Bureau of Legislative Research
Policy Analysis & Research Section

Efficiency of School Districts in Arkansas Based on Per Pupil Expenditures and Student Achievement

April 2014

2014 Adequacy

Introduction to Efficiency Study

Efficiency is one of the foundational concepts, or pillars, of school finance. The primary assumption underlying the concept of efficiency is that there is a linear relationship between inputs (e.g., expenditures) and outcomes (e.g., achievement).

For example, studies of school or district efficiency often have been based on the assumption that increased educational expenditures leads to improved student achievement (**positive linear relationship**), or decrease in dropping out of school (**negative linear relationship**).

Examining efficiency is important to ferreting out inefficient districts, identifying lighthouse districts to serve as a model for less efficient districts, and measuring statewide efficiency.

In examining the efficiency of school districts, it is important to statistically adjust (or control) for *extraneous* influences on expenditures and achievement, such as poverty (e.g., typically measured by NSL %).

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Purpose of the Study

Adjusting for extraneous factors provides a more accurate (or valid) measure of the efficiency of school districts. Districts do not have control over most extraneous factors, such as poverty.

Failure to adjust for *extraneous* influences leads to skewed, or distorted, results regarding efficiency of school districts.

The purpose of this study is to examine the efficiency of Arkansas school districts by analyzing the linear relationship between per pupil expenditures and achievement.

The underlying assumption in this study is that there is a significant linear relationship between per pupil expenditures and performance on the state Benchmark exams (or ACTAAP).

This linear assumption is tested by adjusting for differences in NSL rates and minority % among Arkansas school districts.

Appendix A. Bivariate OLS Regression Analyses of Achievement

Predictor	Standardized Coefficient (β)	Significance Level (α)	Explained Variance (r^2)
NSL %	-.654	.000	.425
% non-White	-.655	.000	.427
Property Assessment*	-.161	.013	.022
3 Quarter ADM	.059	.361	.001
Instruction Cost**	.466	.000	.214
Teacher Salary**	.570	.000	.323
Student Services**	.046	.477	.002
Instruction Support**	-.512	.000	.259
School Administration**	.224	.000	.046
Central Administration**	-.275	.001	.072
Maintenance/Operation**	-.074	.254	.001
Transportation**	.017	.800	.000
Per Pupil Expenses	-.534	.000	.283

Note: *Property assessment is divided by 3 quarter ADM. ** Denotes that expenditure items are the percentage of the total district expenditures from all funding sources. All expenditures were based on all funding sources.

Quadriform Analysis Procedures

A primary method of examining efficiency is known as quadriform analysis. It is based on ordinary least squares regression statistical analysis of the linear relationship between per pupil expenditures and achievement.

The regression line that indicates the relationship between these expenses and achievement becomes the predicted (or expected) achievement for each school district based on its particular per pupil expenditure.

The regression line is derived from the observed (or actual) data on per pupil expenditures and on achievement.

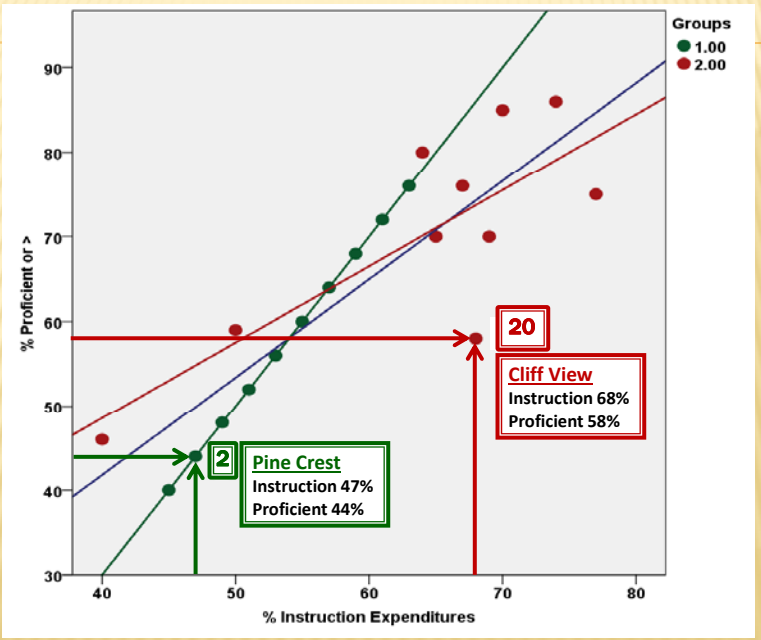
In quadriform analysis, these predicted levels of performance are subtracted from observed (or reported) performance levels for each district, and the differences are referred to as "residuals." Residuals are used to construct the efficiency classifications.

The performance outcome analyzed in this study is based on Arkansas Comprehensive Testing, Assessment and Accountability Program (ACTAAP) testing, commonly called state Benchmarks.

District Number	% Instruction Expenditures	% Proficient or >	Groups
1	45.00	40.00	1.00
2	47.00	44.00	1.00
3	49.00	48.00	1.00
4	51.00	52.00	1.00
5	53.00	56.00	1.00
6	55.00	60.00	1.00
7	57.00	64.00	1.00
8	59.00	68.00	1.00
9	61.00	72.00	1.00
10	63.00	76.00	1.00
11	65.00	70.00	2.00
12	67.00	76.00	2.00
13	69.00	70.00	2.00
14	50.00	59.00	2.00
15	70.00	85.00	2.00
16	40.00	46.00	2.00
17	77.00	75.00	2.00
18	74.00	86.00	2.00
19	64.00	80.00	2.00
20	68.00	58.00	2.00

Groups	Unstandardized Beta	Standardized Beta	R^2
Group 1	2.00	1.00	100%
Group 2	0.899	0.78	56.7%
Groups 1 & 2	1.163	0.87	74%

Example Scatter Plot & Regression Lines



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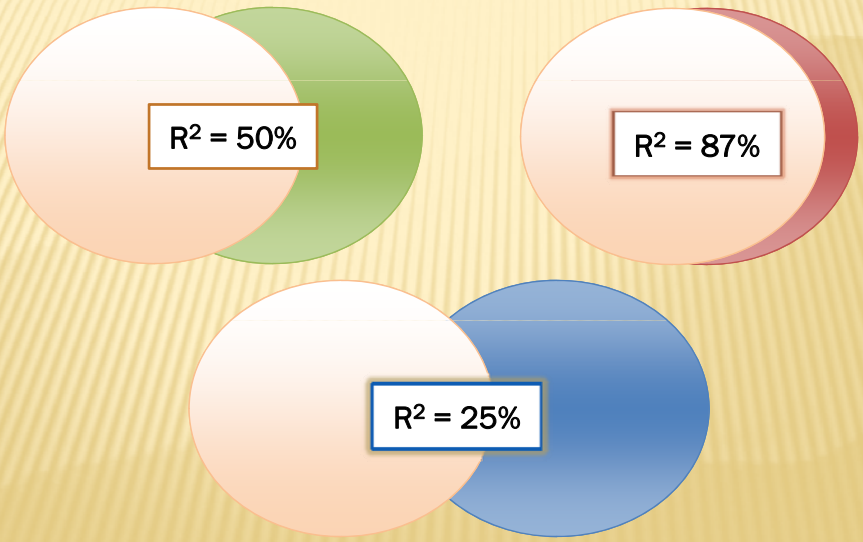
Variance in Achievement Explained by Per Pupil Expenditures



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Example of Regression Scatter Plot

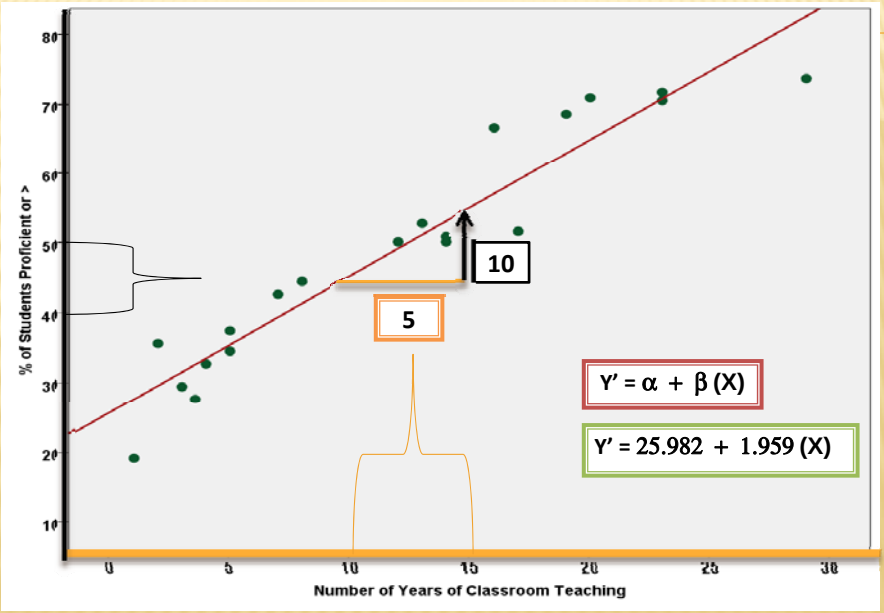

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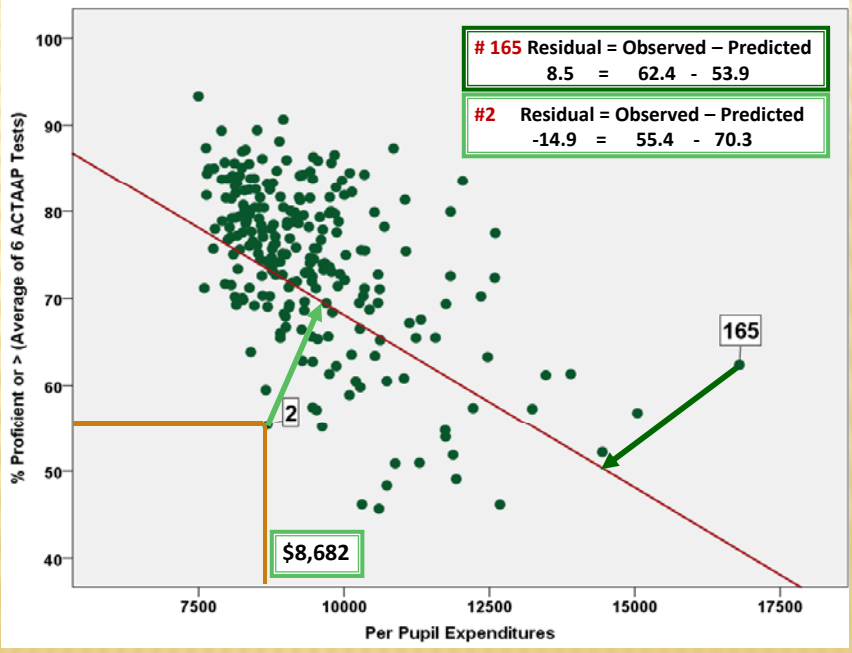
Chart 1. Linear Relationship Between Per Pupil Expenses & Achievement



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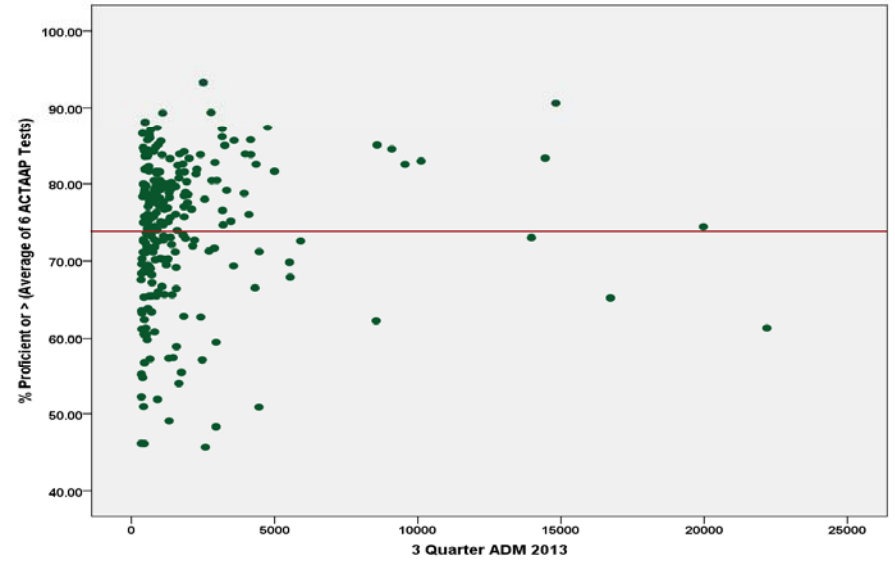
Example: No Relationship Between 3 Quarter ADM & Student Performance



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Quadriform Procedures

The red regression line in Chart 1 represents the predicted achievement for each district, based on its per pupil expenditures, adjusted for % NSL and minority %. Other study factors were not statistically significant ($\alpha = 0.05$) predictors, or they were redundant measures.

For example, the gold lines (vertical and horizontal) indicate that District # 2, based on its per pupil expenditures ($8,682), would have a predicted % proficient or above (>) of 70.3%, whereas its observed (or actual) % is 55.4%.

Subtracting District # 2's predicted % from its observed % gives a difference (or residual) of -14.9%. The green lines indicate residuals.

Residuals are calculated for all 239 Arkansas school districts represented Chart 1 by green dots. Each green dot represents the intersection of per pupil expenditure and student achievement (average % proficient or > on 6 Benchmark exams) for a particular school district.

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QUADRIFORM PROCEDURES

In the final step of the quadriform analysis, these residuals are entered into a separate scatter plot along with residuals derived from regressing per pupil expenditures on % NSL and minority % as predictors.

The achievement efficiency classification shown in Chart 2 consisted of a scatter plot of adjusted (for % NSL and minority %) expenditure residuals and achievement residuals for the 239 districts in Arkansas.

A zero residual indicates that there is no difference between the observed and predicted expenditures or achievement, or perfect prediction.

Therefore, zero becomes the dividing line for per pupil expenditures (vertical line) and achievement (horizontal line). These lines form the quadrants that separate districts into four levels of efficiency classification.

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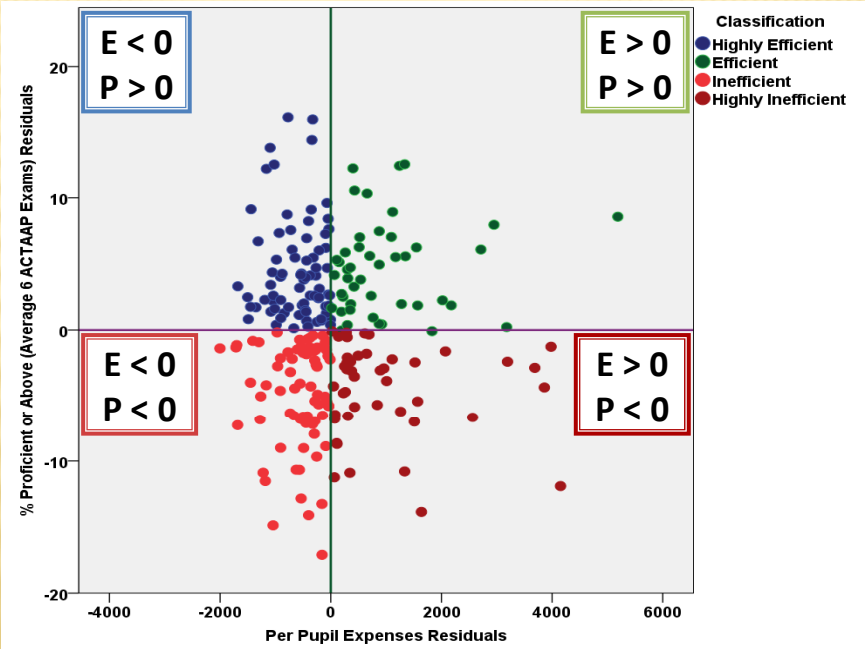
Chart 2. Efficient Achievement Classifications



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QUADRIFORM PROCEDURES

For example, districts (**blue dots**) in the upper left quadrant are classified as ***highly efficient*** because their observed per pupil expenditures (E) are lower than predicted, and their achievement (P) is higher than expected. P refers to % proficient or >, and 0 indicates no difference between observed and predicted expenditures or achievement.

Districts in the upper right quadrant (green dots) were classified as *efficient* because have higher than expected achievement, but also higher than expected expenditures.

***Inefficient* districts in the lower left quadrant (orange dots) had lower than expected expenditures and achievement,**

***Finally, highly inefficient* districts (red dots) had higher than expected per pupil expenditures, with lower than predicted achievement.**

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Table 1. Achievement Efficiency Classifications

Efficiency Classification	Number of Districts	Percent of Districts
Highly Inefficient	44	18.4%
Inefficient	73	30.5%
Efficient	45	18.8%
Highly Efficient	77	32.2%

Table 1 shows the number and percentage of districts in each classification. It indicated that 51% of the districts were classified as ***efficient***, leaving 49% classified as ***inefficient***. Forty-four districts, or 18.4%, were classified as ***highly inefficient***. Together, per pupil expenditures, NSL %, and % minority accounted for 56% of the variance in achievement.

The classification percentages shown in Table 1 were in accord with those reported in Texas, Georgia, and Indiana, using the same quadriform methodology and similar factors, lending creditability to this study's findings.

Table 2. Average % Proficient or > By Efficiency Classification

Efficiency Classification	Number of Districts	Average % Proficient or Advanced (6 Tests)
Highly Inefficient	44	68.1%
Inefficient	73	69.6%
Efficient	45	79.4%
Highly Efficient	77	79.0%

Table 2 shows the district average % proficient or above on 6 tests by efficiency classifications. All possible comparisons between classifications were statistically significant ($p < 0.05$), except between *highly efficient* and *efficient* districts, and between *highly inefficient* and *inefficient* districts. Those comparisons were based on Anova, or analyses of variance, and Tukey post hoc tests.

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Other Results in the Appendices

Other efficiency classification comparisons, based on demographic factors, were shown in Appendix B. They were examined with the same statistical procedures.

The only statistically significant ($p < 0.05$) differences between efficiency classifications were based on property assessments, which were divided by 3 quarter ADM.

The significant differences were between *highly efficient* and *efficient* districts, *highly efficient* and *highly inefficient* districts, *efficient* and *inefficient* districts, and *inefficient and highly inefficient* districts.

The noticeably large differences in 3 quarter ADM were not statistically significant because differences between districts within classifications were larger than between classifications.

There were statistically significant differences in per pupil expenditures between *highly efficient* and *efficient* districts, *efficient* and *inefficient* districts, *inefficient* and *highly inefficient* districts, and *highly efficient* and *highly inefficient* districts.

Discussion of Efficiency Results

Confidence in this study's findings is bolstered by similar classification results reported in other state studies, using the same methodology and similar measures.

Furthermore, the predictors (% NSL, minority %, and per pupil expenditures) in this study account for 56% of the variance (difference) in efficiency classifications (Table 1).

This evidence of the validity and strength of these classifications suggests that they can be used to inform policy and practice.

However, because of study limitations to be discussed these classifications should not be the sole basis for policy and practice decisions. These classifications should confirm other professional observations and sources of information (i.e., they should be confirmative, not determinative).

These efficiency classifications function in much the same way as diagnostic instruments in medicine or psychology.

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Discussion of Efficiency Results

The efficiency classifications provide an (not "the") indicator of which districts may need to make changes in efficiency.

They do not function to prescribe exactly what needs to be changed or how changes should be made. These decisions have to be made based on other evidence and professional observations and judgments.

It is important to understand that the negative relationship found between per pupil expenditures and achievement is not indicating that increasing expenditures (or funding) led to declines in achievement.

In actuality, the negative relationship between per pupil expenditures and student performance is a reflection of the fact that additional funding (e.g., NSL, Title 1) is provided to school districts with higher concentrations of poverty. In other words, per pupil expenditures are not negatively influencing student performance, but rather they are an indicator of the additional funding provided to address poverty-related issues.

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Limitations of the Study

Furthermore, it needs to be noted that this cross-sectional study cannot test causal relationships, such as between expenditures and achievement.

This cross-sectional study also does not examine achievement gains, nor does it account for fluctuations in achievement data from one year to another.

Use of classifications with more than one outcome would have provided information about the range of applicability.

More detailed information about districts would have permitted more discussion of characteristics associated with the classifications. What are the critical factors that differentiate efficient from inefficient districts?

Finer grained data might have offered clues about what factors lead to more efficient use of resources.

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Conclusions

In making comparisons between districts for purposes of enhancing efficiency, it must be kept in mind that there are extraneous influences, such as poverty, on achievement that affect district expenditures and operations.

Schools districts have limited influence on extraneous factors, such as poverty. Poverty requires a broader societal response to address the variety of problems associated with it.

Therefore, comparisons between districts and efficiency decisions should be tempered with knowledge that there are demographic differences over which districts exercise little control.

Finally, it must be kept in mind that this was a study of expenditures. Expenditures do not measure quantity or quality of interventions, strategies, or practices, nor the integrity of their implementation.

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Appendix A. Bivariate OLS Regression Analyses of Achievement

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Appendix B

Difference in Averages of Efficiency Classifications

Factors	Highly Efficient	Efficient	Inefficient	Highly Inefficient
% NSL	64.9%	61.7%	65.4%	66.7%
% Non-White	26.1%	23.3%	24.3%	26.9%
3 Quarter ADM	2246.5	1915.4	1533.0	2002.7
Property Assessment/ADM*	$69,121.08	$113,283.94	$67,981.88	$99,012.62

Note: *3 quarter ADM. Differences in averages were examined with Anova and Tukey post hoc tests. The colors indicate that the ***red numbers*** significantly ($p < 0.05$) differ. The significant differences are between *highly efficient* and *efficient*, *highly efficient* and *highly inefficient*, *efficient* and *inefficient,* and *inefficient and highly inefficient*. The noticeably large differences in 3 quarter ADM are not statistically significant because differences between districts within classifications are larger than between classifications.

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Appendix C

Other Differences in Averages of Efficiency Classifications

Factors	Highly Efficient	Efficient	Inefficient	Highly Inefficient
Per Pupil Expenditures	$8,843.83	$10,248.13	$8,879.68	$10,569.59
% School Administration*	4.9%	4.7%	4.8%	4.6%
Average Teacher Salary	$43,666.58	$43,825.44	$43,033.49	$43,172.86
Teacher's with Master's Degree	38.3%	38.1%	36.6%	38.1%
Student Services*	4.5%	4.6%	4.6%	4.6%

Note: *Indicates average % of total expenditures. *Significant (p <50.05) differences are in **red numbers.** They are between highly efficient and efficient, between efficient and inefficient, between inefficient and highly inefficient, and between highly efficient and highly inefficient.*

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