factors unique to Texas education were considered in the

methods and analyses. All data and reports accessed are available from the TEA's Academic

Excellence Indicator Report system. The Texas public school districts with complete data sets

were assessed for efficiency and compared in order to examine the variables leading to greater

student achievement realized with minimum expenditure. Comparison groups of peer school

districts were observed using the theoretical framework to determine relative efficiency and

effectiveness based on s student performance outcomes. Concurrently, sources influencing the

relative efficiency of school districts statewide surfaced through the data analyses. The variables

determined to effect school district efficiency were discovered at the statewide level through

regression analysis. The data analysis is presented in Chapter 4 and with results and conclusion

appearing in Chapter 5. The current study has provided a replicable model for measuring public

school district efficiency.

CHAPTER 4

ANALYSIS

The purpose of this study was to determine the discretionary and non-discretionary factors which significantly contribute to the efficiency of Texas public school districts. The study selected the outcome of efficiency on student performance on the state mandated assessment, the Texas Assessment of Knowledge and Skills (TAKS) for the 2009-2010 school year. The data examined in this study was accessed through the Texas Education Agency (TEA) and the United States Department of Labor: Bureau of Labor and Statistics. All data necessary to replicate the current study is publically accessible through the above organizations' websites with no security measures in place in order to retrieve the data.

According to the TEA (2009), though charter school districts are regulated and monitored by the state, public school districts are required to adhere to a greater number of rules and regulations than charter school districts. Subsequently, data from charter schools was eliminated from the TEA data set. School districts analyzed in this study were compared in like groups using the TEA's (2009) predetermined, comparable categories or district type classifications. The TEA public school district classifications utilize factors such as student enrollment, growth in enrollment, economic status, and proximity to urban areas. The effectiveness and efficiency results of this study are reported by the TEA's district type terms. Efficiency variable analysis occurred for the statewide sample of school districts.

The school districts that had complete data for the 2009-2010 school year were used in this study and totaled 931 Texas public school districts. Due to small numbers of students reporting results in one or more of the student performance indicators included in the analysis, data for 98 rural school districts were not complete and therefore dropped from the current study.

Student Enrollment

The results displayed in Table 2 show the average student enrollment by district type. The smallest average student enrollment occurred among "rural" schools with 391 students (SD = 150.89), while districts classified as "major urban" maintained the largest average student enrollment of 90,449 students ($SD = 49,712$).

Table 2

Average Student Enrollment by District Type

District Type	n*	Mean	SD**
Independent Town	71	3710.61	2278.05
Major Suburban	78	20369.83	19508.70
Major Urban	10	90449.40	49721.25
Non-Metropolitan Fast Growing	18	3066.28	5854.61
Non-Metropolitan Stable	227	1474.70	753.40
Other Central City	39	19175.28	12474.46
Other Central City Suburban	153	4330.25	4741.55
Rural	335	391.21	180.88

*n=Number of Districts; **SD = Standard deviation

To determine the overall efficiency of school districts in expending their total operating funds in relation to the student performance, a 2-stage data envelopment analysis (DEA) model and ordinary least square (OLS) regression model was employed to examine district efficiency. The DEA method examines decision making units (DMU) when evaluating efficiency (Cooper, Seiford, & Zhu, 2004.) The DMUs designated in this study include 931 Texas public school districts. The models controlled for local socio-economic conditions and non-discretionary inputs

which are beyond the control of the local district. One critical aspect to identify concerning DEA efficiency scores lies with the calculation of relative efficiency. The DEA model, by design, does not estimate technical, absolute efficiency, but rather produced an efficiency score in relation to the efficiency of all the DMUs in the sample. Thus, school districts that received an efficiency score of 1 should not be construed as absolutely efficient and can potentially improve efficiency (Haveman, 2004).

The results reported in Table 3 shows that overall in 2010, districts in Texas operated at 61% efficiency, with rural schools functioned the least efficiently ($M = .53$, $SD = 12$), while districts classified as major suburban operated most efficiently ($M = .73$, $SD = .106$).

Table 3

Comparison of 2010 Texas Public School District Efficiency Scores

District Type	n*	Mean	SD**
Independent Town	71	.65	.08
Major Suburban	78	.73	.10
Major Urban	10	.70	.03
Non-Metro Fast Growing	18	.62	.16
Non-Metropolitan Stable	227	.60	.09
Other Central City	39	.68	.07
Other Central City Suburban	153	.66	.09
Rural	335	.53	.12
Total	931	.61	.12

*n = Number of districts; **SD = Standard deviation.

Districts who operated at 100% efficiency include Highland Park ISD and Eanes ISD, both major suburban school districts as well as Friendswood ISD and Wylie ISD in the other

central city suburban category and China Spring ISD, a non-metropolitan fast growing school district. The lowest efficiency score, 14% was recorded for Galveston ISD.

Theoretical Framework with Results

The theoretical model, the effectiveness and efficiency framework (Daggett, 2009) was employed in this study. Daggett (2009) created an intentionally simple framework and though the current study includes more complex analysis, the theory of the analysis and purpose of the results correspond. This study compared Texas public school districts on efficiency scores and TAKS commended performance percentages simultaneously. The four quadrants comprising the framework in Daggett's (2009) original framework contain Quadrant A representing high cost and low student performance, Quadrant B representing low cost and low student performance, Quadrant C representing high cost and high student performance, and Quadrant D representing low cost and high student performance.

For the purposes of the current study, the high and low cost terms have been replaced with high and low efficiency scores. The original functionality of the Effective and Efficiency Framework (Daggett, 2009) remains intact. For example, the school districts with high efficiency and high student achievement results appear in Quadrant D in the modified framework. Figure 5 reflects the modified version of the effectiveness and efficiency framework originally based on Daggett's (2009) model.
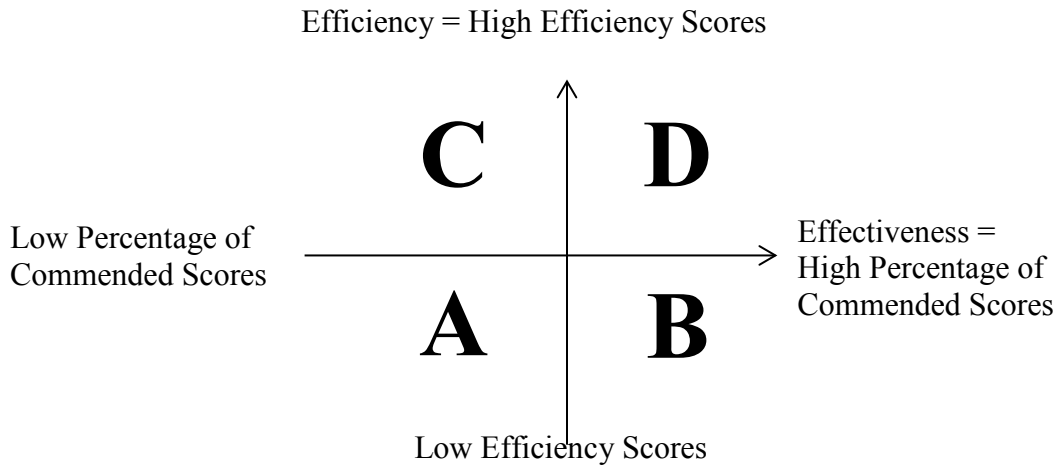
Efficiency = High Efficiency Scores

C   D

Low Percentage of
Commended Scores

Effectiveness =
High Percentage of
Commended Scores

A   B

Low Efficiency Scores

Figure 5. The modified theoretical framework.

The modified theoretical framework has been incorporated in this study to further illustrate the comparison of peer school districts though slightly modified to more specifically clarify the analysis of this study. The following scatter graph, Figures 5-13, plot the results of the efficiency scores, described in Table 3, ranging between 0 and 1, with 1 indicating the most efficient scores and concurrently shows the percentage of student earning a commended performance on TAKS.

The y-axis label "DA311CA10R" is the variable term used by the TEA in the data and denotes district 2010 TAKS scores of commended performance for all students on all tests in grades 3-11 as shown in abbreviated form on Figures 5-13. The vertical line separates commended TAKS scores at 25 designating that all school districts' charted to the right of the vertical line had greater than 25% of the testing student population achieving commended scores. The 25% mark denotes the combination of averages from student performance on all tests with specific emphasis on math and reading as these subjects comprise the majority of all tests taken in grades 3-11. Additionally, the 25% divisor represents the average commended scores for two most outlying districts at 0% and 50%, in order to encompass the range of percentages of the full sample.

The x=axis indicates the derived efficiency scores for each school district labeled "state_eff." The horizontal line in each figure divides the school districts' efficiency scores at .61 representing the average efficiency scores for all 931 school districts. The school districts with scores appearing above the horizontal line operated with at least 61% efficiency.

All 931 school districts examined appear in Figure 6. The four most outlying school districts are listed below:

- Highland Park ISD was one of 4 districts with 100% efficiency.

- Borden County ISD earned higher TAKS scores with lower efficiency.

- High Island ISD scoring the lowest efficiency score, 14%.

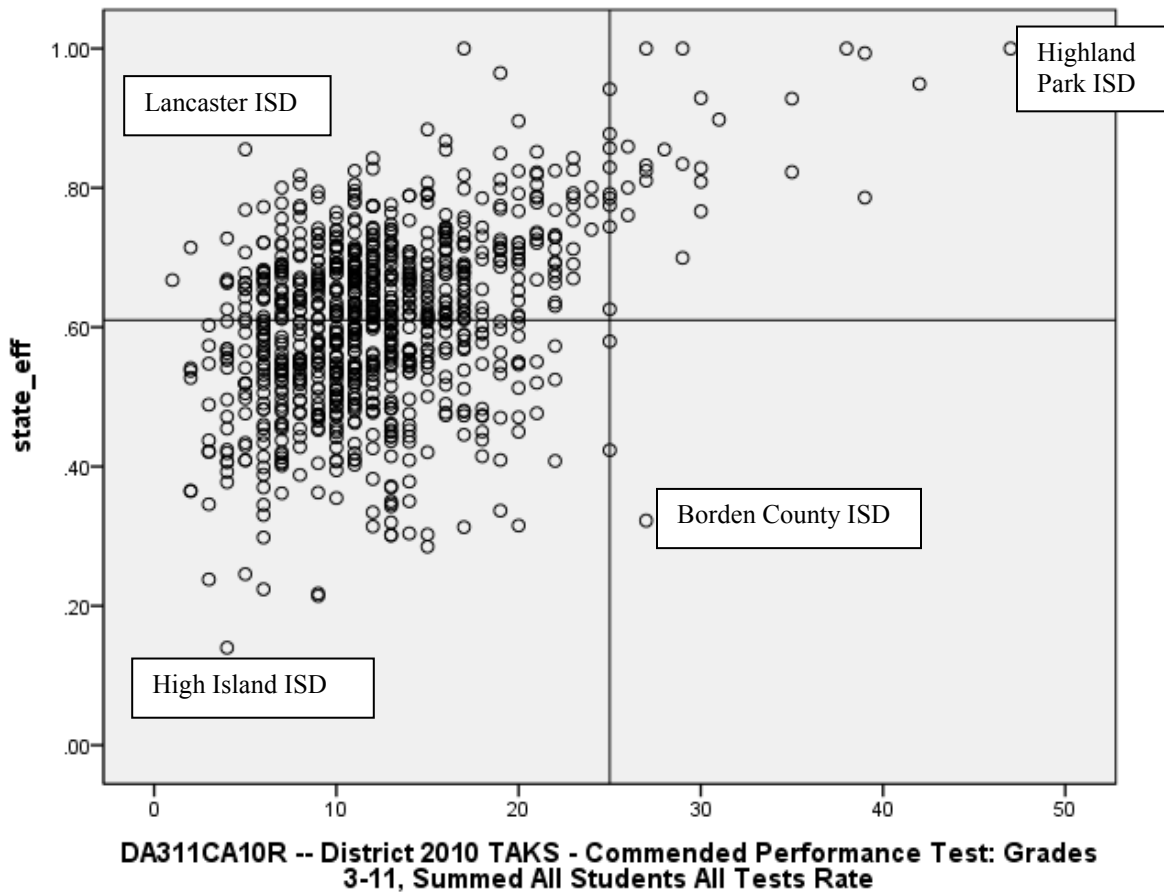- Lancaster ISD showed relatively high efficiency, yet low TAKS scores.

Figure 6. Total school district sample.

Figure 7 illustrates the independent town results and reveals that 1 school district operated with at least 61% efficiency and produced commended student performance of at least 25%. Barbers Hill ISD scored the slightly above the efficiency barrier and exactly 25% commended on TAKS, directly between Quadrant D and Quadrant C. All other school districts varied in low scores. The school district earning the highest efficiency rating was Gregory-Portland ISD at 87% with the lowest, 44% for Jasper ISD.
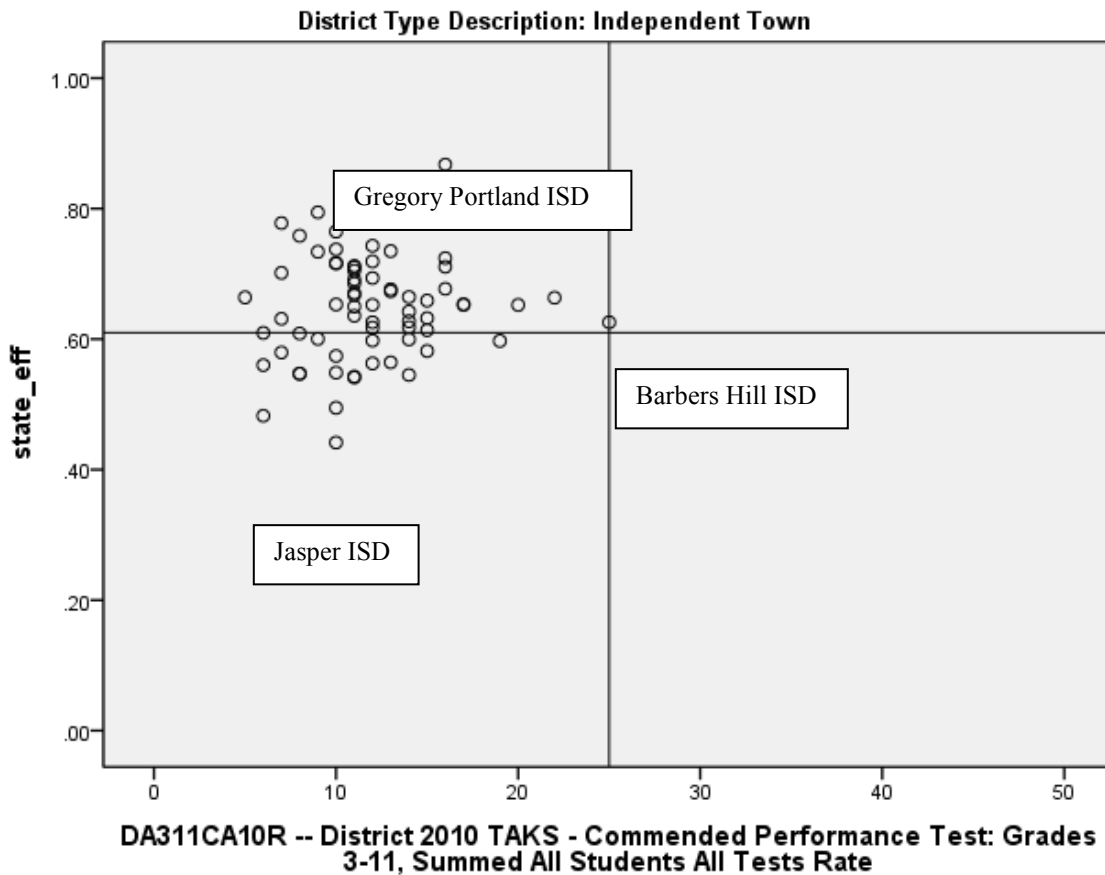

Figure 7. Independent town.

Major suburban school districts, shown in Figure 8, clustered mainly in Quadrant C indicating higher efficiency yet lower student achievement. This category includes the school district earning the highest commended performance rate, 47%, with the highest efficiency score of 100%, Highland Park ISD. Eanes ISD also operated 100% relative efficiency. Coppell ISD

received a comparable 99% efficiency rating. Sheldon ISD produced the lowest efficiency score, 52%. Lancaster ISD produced an extreme outlying scores combining high efficiency and low commended performance.
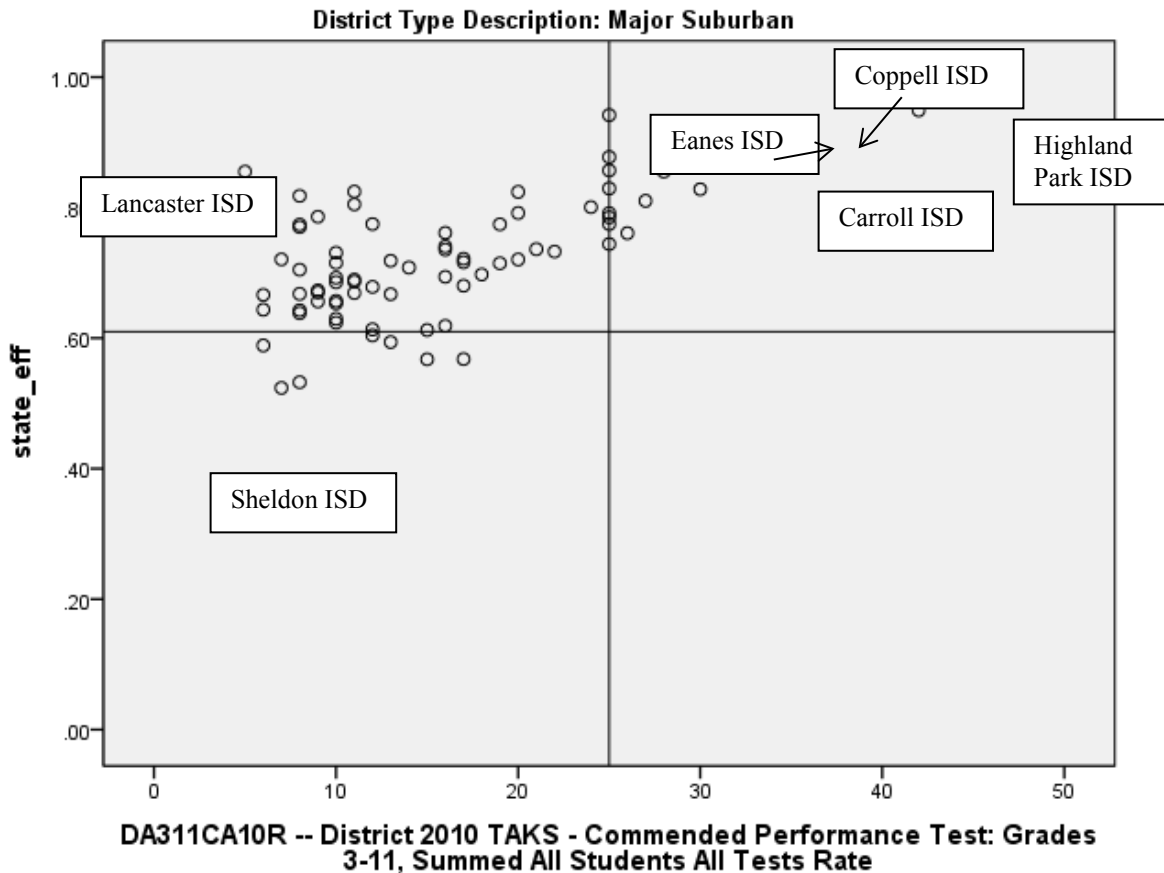

Figure 8. Major suburban.

The classification with the fewest peers, yet most students, major urban shown in Figure 9, all appear in Quadrant C indicating higher than average efficiency and lower student outcomes. Northeast ISD produced the highest commended performance, 19%, while San Antonio ISD produced the lowest, 7%. Austin ISD operated at 62% which was the least efficient as compared to peers though above the state average..
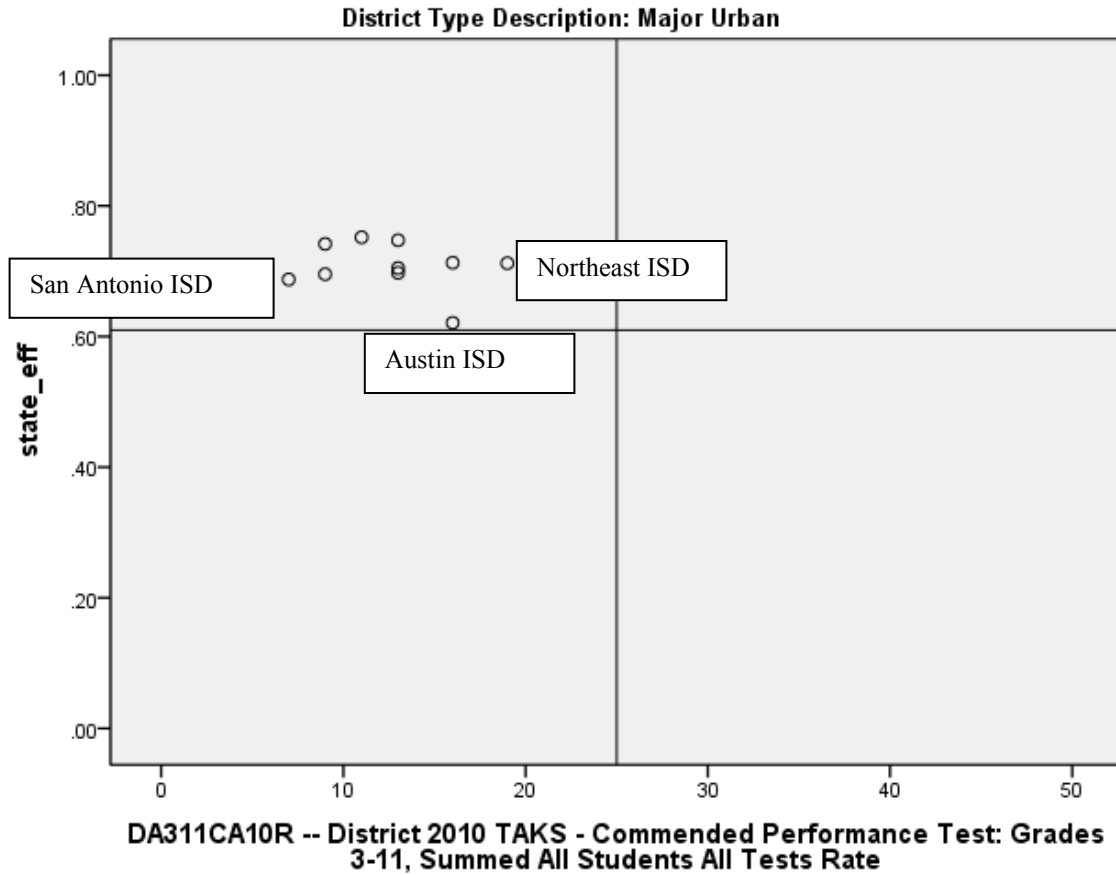
Figure 9. Major urban.

Non-metropolitan fast growing districts, displayed in Figure 10, appeared in Quadrants A, C and D. McKinney ISD singularly placed in Quadrant D indicating higher than average efficiency, 82%, and high commended TAKS scores, 27%. Brookeland ISD scored lowest for efficiency with 33% in Quadrant A. Mumford ISD recorded one of the state's 100% efficiency ratings in Quadrant C which also indicated lower TAKS commended scores.
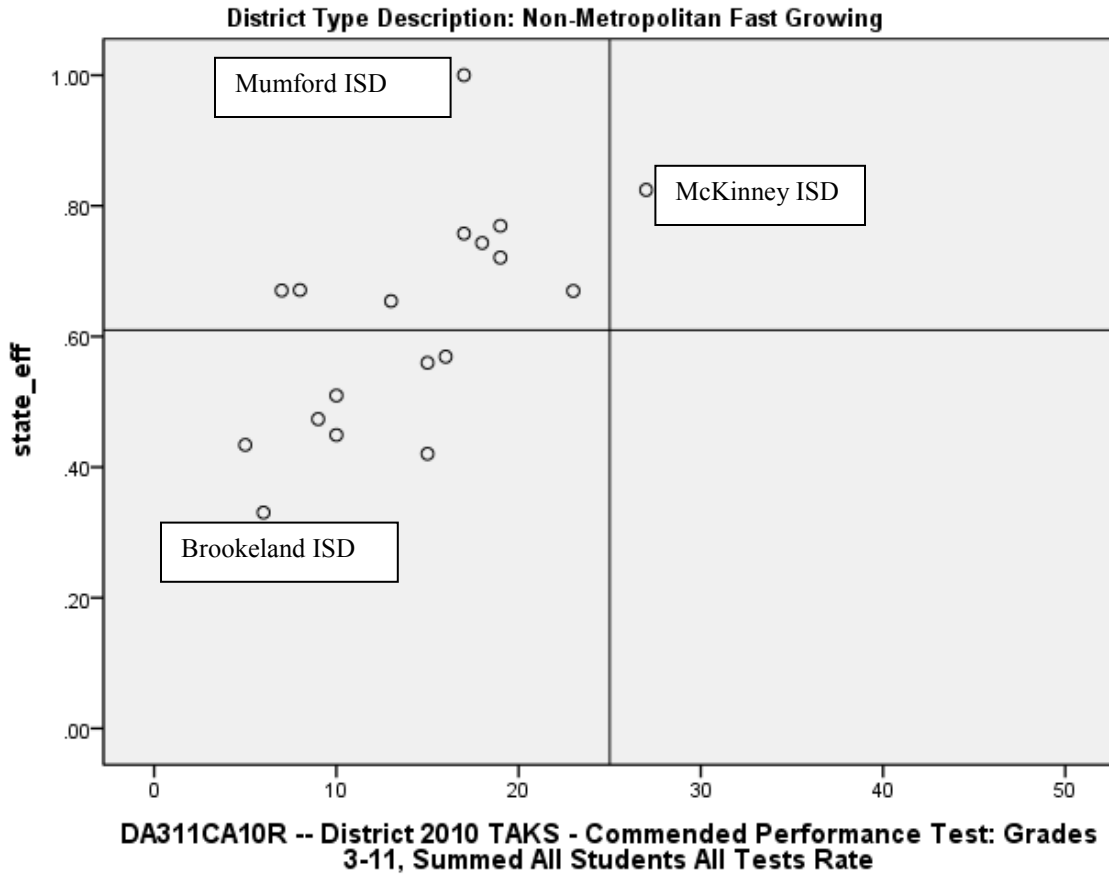
District Type Description: Non-Metropolitan Fast Growing

Figure 10. Non-metropolitan fast growing.

Figure 11 represents non-metropolitan stable school districts that concentrated in quadrants indicating low efficiency. Only Gunter ISD achieved a commended performance rate greater than 25% and a higher than average efficiency score. Hooks ISD scored the lowest for efficient operation at 34%.
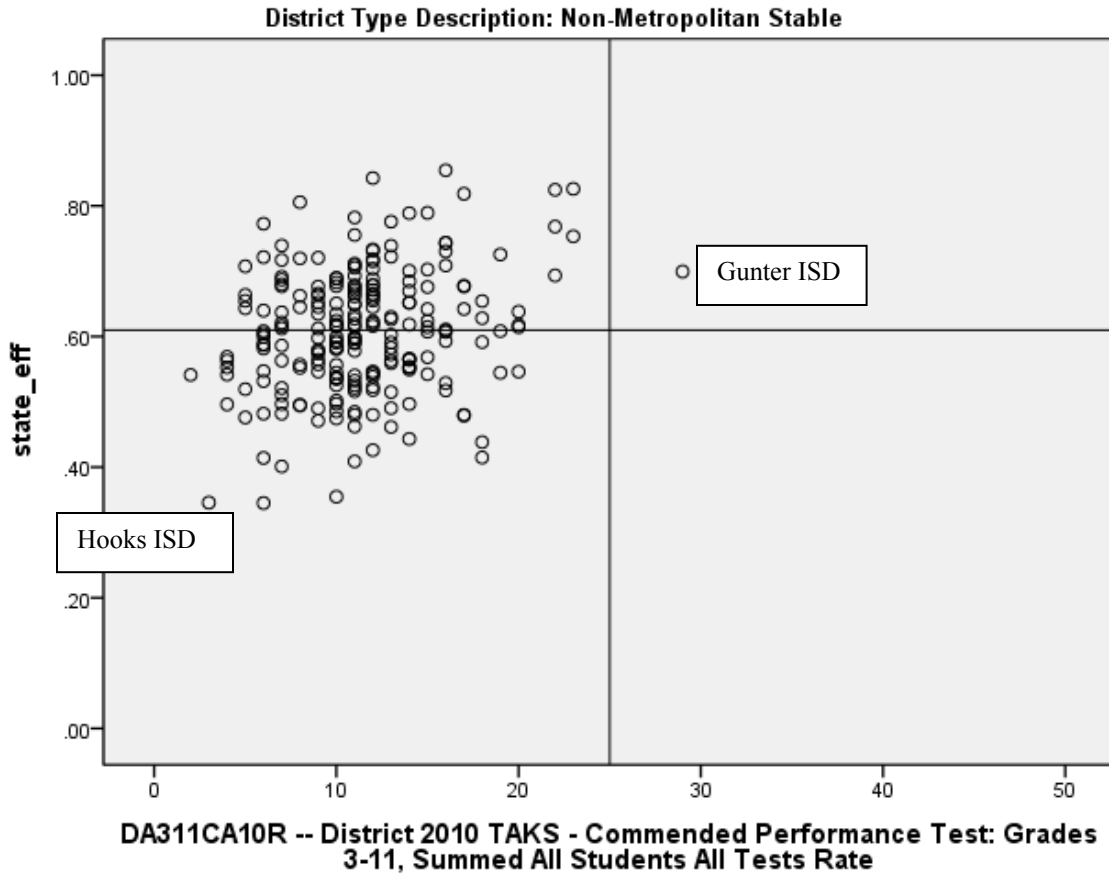
Figure 11. Non-metropolitan stable.

The school districts compared in Figure 21 as other central city mainly scored in Quadrant C with higher relative efficiency and lower commended performance. Canyon ISD and Conroe ISD scored similarly high for efficiency at 85% and 84%, respectively compared with the remaining districts. The lowest efficiency score, 56%, occurred for Galveston ISD in this group.

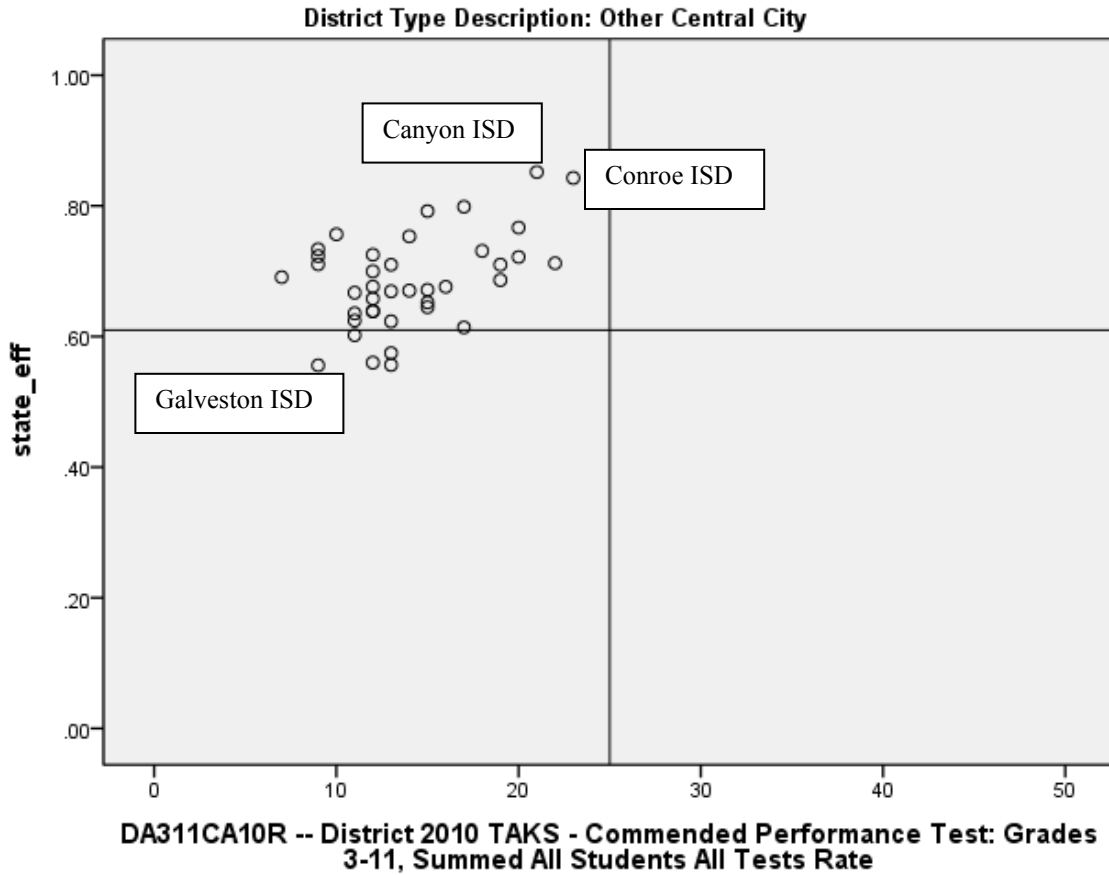**District Type Description: Other Central City**

Figure 12. Other central city.

The other central city suburban school districts scored in all except Quadrant B in Figure 13. The highest student performance rate of 39% occurred for Lovejoy ISD. The highest efficiency ratings were shared by Wylie ISD and Friendswood ISD, both 100%. The lowest efficiency rating in this category was produced by Crane ISD with 45%.
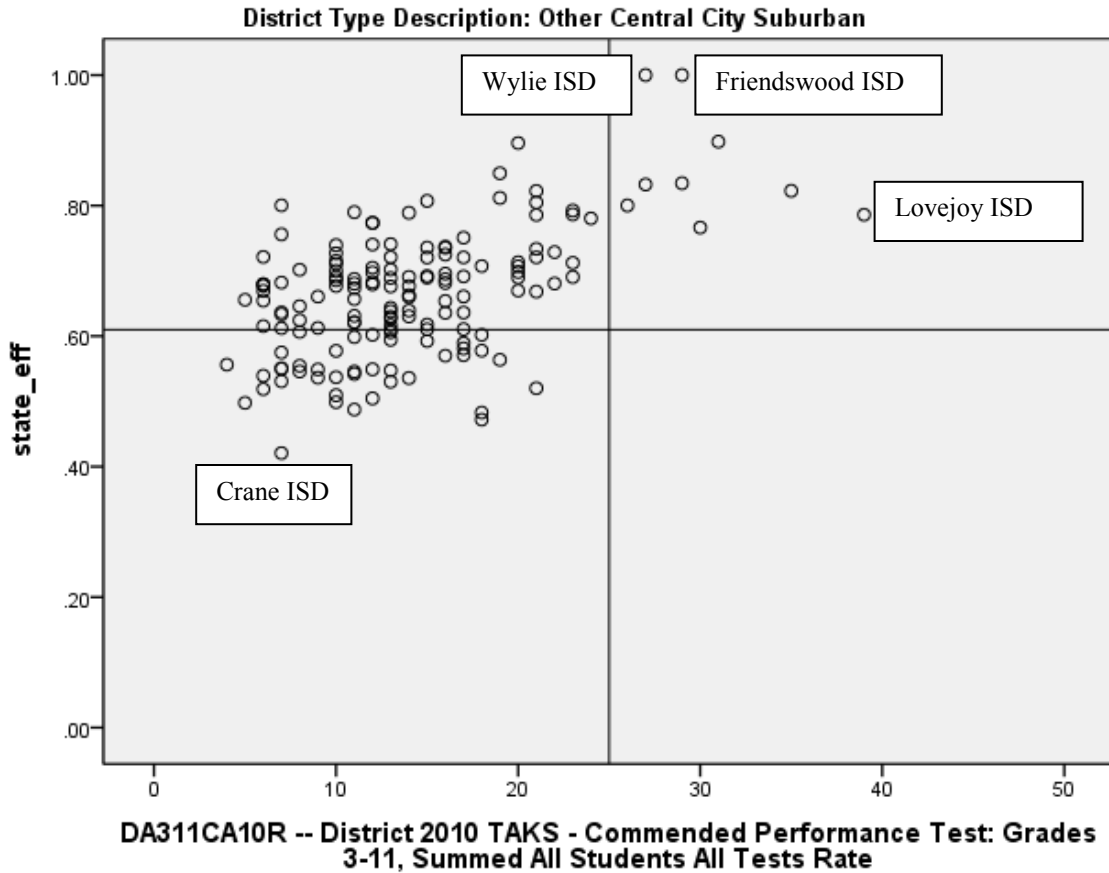
Figure 13. Other central city suburban.

Figure 14 contains the rural school districts outnumbering all other categories. Falls City ISD and Nazareth ISD denote the two Quadrant D school districts that were highly efficient combined with higher TAKS commended rates. Borden County ISD was the only school district out of the entire 931 district sample that exhibited lower than average efficiency rate of 32%, yet relatively high TAKS scores at 27%.

The school district with the lowest efficiency score of all total school districts occurred in the rural classification, High Island ISD with 14%. The highest efficiency score for the rural school districts was 96% for Shiner ISD.
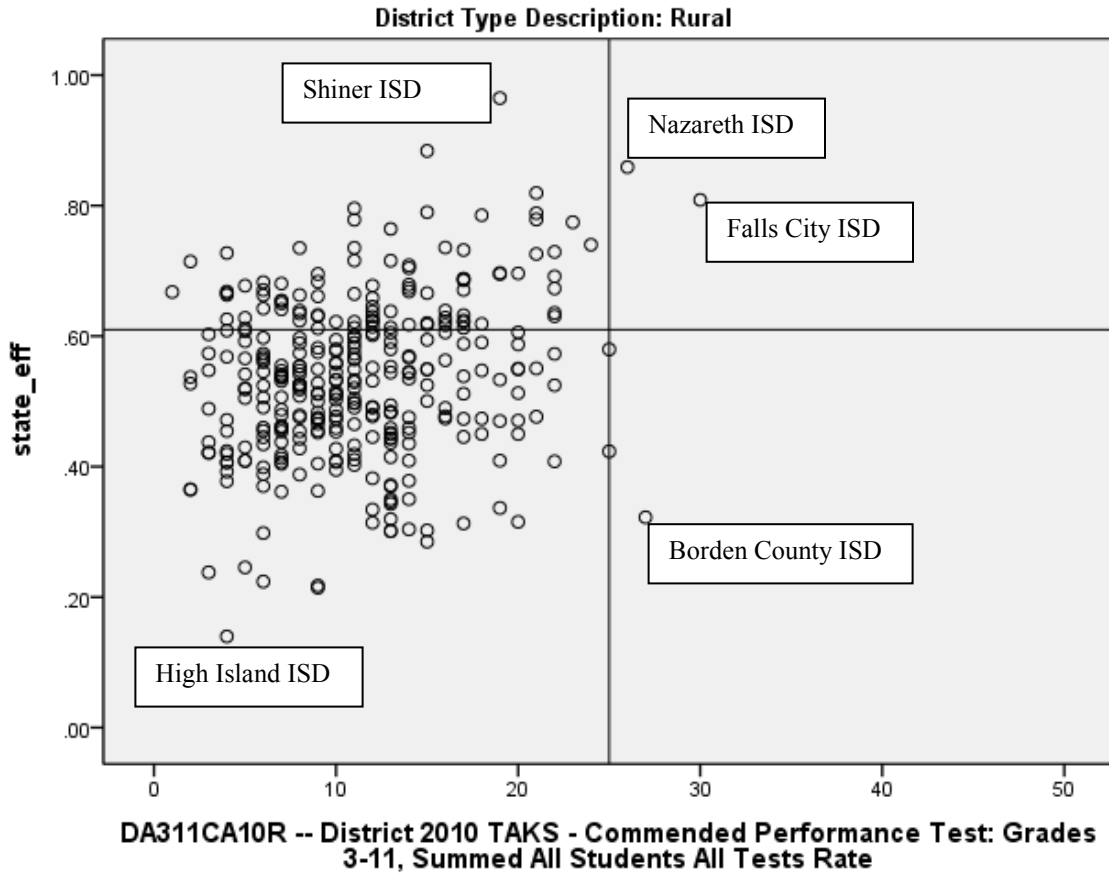
Figure 14. Rural.

The Teacher Salary Index

To compare the costs for hiring teachers, which is the largest portion of operating costs, to district efficiency, the Teacher Salary Index (TSI) was replicated from Haveman's (2004) model that compensates for the variance in the value of the dollar from one school district location to another. An ordinary least squares regression was calculated on factors pertaining to teacher experience and level of education, student performance outcomes ranging from elementary to high school, student demographic information concerning low socio economic, termed by the TEA as economically disadvantaged and non-white percentages as well as local economic factors including the county unemployment rate for every school district. The TSI

results displayed in Table 4 present the discrepancies between the state average teacher base salary and the predicted salaries required to employ teachers with average years of experience and average educational background to achieve average student performance outcomes.

To define the measurements from the TSI calculation, consider a school district that has a TSI of 1.10, which indicates the district must offer an excess of 10% of the state average salary to recruit a teacher with average experience and educational background to the district given the local socio-economic conditions. Furthermore, a district with a TSI equal to .95 employs an average teacher; with average experience, education and student performance outcomes with a salary equal to 5% less that the state average salary. Note the 2010 state average salary for a teacher with 12 years' experience and a Master's degree is $44,244.54 (SD = $4,027.88) among districts in the current study.

Table 4

Comparison of 2010 Teacher Salary Index among Districts Controlling for Local Socio-Economic Conditions

District Type	n*	Mean	SD**
Independent Town	71	1.02	.03
Major Suburban	78	1.10	.05
Major Urban	10	1.17	.03
Non-Metro Fast Growing	18	1.01	.06
Non-Metropolitan Stable	227	1.00	.03
Other Central City	39	1.10	.03
Other Central City Suburban	153	1.03	.05
Rural	335	0.96	.04
Total	931	1.00	.00

*n = Number of districts; **SD = Standard deviation

Variables Influencing Efficiency

Prior research has identified both discretionary and non-discretionary variables which influence school system efficiency. Non-discretionary variables including the percentage of non-white students, percentage economically disadvantaged students and total student enrollment figures have been related to the efficiency of schools (Rassouli-Currier, 2007) (Chakraborty, 2009). Previous DEA studies on school systems have determined that higher percentages of non-white students enrolled negatively effects efficiency (Haveman, 2004) (Rassouli-Currier, 2007) (Chakraborty, 2009).

Discretionary variables established in research to impact efficiency include the average number of years of teacher experience and the percentage of teachers who have obtained a master's degree. These two factors contribute to higher teacher salaries yet have not been determined to correlate to higher student performance implicating a desecration of funds (Haveman, 2004) (Ruggiero and Vitaliano, 1999). The average number of students per teacher ratio has previously been included in DEA efficiency estimation studies (Haveman, 2004) (Chakraborty, 2009). Preceding studies coupled with state mandates in place for the younger grade levels, initiated the investigation into the possible effects of teacher-to-student ratio.

To examine the effects of the selected variables on statewide school district efficiency, an ordinary least squares regression (OLS) was performed. Note in similar studies a Tobit regression model was additionally considered and yielded clearly similar results (Haveman, 2004). The OLS regression model analyzed the entire samples of 931 school districts. The selected independent variables for school districts include:

- Total student enrollment = the actual number of students enrolled
- Non-white = the percentage of students enrolled not classified as white

75

- Economically disadvantaged = the percentage of enrolled student qualifying for free or reduced lunch prices

- Teacher student ratio = the average ratio of students per teacher

- Teacher average experience = the average number of experience years of the teachers

- Teacher base salary average = the average of all teacher salaries

Table 5 presents the results of the regression analysis of independent non-discretionary and discretionary variables. The dependent variable included statewide efficiency previously calculated with DEA.

Table 5

Variables' Used in Efficiency Score Analysis: Full Sample of School Districts

Variable	Coefficient	Sig.
Total Student Enrollment	1.176E-6	.000*
Non-White Students	.001	.000*
Economically Disadvantaged Students	-.004	.000*
Teacher-to-Student Ratio	.001	.595
Teachers' Average Years' Experience	-.013	.000*
Teachers with Master's Degrees	.001	.034*
Teacher Base Salary Average	-9.766E-7	.441

*Statistical significance indicated at .05.

The results of the full sample study indicated statewide efficiency was significantly affected positively by total student enrollment, the percentages of non-white students and teachers with master's degrees. Negative, significant effects were found for the percentages of

economically disadvantaged and teachers average years of experience. Statewide efficiency was not influenced by the teacher-to-student ratio and the teacher base salary average.

Summary

The current study revealed the relative efficiency scores in comparison with student commended performance on TAKS for 931 Texas public school districts during the 2009-10 school year. The effectiveness and efficiency of the school districts were compared statewide and in peer groups using classifications of school district types established by the TEA (2009). The school district data extracted from the TEA included information on student demographics, student performance, teacher related variables and financial information. At the commencement of this study, the data stored in the Academic Excellence Indicator System (AEIS), may be accessed through the TEA website and continues to be publically accessible. One economic variable, the unemployment rate for all counties in Texas may currently be openly retrieved through the website managed by the United States Department of Labor: Bureau of Labor and Statistics.

DEA was utilized to calculate relative efficiency scores for all school districts included in the study. To compensate for the adjustment dollar values across Texas, the TSI was created incorporating local economic and school district factors. The theoretical effectiveness and efficiency framework (Daggett, 2009) employed by the current study was altered to more accurately illustrate and clarify the results of the efficiency and student performance comparisons by district type. Outliers of the school district comparisons were identified in all quadrants of the amended framework.

Finally, a regression analysis was conducted to identify discretionary and non-discretionary variables that influenced school district efficiency. Amongst the seven variables selected to examine influence on statewide efficiency, five statistically significant factors and two insignificant variables were presented. The conclusions of the findings are discussed in Chapter 5.

CHAPTER 5

RESULTS

Discussion

The purpose of this study was to apply the DEA model in order to examine the efficiency of Texas public school districts. This study was performed on school district data to define both discretionary and non-discretionary variables impacting efficiency. The study analyzed the 931 school districts' efficiency in a statewide sample. Variables which were statistically significant and insignificant factors were identified. Factors for consideration were selected based on consistency from the related scholarly literature. The effectiveness and efficiency of peer groups was examined with school districts sorted into TEA (2009) pre-determined categories. Chapter 5 encompasses the findings of the study addressing the research questions posed in Chapter 1. Additionally, chapter 5 includes the conclusions and future research recommendations which are based on the results and focused on the solutions to the two research questions.

The following research questions guided the current study.

Research Question 1: Which non-Discretionary Factors Influence Efficiency, among Texas Public School Districts?

This study revealed all three non-discretionary factors selected for regression analysis influenced public school districts' efficiency at the state level which included the total number of students enrolled, the percentage of non-white students and the percentage of economically disadvantaged students. Positive statewide effects on efficiency occurred for total student enrollment and the percentage of non-white students. The percentage of economically disadvantaged students negatively influenced efficiency statewide.

Research Question 2: Which Discretionary Factors Significantly Contribute to Efficiency, among Texas Public School Districts?

Among the four discretionary factors analyzed on the full data set of school districts, two factors were found to contribute to school district efficiency statewide which included the percentage of teachers with master's degrees and the average number of years of teachers' experience. The percentage of teachers with master's degrees positively influenced statewide efficiency. However, the average number of years of teachers' experience caused a statistically significant, negative impact on statewide efficiency

The remaining two discretionary variables, teacher-to-student ratio and teacher base salary, were not found to affect statewide school district efficiency.

Conclusions

This study sought to identify variables which impact school district efficiency. The results of this study revealed school districts have not reaped a return on investment by offering higher salaries to teachers based on years of experience. This discretionary variable significantly, negatively impacted school district efficiency. Yet, teachers receive additional compensation due to additional years of service in public schools. Therefore, traditional teacher salary schedules should be examined. Further, teachers should be following appropriate professional development plans designed to improve teacher quality. Additional years of service should correspond with continuous professional growth. School district hiring and retention practices should reflect methods of recruiting and retaining teachers focused on quality without emphasis on years of experience. Moreover, the results of this study revealed the value of employing teachers who hold master's degrees, a discretionary variable which positively influenced efficiency.

This study compared the effectiveness and efficiency of Texas public school districts both statewide and in categorized peer groups of school districts. The theoretical framework employed in this study is represented in Figure 15. The four quadrants of the framework were defined by efficiency scores and 2010 TAKS commended performance.
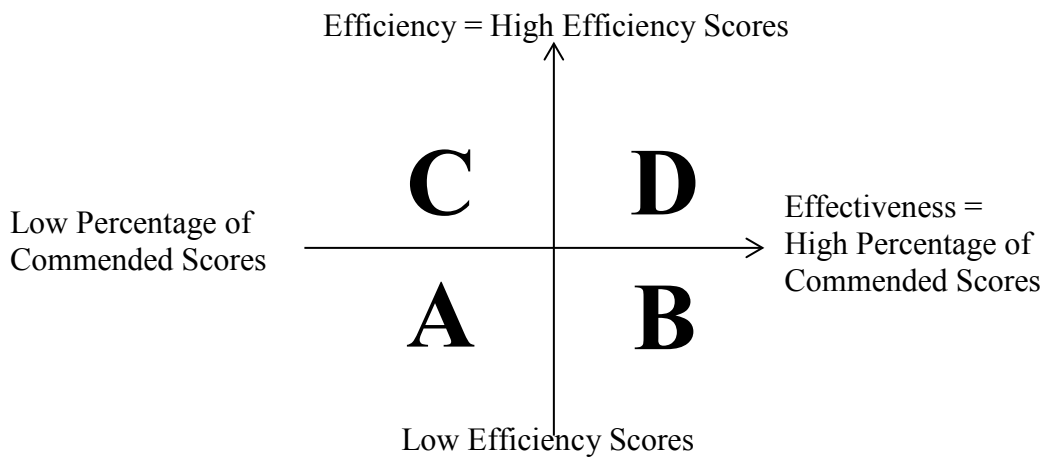
Efficiency = High Efficiency Scores

C | D

Low Percentage of
Commended Scores

A | B

Effectiveness =
High Percentage of
Commended Scores

Low Efficiency Scores

Figure 15. The modified theoretical framework.

Statewide

Throughout the state in 2010, the public school districts in this study operated with an average efficiency of 61%. Amongst the eight categories of school district peer groups, major suburban schools performed at the most efficient level of the categories of school districts at 73% efficiency on average. Rural school districts performed least efficiently of the peer groups with an average efficiency of 53%. Overall, the theoretical framework employed presents the majority of Texas public school districts operated in Quadrants C and A indicating that fewer than 25% of students in most school districts achieved commended performance on TAKS in 2010.

The average efficiency score for the state was 61% for the 931 Texas public school districts considered. Four school districts achieved a score or 100% efficiency in relation to the remainder of school districts. The most efficient school districts in the study included, Highland Park ISD, Friendswood ISD, Wylie ISD and China Spring ISD. The lowest efficiency score for the total school district samples was calculated for High Island ISD at 14% efficiency.

Independent Town

School districts classified as independent town totaled 71 districts and operated with a mean efficiency of 65%, slightly higher than the overall state average. The average student enrollment in independent town districts was 3,711 students. The TSI calculated for independent town school districts revealed an average teacher salary of 2% more than the state average. The theoretical framework utilized in the current study revealed independent town districts operated almost exclusively in the lower commended performance percentages in Quadrants C and A which both indicated lower TAKS commended scores. Barbers Hill ISD was the single independent town school district that scored exactly 25% commended performance on TAKS, and represented the highest student achievement score in the category. Gregory Portland ISD operated at 87% efficiency, the highest efficiency score of independent town districts while Jasper ISD operated least efficiently at 44%.

Major Suburban

Major Suburban school districts operated with the highest level of efficiency averaging 73% efficiency with 78 peer districts in the category. In the major suburban school districts the average student enrollment was 20,640 students. The TSI for major suburban districts was 10%

more than the state average base salary for teachers. The framework analysis revealed Highland

Park ISD was the farthest outlying Quadrant D district in this category, and the state. Highland

Park ISD earned the highest TAKS commended performance rate of 47% and one of four

districts that operated with 100% efficiency statewide. Considering the major suburban school

districts, Sheldon ISD operated least efficiently at 52%.

Major Urban

The major urban classification encompassed the least number of districts including 10

school districts that operated with the largest average student enrollment per district. Major urban

school districts' enrollment averaged 90,449 students in 2010. Major urban school districts

operated on average at an efficiency rate of 70%. The TSI revealed a 17% increase in salaries

than the state average teacher salary. According to the theoretical framework, all 10 major urban

school districts operated in Quadrant C of the framework indicating higher than average

efficiency yet lower commended TAKS scores. In the major urban group, Northeast ISD

operated at 71% efficiency and earned the highest commended TAKS rating though the student

achievement score, 19%. Austin ISD received the lowest efficiency rating in the major urban

category with 62%. The lowest TAKS commended performance, 7% occurred in San Antonio

ISD. Ysleta ISD operated the most efficiently of the major urban category at 75%.

Non-Metropolitan Fast-Growing

From the statewide sample 18 school districts were categorized as non-metropolitan fast

growing and received a mean efficiency score of 62%. The non-metropolitan fast-growing

districts operated with an average student enrollment of 3,066 students in 2010. The scores on

the framework indicated McKinney ISD was the one district of this peer group to receive a combination of higher than average efficiency at 82% and greater commended scores of 27%. McKinney ISD solely appeared in Quadrant D of the framework in this peer group. China Spring ISD received the highest score for efficiency, 83% while Brookeland ISD scored lowest in efficiency at 33%.

Non-Metropolitan Stable

Non-metropolitan stable school districts operated at an average efficiency rate of 60%. Average student enrollment for non-metropolitan stable school districts was 1,475 students. Non-metropolitan stable school districts' TSI equaled the state base teacher salary average. The theoretical framework indicated one school district in the non-metropolitan stable category of 227 districts appeared in Quadrant D, Gunter ISD with a 29% earned TAKS commended score and an efficiency rating of 70%. Huffman ISD operated the most efficiently of non-metropolitan stable school districts at 84%. The lowest efficiency score, 34% occurred for Hooks ISD in Quadrant A which indicated low commended scores on TAKS and lower than average efficiency.

Other Central City

The 39 school districts studied in the other central city group operated at an average of 68% efficiency. The student enrollment average of other central city school districts was 19,175 students. The other central city TSI indicated a 10% increase of teacher pay over the state average for other central city school districts. The majority of these districts appeared in Quadrant C of the theoretical framework, earning higher than average efficiency and lower

commended TAKS performance. Galveston ISD earned the lowest efficiency score, 56%, for the other central city category. Canyon ISD operated the most efficiently at 85%. The highest TAKS commended performance score occurred for Conroe ISD with 23%.

Other Central City Suburban

The other central city suburban school districts operated with a mean efficiency of 66% among the 153 districts. Other central city suburban school districts had an average student enrollment of 4,330 students. The TSI calculation for this group was of 3% above the state base salary average. Lovejoy ISD appeared in Quadrant D with the highest student achievement at 39%. Additionally in Quadrant D, both Friendswood ISD and Wylie ISD earned 100% efficiency scores.

Rural

The largest school district group, the rural category included 335 school districts. The average rate of 53% efficiency represented the least efficient of all categories. Rural school districts averaged a student enrollment of 391 students. Shiner ISD operated with the highest efficiency of rural school districts at 96%. The lowest efficiency score for the rural category occurred for High Island ISD at 14%. The highest student performance percentage was earned by Falls City ISD with 30% of the students achieving commended performance on the 2010 TAKS. The TSI for rural school districts was calculated at 4% lower than the state average base teacher salary.

The student achievement data analyzed in this study focused on student commended performance on the 2010 Texas Assessment of Knowledge and Skills. However, in 2012, TEA

began the implementation of an assessment to replace TAKS which will offer updated student outcomes for future data analysis of Texas student performance.

Future Research Recommendations

This study submits several topics for future research. During the 2011-2012 school year, Texas public school districts administered the first State of Texas Assessment of Academic Readiness (STAAR) and TAKS concurrently, the latter of which to be phased out in the succeeding school year. The student performance outcomes for STAAR should be analyzed in future research regarding Texas public school districts.

This study revealed a negative influence on statewide efficiency due to the average number of years of teacher experience; although school district teacher pay schedules are currently based on this discretionary factor. The negative effect of teachers' years of experience on statewide efficiency calls for further investigations into professional development practices for teachers. Further research on teacher professional development would provide strategies to improve teacher quality and lead to higher student outcomes for public schools. Studies focused on reorganizing teacher salary schedules would create an opportunity to restructure compensation in a manner conducive to hiring and retaining effective teachers thus increasing efficiency.

The current study analyzed the timeliest data available examining Texas public schools' efficiency after the economic fallout that began in 2008 throughout the United States which affected the private sector and public services. Public school efficiency studies should routinely be performed to offer opportune data analysis. Efficiency studies should include longitudinal

data of school years occurring under similar economic conditions to provide data-driven improvement strategies.

Regression analysis of efficiency predictor variables on school district peer groups would lead to more specific knowledge of influence on efficiency. Additionally, school districts could be compared with alternative methods of categorizing peer groups. School district peer groups in the current study were used based on the TEA (2009) categories model, yet designs focused on alternate organization of peer districts would provide further insight on variables influencing efficiency. Factors considered specifically for similar groups of school districts could indicate deliberate and reasonable changes in local practices making data-driven strategies more precise and improvement goals more attainable.

School district level data analysis should follow for further investigation. Efficiency studies aimed directly at one school district should reveal more specific implications of predictor variables. Further, a school-district level efficiency study could reveal estimation variables not considered in a statewide study based on the specific dynamics of the school districts and individual schools.

Charter schools, which were not included in this study, should be analyzed for effectiveness and efficiency. TEA monitors and regulates charter schools with rules and regulations that differ from those imposed on public schools. However, charter schools should be investigated with the intention of identifying variables which influence efficiency.

A few examples of DEA in statewide educational efficiency studies exist currently though DEA has been utilized predominately in private sector studies. DEA research should continue on school systems nationwide to investigate causes contributing to efficiency.

Summary

This study examined relative school district efficiency and effectiveness. The research questions focused on identifying variables that influenced efficiency of Texas public school districts statewide. The consequences of the economic downturn that began in 2008 impacted school districts by causing budget restrictions as well as diminished state and local revenue resources. School district efficiency studies have increased in recent years in accordance with the dominate issues facing school districts which include improving student performance, operating with diminishing financial resources and making data-driven decisions (Byrd, J., Daggett, W., Silver, D., & Williams, C. 2011) (Daggett, 2009). The school year 2009-2010 was selected to provide the most timely, current research data possible.

The fundamental outcomes from this study included identifying five factors impacting the statewide efficiency of school districts in Texas. All three non-discretionary factors influenced statewide efficiency and included the total number of students enrolled, the percentage of non-white students and the percentage of economically disadvantaged. The total number of students enrolled and the percentage of non-white students positively influenced statewide efficiency. The percentage of economically disadvantaged students negatively affected efficiency at the state level. Amongst the four discretionary variables, two factors, the average number of teachers' years of experience and the percentage of teachers with master's degree affected state efficiency. Significant, negative effects on efficiency were revealed for the average number of teachers' years of experience. The percentage of teachers with master's degrees increased statewide school district efficiency, significantly. However, the teacher-to-student ratio and the teacher base salary average were discretionary variables not found to influence efficiency statewide.

The theoretical framework displayed the effectiveness and efficiency of the school districts both as a full sample and in comparable peer groups. The DEA efficiency scores were displayed in relation to the school districts' 2010 TAKS commended performance on all tests for all tested grade levels 3-11. The average statewide efficiency score was identified at 61%. In school district peer categories, average efficiency ranged from 73% for major suburban school districts to 53% for rural districts. Outlying districts were observed and defined in each of the four quadrants of the framework considering the full school district sample. Additional figures of the framework presented the school district types for closer comparison. Analysis of the statewide framework observed the majority of the state's school districts performed with lower than 25% commended student achievement on the 2010 TAKS.

The current study adds to the research utilizing data envelopment analysis as an essential estimation method for studying school system efficiency. Further, this study offers relevant information to the school districts and stakeholders in the state of Texas. Texas school districts strive to provide a quality education to students in all schools in a challenging economic climate.

Educators and stakeholders should be equipped with the information necessary to meet the needs of all students regardless of the state of the economy or the demographics of school district constituents. Data driven decision making is essential to creating successful strategies aimed at constantly improving the educational system.

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