Spring | 18

Economics Honors Thesis: Impact of Changes in School Financing on Student Performance in Tennessee

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Research Question

How does increased education funding impact student performance in Tennessee public schools?

Introduction

Students' academic preparedness has been well documented to have important implications for their future employment outcomes and overall long-term wellbeing (Jackson et al. 2014). Additionally, the aggregate preparedness of high school graduates within a state may also carry consequences for the state's overall labor force quality and future economic health. Increased educational funding is also frequently cited as a tool for reducing the achievement gap for students with low socio-economic status (Cohen-Vogel & Cohen-Vogel 2001). Therefore, it is important to understand the determinants of academic performance and whether increasing funding in schools is a sound investment in improving student preparedness.

History of Litigation Surrounding Education Funding in Tennessee

Education funding is a controversial policy topic and has been the subject of extensive litigation in Tennessee. Funding allocation formulas are the subject of much criticism and are frequently changed, resulting in periodic and occasionally dramatic shifts in school budgets and per-pupil expenditure. Several lawsuits have been brought forth against the Tennessee state government since 1990 alleging underfunding and discrimination against different types of school systems. In the three cases decided so far, the Tennessee Supreme Court has consistently sided with the petitioning school systems. Suits brought forth by Shelby County, Metro Nashville Schools, and Hamilton County are still pending.

The first such lawsuit occurred in 1993 in *Tennessee Small School Systems v. McWherter* (*Small Schools I)*. In this lawsuit, the state's smaller school districts alleged that the state's funding model violated the Equal Protection Clause of the Fourteenth Amendment by discriminating against students in smaller school systems and creating gross disparities in school quality. The plaintiffs' victory resulted in a court order requiring increased funding for smaller school systems. In 1998, the plaintiffs sued again (*Small Schools II)* in response to a delay in implementation of the resolution reached in *Small Schools I*. In a third iteration, the plaintiffs sued for teacher salary equalization (*Small Schools III*) and the Supreme Court ruled that the state must also incorporate teacher salary and an annual cost review into its funding calculations.

In March 2015, the Hamilton County Board of Education (county seat Chattanooga) sued the state in *Hamilton County Board of Education v. Haslam* on grounds that the current funding formula underestimated instructional costs, especially teacher salaries, resulting in underfunding of education. The petitioners claimed that wealthier school districts were able to supplement lower state funding with higher amounts of local funding derived from parent fundraisers. A decision on the case is still pending.

In August 2015, the Shelby County Board of Education (county seat Memphis) sued the state in *Shelby County Board of Education v. Haslam* alleging that the state failed to provide sufficient funding for the county to bring low-achieving students up to state standards and accommodate high-need immigrant, impoverished, and disabled students. Most recently in September 2016, the Metro Nashville Board of Education sued the state in *Metro Nashville Board of Education v. Haslam* for full funding for its English learner program. In October 2017, the Metro Nashville Board of Education also joined Shelby County in its suit as a plaintiff. Consequently, three of the four metropolitan school systems (except Knoxville) – all of which are in the top five school districts for largest student enrollment– are engaged in active lawsuits with the state regarding funding for large, urban school districts.

Basic Education Program (BEP)

Tennessee public schools are funded through the Basic Education Program (BEP). The BEP was initially phased in during the mid-1990s and relies on several factors to estimate the total cost of education for a given county, including the ability of the local government to contribute to school finance, or fiscal capacity. Funding is broken down into three categories: instructional (e.g., teacher salary), classroom (e.g., textbooks), and non-classroom (e.g., school bus costs). The BEP determines the amount of state funding that counties receive to supplement local funding for education. State funding is only a portion of the total amount of educational funding, as the BEP allocated funding is combined with local and federal funding to arrive at the final funding amount, often measured as per-pupil expenditure. The full list of inputs into BEP is detailed in the appendix in *Table A1*.

BEP 2.0 Changes

The BEP 2.0 model passed by the state legislature in 2007 currently determines school funding in Tennessee. The funding change took effect in the 2007-2008 academic year and resulted in a net increase or constant funding (but no decrease) for all counties in Tennessee. Because education is such a critical policy area, it is important to understand what the actual effect of this funding increase has been on student achievement.

The biggest change in the BEP 2.0 formula was an alteration in fiscal capacity calculation. Fiscal capacity calculations are undertaken to estimate the amount of funding local governments can devote to education in order to determine what supplementary funding the state must supply to ensure that there are sufficient resources for students in that county. The state finds the fiscal capacity of the entire county and assumes all districts within the county have equal fiscal capacity (adjusted by district size). This does not account for the fact that there may be a wealth disparity within a county if one district is wealthier than another district within the same county. Fiscal capacity calculations use a three-year average for each input and are detailed in the appendix *Table A2* and *Figure A1*. The funding factors in *Table A2* are used to calculate the state's contribution to education funding.

Both the original BEP and BEP 2.0 allocate funding to counties, and money is spent by the individual school districts within the counties. Because some counties may have more than one school district per county as described above, this allocation method may misrepresent the actual needs of individual districts in the fiscal capacity calculation. Furthermore, because the local education agencies within each county are allowed discretion to distribute funds to the school districts, individual school districts could have seen funding decreases. This may have been driven by changes in funding needs, such as a decrease in the enrolled population of students at a particular school district.

Prior to BEP 2.0, the state paid for 65% of the cost of instructional positions (e.g., teacher salaries), 75% of all other classroom-related costs (e.g., textbooks, lab equipment, etc.), and 50% of non-classroom costs (e.g., subsidized meals, student transportation, etc.). Following BEP 2.0, the state increased its share of the cost of instructional positions to 70%. In addition to the changes listed in *Table A1*, BEP 2.0 also increased the state share of funding for health insurance premiums, technology renovations, and educational programs for English language learners and students with disabilities.

Because BEP 2.0 was passed prior to the Great Recession, it was designed at a time when the state enjoyed comparatively high revenues. Consequently, it set an optimistic goal for education funding increases that were scheduled to begin in the 2007-2008 academic year. BEP 2.0 was partially funded with a cigarette tax hike, but the state was unable to find sufficient funds at the time of the implementation. This was primarily due to the onset of the Great Recession and a sharp decrease in state revenue.

Consequently, the state adopted a temporary measure of fulfilling only 50% of the funding increase. Despite improvements in the overall state economy, the state has yet to meet the full funding increase. This modified version of BEP 2.0, popularly dubbed "BEP 1.5," was in effect since the passage of BEP 2.0 until fall of 2016, In August 2016, Governor Haslam passed the BEP Enhancement Act, which increased funding for teacher salaries and provided higher compensation for health insurance premiums following the complaint brought forth by Hamilton County. It also provided more money to fund educational programs for high-need populations and address the allegations leveled by Shelby County. The BEP Enhancement Act saw a total funding increase for education of approximately $200 million.

Literature Review

Summary

My literature review focuses on studies that examined the relationship between school finance reforms and academic outcomes. I discovered two primary methods of measuring academic outcomes: test scores and graduation rates. Most finance reforms studies focused on academic test scores as a measurement of academic performance. The relevant literature will be divided into two categories: 1) studies examining finance reforms outside Tennessee and 2) studies examining finance reforms in Tennessee. I have highlighted three studies that I feel bear the most relevance to my thesis.

Summary of Selected Literature

The results of the literature are mixed. There appears to be some consensus that finance reforms improve spending equity, or the gap between the amounts that wealthier and poorer districts can spend on students, and have more of an impact on graduation rates. There is weaker consensus regarding the impact on test scores, and results seem to vary based on the test being used. For example, some studies found a funding increase within the same district resulted in higher test scores for one age group, which was subject to one type of examination, and lower test scores for another age group, which sat for a different age-appropriate examination.

Funding Reforms Outside of Tennessee

<u>"Equality of Educational Opportunity" – Coleman & Campbell, et al.</u>

The first study I examined was commissioned by the U.S. Department of Health, Education, and Welfare in compliance with the Civil Rights Act of 1964. At the time of the report, author Dr. Ernest Coleman was the Chair of Sociology and Anthropology at Vanderbilt University. The report focused on barriers to educational opportunity for traditionally disadvantaged student populations, particularly ethnic minorities.

The study surveyed students in public schools across the United States in 1965 to gather information about student background such as location, parental education, quantity of newspapers in the home, perspective on education, race, etc. The authors also gathered information about the quality of the school as measured by the background of educators and available resources. Standardized test scores were used to measure academic achievement in an OLS multiple regression model.

The authors found that differences in school quality accounted for a minimal portion of the achievement gap. Rather, the largest predictor of student success was the "pupil attitude factor" or the degree to which individual students felt they had control over their future as assessed by student surveys. Coleman and Campbell suggested that closing the achievement gap was dependent on upstream interventions that targeted students and their families rather than school reform.

<u>"The Effect of School Finance Reforms on the Distribution of Spending, Academic Achievement, and Adult Outcomes" – Jackson & Johnson, et al.</u>

This study was published as a working paper by the National Bureau of Economic Research in May 2014. The authors conducted an event-study analysis of finance reforms to analyze the impact of court-mandated reforms on educational outcomes using a difference-in-difference model with a linear combination of estimated treatment effects to account for any lag. The study differentiated between adequacy-based reforms (regarding absolute levels of spending) and equity-based reforms (regarding relative levels of spending between districts). The sample was compared to a nationally representative dataset for children born in that era to examine both student performance and long-term adult outcomes through event-study and instrumental variable models.

The authors used graduation rates and adult outcomes instead of standardized test scores to measure the impact of school spending. They found that increasing per-pupil expenditure by 20% for students from poor families over their educational lifetime (both primary and secondary school) lead to 25% higher earnings as well as reduced incidence of adult poverty by 20 percentage points. The study found that a 20% expenditure increase raised the likelihood that students would complete high school by nearly 23%, and on average, led to nearly one full year of additional education. No effects were found for students who were not from low-income backgrounds.

Funding Reforms in Tennessee

"School Finance Reform in Tennessee: Inching Toward Adequacy" – Cohen-Vogel & Cohen-Vogel

This study was published in the *Journal of Education Finance* and focused on the impact of the implementation of the first BEP funding program on TCAP (Tennessee Comprehensive Assessment Program) scores. The TCAP serves as the mandatory, standardized test for all students in grades 3-8 in Tennessee and is the measurement of academic performance that I use in my analysis. The implementation of the BEP funding program brought Tennessee's first attempts to include equalization, or attempts to make funding levels more uniform across school districts, in its funding decisions. The study used the normalized version of TCAP scores, determined by placing each school district's TCAP average on a statewide curve of all school districts. Cohen-Vogel and Cohen-Vogel compared scores between the 1991-1992 school year and 1997-1998 school year once the BEP had been primarily phased in and spending had substantially increased across the state.

The authors found that overall spending equity was improved but that the spending extremes did not grow closer together. The absolute difference between the highest spending and the lowest spending districts did not decrease, but the relative ratios of spending between the 95^{th} percentile and 5^{th} percentile of spenders decreased. Promotion rates for K-8, or the percentage of students who advanced from one grade to the next, improved over the time span that the BEP was implemented. Students in grades 3-8 in the lowest spending quintile showed greater gains in TCAP test scores than students in any other quintile, but ACT test scores for high school students dropped across Tennessee.

Cohen-Vogel and Cohen-Vogel also compared the test scores of the individual math and reading sections of the TCAP for different grades and spending quintiles. The authors found that the greatest gains relative to the statewide average were concentrated in the lowest spending quintiles. Overall, the authors concluded that the BEP was effective in improving test scores, especially for students in schools in the lowest expenditure quintile prior to the reform measures.

The goal of my paper is similar to that of Cohen-Vogel and Cohen-Vogel, with the important difference of evaluating a different policy change. The first iteration of BEP had a greater focus on equity, or the difference in education expenditure between wealthy and poor schools. While equity was a concern in BEP 2.0, its primary motivation was adequacy, or providing enough funding for schools to improve student performance in Tennessee and raise test scores closer to the national average (Green & Morgan 2008). Therefore I am focusing my analysis on the impact on test scores.

While this study provides a useful analysis for understanding the historical impact of funding reform in Tennessee, BEP and BEP 2.0 used different mechanisms to improve the state of education in Tennessee, and as such, require separate analysis. In addition, my analysis differs in several substantial ways. First, instead of dividing schools into quintiles by spending levels and comparing academic performance among these quintiles to draw my conclusion, I employ a panel regression with each district's spending level as the regressor of interest. I also divide school districts by 1) percentage of students from economically disadvantaged backgrounds and 2) size of enrolled student population.

Data

The data was retrieved from the publicly available data on the Tennessee Department of Education website for 135 school districts out of a total of 141 school districts across the state. Data was missing for the six districts excluded from the dataset. Data for the 2005-2006 academic year through the 2008-2009 academic year are used (two years before and two years after the implementation of BEP 2.0). The first year of data available was 2005-2006, and analysis ended with the 2008-2009 academic year due to a shift in test score calculation methods that lowered TCAP scores in 2010 (O'Hara). Graduation rates were not used because they were not available for all school districts in the dataset, and there was also a shift in how the state calculated its graduation rates during this period.

District-level data was collected for three variables: TCAP score, per-pupil expenditure (PPE), and percentage of students on free and reduced lunch (FRL). Per-pupil expenditure measures the average amount spent on each student in the district and is calculated using average daily attendance rather than average daily membership, meaning that truants are not fully reflected in this value. This value includes expenditures on both instructional spending (teacher salaries, textbooks, etc.) and non-instructional spending (administrative costs, student busing, etc.). The percentage of students on free and reduced lunch (FRL) measures the percentage of students in each school district who are eligible for free and reduced lunch based on family income level, whether or not they have opted to receive the subsidized meals.

The TCAP is Tennessee's standardized test administered to all students in grades 3-8 at the end of each academic year, covering math, social science, science, and reading & language arts. Total composite scores are found by aggregating a student's performance in each of these subjects. Students below the third grade are not required to participate in standardized testing due to their youth. Students in high school are administered the End of Course tests in more specific subjects based on their course selections for the year (Biology, Algebra II, etc.) so that all students in each year do not take a uniform set of tests and are not directly comparable to one another. Additionally, the highest achieving students may not take some End of Course exams at all if they choose to take Advanced Placement (AP) courses instead. Therefore, high school students are not included in the TCAP analysis.

Testing data was gathered based on the normal curve equivalent of all districts. The Tennessee Department of Education finds the normal curve equivalent by compiling the test scores for all students within the district to arrive at an average value of student performance in each subject at the district level. This district performance is curved in comparison to all school districts in the state to create a district grade in each subject ranging from A-F. I assigned a score of 0-4 (with 4 representing an A and 0 representing an F) to each subject performance value within a district. Thus, the composite score representing the total performance in all four subjects ranged from 0 (district failure in all four subjects) to 16 (district grade of A in all subjects).

Summary Statistics

Summary statistics for the average per-pupil expenditure and academic outcomes in the academic year prior to the implementation of BEP 2.0 (2006-2007) and the year following the implementation of BEP 2.0 (2007-2008) are included in *Table 1*. They are further broken down into two sets of evenly sized quartiles based upon percent of students considered economically disadvantaged and population size of school districts in *Tables 2-3* and *Tables 4-5* respectively.

Summary statistics in *Table 1* indicate that average test scores increased across the board following the implementation of BEP 2.0. On average, school districts saw over a 6% increase in per-pupil expenditure immediately after BEP 2.0. Composite scores grew over 5.5%, driven by large gains in science and reading test scores. In addition, the percent of students on free and reduced lunch grew for all school districts across this time period as well, likely in part due to the simultaneous occurrence of the Great Recession.

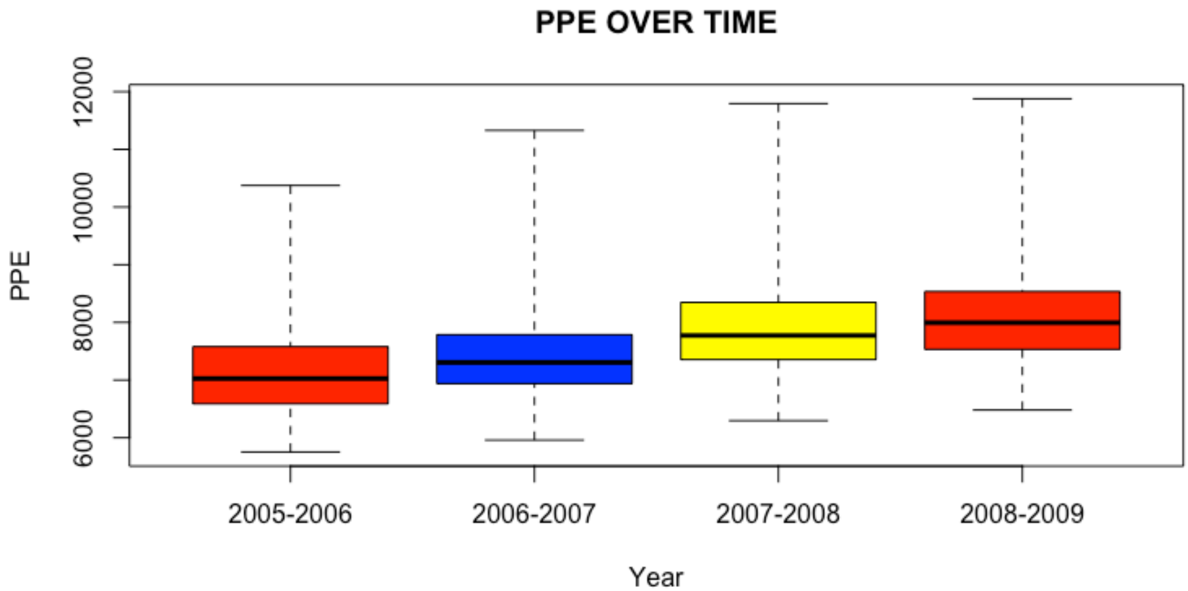
The boxplots in *Figure 1* demonstrate the upward trend in per-pupil expenditure over time. *Figure 1* shows a general increase in per-pupil expenditure over the period of the study, with the largest jump in the median per-pupil expenditure occurring between the 2006-2007 and 2007-2008 academic years as expected. The lengths of the whiskers remain fairly consistent over time. This is in keeping with the trend found by Cohen-Vogel and Cohen-Vogel after the implementation of the initial BEP model; like its predecessor, BEP 2.0 does not appear to substantially narrow spending differences between the highest-spenders and lowest-spenders.

Two school districts saw a small funding decrease despite the state's pledge to maintain or increase school funding with BEP 2.0. As discussed above, this was likely driven by the fact that funding is allocated to counties but spent by school districts, and counties could have allocated funding from BEP 2.0 in such a way that a school district received less money. This decision could have been driven by changes in relative district funding needs within a county, such as a migration in student population from one part of a county to another.

Table 1. Summary Statistics Before and After BEP 2.0, All Districts

	All Districts (2006-07)	**All Districts (2007-08)**	**Change (Absolute)**	**Change (%)**
Average % FRL	54.59%	57.10%	+2.51	+4.60%
Average PPE	$7467.44	$7931.96	+$464.51	+6.22%
Average Composite	12.90	13.62	+0.072	+5.57%
Average Social Studies	2.85	2.95	+0.101	+3.53%
Average Science	3.10	3.40	+0.295	+9.50%
Average Reading & Language Arts	3.37	3.61	+0.237	+7.03%
Average Math	3.74	3.81	+0.074	+1.98%

Figure 1. Boxplot of PPE Over Time



Summary Statistics of Funding by Percentage of Students Economically Disadvantaged

Across the state, the average school district has nearly 57% of its students enrolled in free and reduced lunch programs over the time period ("Avg % FRL"). As demonstrated in *Table 2*, the distance from this mean is similar for both the wealthiest schools and the poorest schools. The percentage of economically disadvantaged students increases by 15.7 percentage points from the mean for the poorest districts and falls by 15.3 percentage points for the wealthiest.

Table 3 displays the spread in per-pupil expenditure for each wealth quartile of districts between the 2006-2007 and 2007-2008 academic years. The wealth quartiles are evenly sized and determined by the percent of highly economically disadvantaged students. *Figure 2* depicts the data in *Table 3*. Changes in per-pupil expenditure were substantially more varied for the second poorest school district. Conversely, changes in per-pupil expenditure were the least spread for the second wealthiest school district. The wealthiest and the poorest districts had similar spreads in expenditure change, but the wealthiest district appeared to be skewed towards slightly larger increases.

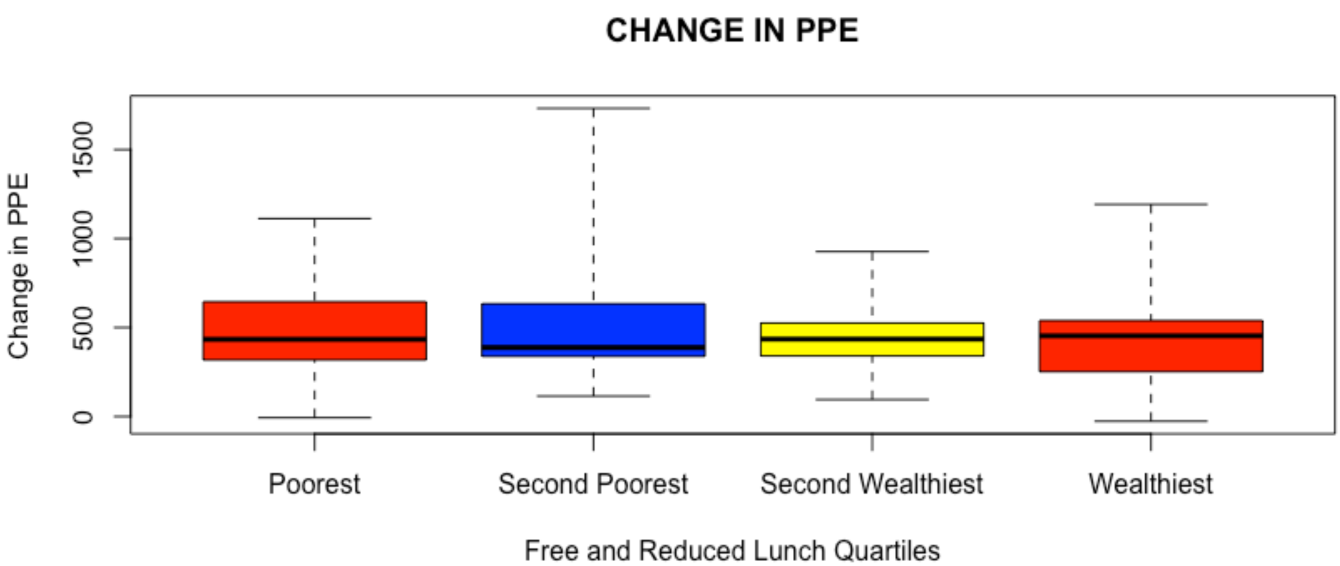
Table 2. Distribution of PPE Changes, by % Economically Disadvantaged

	All Districts	**Poorest**	**Second Poorest**	**Second Wealthiest**	**Wealthiest**
Avg % FRL	56.81%	72.51%	60.01%	53.78%	41.51%
Minimum	-$26.90	-$7.00	$114.70	$95.20	$-26.90
25%	$321.40	$317.90	$337.90	$340.20	$264.60
Median	$436.10	$433.60	$387.60	$434.90	$453.20
Mean	$464.50	$477.80	$496.60	$457.40	$435.40
75%	$590.00	$644.70	$633.60	$523.10	$535.70
Max	$1731.90	$1112.50	$1731.90	$926.80	$1192.20

Table 3. Summary Statistics for Wealth Quartiles

	Poorest	Second Poorest	Second Wealthiest	Wealthiest
Average % FRL	72.51%	60.01%	53.78%	41.51%
Average PPE	$7875	$7410	$7463	$7939
Average Composite	9.63	12.52	12.81	14.15
Average Social Studies	2.06	2.77	2.88	3.31
Average Science	2.17	3.09	3.13	3.47
Average Reading & Language Arts	2.49	3.14	3.27	4.00
Average Math	2.90	3.51	3.54	3.74

Figure 2. Boxplot of Changes in PPE Following BEP 2.0, by Free and Reduced Lunch Quartiles



Summary Statistics of Funding by Enrollment Size of School Districts

As displayed in *Table 4* enrollment ("Avg Size") substantially jumps for the largest quartile and skews the mean for all districts. This is primarily driven by the disproportionately large enrollment in the state's four cities: Nashville, Memphis, Knoxville, and Chattanooga.

Table 5 contains summary statistics for the changes in per-pupil expenditure between the 2006-2007 and 2007-2008 academic years, broken down for all districts across evenly sized quartiles based upon districts' enrollment population. The data in *Table 5* is also represented graphically in the boxplot in *Figure 3*. The two school districts that saw funding decreases fell in the smaller half of school districts. The smallest school districts had a substantially wider variation in per-pupil expenditure than all other quartiles. The largest districts overall saw the tightest spread and had a markedly higher minimum increase. This indicates that more districts in the largest quartile saw gains over $175 dollars per pupil than districts in other quartiles.

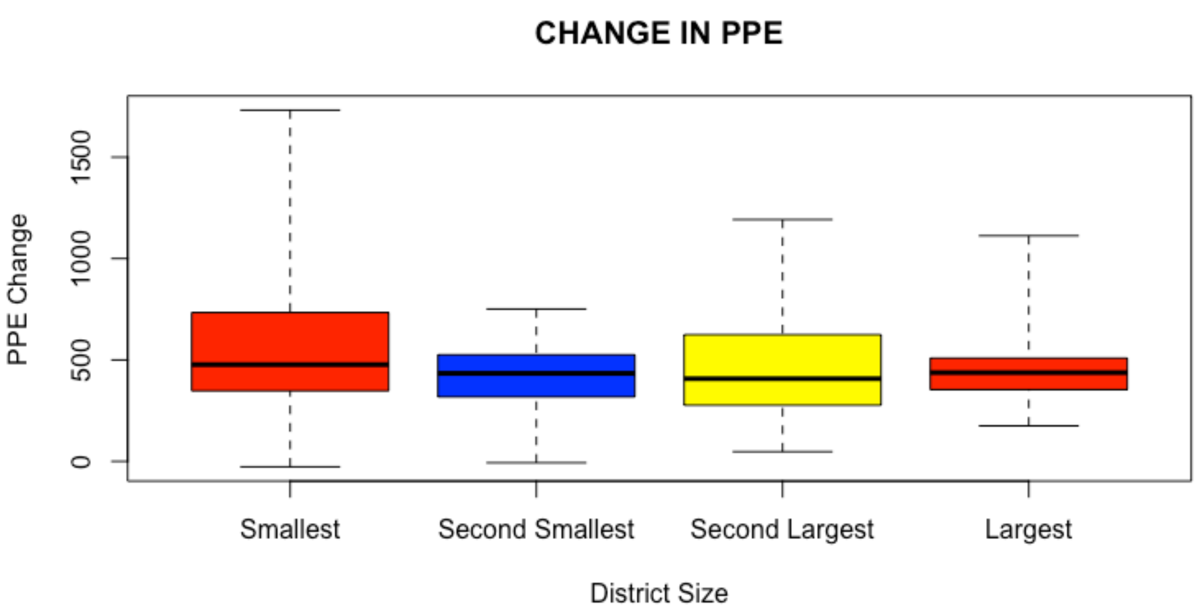
Table 4. Summary Statistics for Size Quartiles

	Smallest	Second Smallest	Second Largest	Largest
Average Size	1028	2549	4568	41.51%
Average PPE	$7696	$7950	$7498	$7939
Average Composite	12.45	12.26	11.95	12.53
Average Social Studies	2.87	2.73	2.65	2.93
Average Science	2.99	3.04	2.86	3.17
Average Reading & Language Arts	3.11	3.11	3.08	3.33
Average Math	3.48	3.38	3.36	3.56

Table 5. Distribution of Per-Pupil Expenditure Changes, by School Sizes

	All School Districts	Smallest	Second Smallest	Second Largest	Largest
Avg Size	7,025	1,028	2,549	4,568	20,166
Minimum	-$26.90	-$26.90	-$7.00	$47.70	$175.20
25%	$321.40	$347.70	$323.50	$282.90	$353.80
Median	$436.10	$477.00	$433.80	$407.60	$437.40
Mean	$464.50	$534.70	$414.10	$458.60	$460.40
75%	$590.00	$733.70	$523.10	$613.30	$509.00
Max	$1731.90	$1731.90	$751.10	$1192.20	$1112.50

Figure 3. Boxplot of Change in PPE Following BEP 2.0, by Size Quartiles



Panel Regression

Model

In order to evaluate the relationship between spending changes resulting from the implementation of BEP 2.0 and student academic outcomes, I have run a panel regression using fixed effects for school districts. District-level data for the academic years 2005-2006, 2006-2007, 2007-2008, and 2008-2009 were used. The variable of interest was per-pupil expenditure ($PPE_{i,t}$) for each school district. Per-pupil values were used because they account for differences in district size and can be thus compared across districts.

The dependent variable was student performance, which was measured using the test scores ($TEST_{i,t}$) generated from the normal curve equivalent of the TCAP scores for each district. $TEST_{i,t}$ was used to represent one of five values: the composite test score or subject test score for math, science, social studies, and reading and language arts. Subject test scores took on a value of 0-4, with 4 representing highest performance within the district and 0 representing failure. The composite score took on a value of 0-16, with 16 indicating highest performance in all subjects and 0 indicating failure in all subjects.

District fixed effects (α_i) were included to account for intrinsic differences among districts that were unlikely to be impacted by changes in per-pupil expenditure but still may have impacted student performance, such as parental education, general health of students, and baseline test scores prior to the intervention. A year variable ($YEAR_t$) was included to account for any simultaneous changes that may have impacted the curve of test scores. The percent of students eligible for free and reduced lunch ($FRL_{i,t}$) was included as a control because economic status has been well understood to significantly influence academic performance. Additionally, the number of students considered economically disadvantaged within districts changed substantially over the same time period as funding as a result of the Great Recession, so the full scope of the impact of economic status was unlikely to be completely captured in the district fixed effects.

Each of the five regressions below were run for nine different groups of school districts: all districts, quartiles of school districts based on percentage of economically disadvantaged students, and quartiles of school districts based on enrollment size. The model is as follows:

$$\mathbf{TEST_{i,t} = \beta_0 + \beta_1(PPE_{i,t}) + \alpha_i + \beta_2(YEAR_t) + \beta_3(FRL_{i,t}) + u}$$

$$\text{(1) } \mathbf{Composite_{i,t} = \beta_0 + \beta_1(PPE_{i,t}) + \alpha_i + \beta_2(YEAR_t) + \beta_3(FRL_{i,t}) + u}$$

$$\text{(2) } \mathbf{Math_{i,t} = \beta_0 + \beta_1(PPE_{i,t}) + \alpha_i + \beta_2(YEAR_t) + \beta_3(FRL_{i,t}) + u}$$

$$\text{(3) } \mathbf{Science_{i,t} = \beta_0 + \beta_1(PPE_{i,t}) + \alpha_i + \beta_2(YEAR_t) + \beta_3(FRL_{i,t}) + u}$$

$$\text{(4) } \mathbf{Social\ Studies_{i,t} = \beta_0 + \beta_1(PPE_{i,t}) + \alpha_i + \beta_2(YEAR_t) + \beta_3(FRL_{i,t}) + u}$$

$$\text{(5) } \mathbf{Reading\ \&\ Language\ Arts_{i,t} = \beta_0 + \beta_1(PPE_{i,t}) + \alpha_i + \beta_2(YEAR_t) + \beta_3(FRL_{i,t}) + u}$$

Test scores, expenditures, and percent eligible for free and reduced lunch were indexed on district "i" in year "t." The coefficient β_1 measures the relationship between changes in school spending on a per-student basis ($PPE_{i,t}$) and academic performance ($TEST_{i,t,}$).

Results

The model outlined above generated the below results for β_1 (*Tables 4-6)*. Significance levels are indicated through the use of stars: *** for significance at the 1% level, ** for significance at the 5% level, and * for significance at the 10% level. For reporting convenience, all expenditures were recorded in thousands. Therefore, a value of 2 for β_1 would suggest that every $1000 increase in student expenditure would improve the relevant test score by 2 points.

All Districts

Table 6. Panel Regression Results, All School Districts

	Composite	**Math**	**Science**	**Social Studies**	**Reading & Language Arts**
PPE	1.269*** (0.337)	0.504*** (0.132)	0.256*** (0.099)	0.056 (0.080)	0.453*** (0.126)
Year	-0.301** (0.137)	-0.313*** (0.054)	0.081** (0.040)	0.072** (0.033)	-0.141*** (0.051)
FRL	-11.673*** (2.896)	-4.379*** (1.134)	-2.796*** (0.847)	-0.640 (0.688)	-3.858*** (1.082)
R^2	0.813	0.632	0.834	0.857	0.646

Discussion of Results for All School Districts

A statewide analysis of all school districts suggests that increased expenditures impact student performance at the 1% significance level in all areas except for social studies. Overall, an increase of $1000 in per-pupil expenditure corresponded to an increase in composite test scores of approximately 1.3 points on a 16 point scale. Math and reading appeared to be the subjects that were the biggest beneficiaries of overall increases in spending, and science also showed significant gains in test scores.

Social studies was the only subject that did not see significant improvements in student performance. It is possible that social studies instruction did not directly benefit from increases in overall per-pupil expenditure if money was diverted elsewhere. If school districts felt that math and reading were more financially needy subjects (which may have been the case if they had observed the effects of the negative time trend), those two subjects could have received a greater share of the increase in per-pupil expenditure while social studies may have received little to no funding increase. The dataset did not include what subjects saw the greatest investment from each school district's funding increase as the state opted to preserve the financial autonomy of the districts. It is also possible that a student's ability to learn social studies is primarily determined by factors other than those influenced by funding changes, such as home life or prior learning.

The economic status of a student is well understood to be a major determinant of academic performance, and this is seen in the large negative coefficient on percentage of students on free and reduced lunch. This coefficient was estimated at -11.7 points, suggesting that a school district with 100% students on free and reduced lunch is likely to score 11.7 points lower on a 16 point scale than a school district with no students on free and reduced lunch. In this scenario, the fully economically disadvantaged district would receive a maximum average grade of "D" for student performance in all subjects by the state's normal curve equivalent comparing school districts to each other. This dramatic difference indicates that economic status is one of the largest determinants of student performance and significantly disadvantages the poorest students.

Wealth Quartiles of School Districts

Table 7. Panel Regression Results, by Wealth Quartiles

	Composite	Math	Science	Social Studies	Reading & Language Arts
PPE Poorest	2.162** (0.835)	1.171*** (0.313)	0.218 (0.235)	-0.009 (0.202)	0.782*** (0.287)
PPE 2nd Poorest	0.427 (0.552)	0.023 (0.212)	0.225 (0.156)	-0.099 (0.135)	0.279 (0.214)
PPE 2nd Wealthiest	1.902** (0.860)	0.688* (0.353)	0.235 (0.252)	0.381* (0.197)	0.598* (0.320)
PPE Wealthiest	1.226** (0.545)	0.468** (0.212)	0.336* (0.188)	0.148 (0.124)	0.274 (0.228)
R^2 Range (min, max)	(0.668, 0.792)	(0.483, 0.648)	(0.723, 0.800)	(0.737, 0.896)	(0.446, 0.542)

Discussion of Results for Wealth Quartiles

The largest estimated coefficient is on composite test scores for the most economically disadvantaged quartile of districts. Composite test scores for districts with the poorest students appeared to grow nearly 2.2 points for every increase of $1000 in per-pupil expenditure at the 5% significance level. The poorest districts also seemed to have the two largest increases in subject test scores, with math scores growing nearly 1.2 points and reading scores growing almost 0.8 points at the 1% significance level. This suggests that the poorest districts may have seen the biggest overall academic benefits from the funding increases associated with BEP 2.0.

Improvements were concentrated in the math and reading subjects, in keeping with the overall trend in all school districts discussed in the previous section. Each quartile except the second poorest quartile appeared to see an increase in math scores of approximately half a point or larger at a minimum 10% significance level. Both the poorest quartile of school districts and the second wealthiest quartile of school districts appeared to see an increase of more than half a point in reading scores at the 1% significance level and 10% significance level respectively.

Across the board, there was little impact on science and social studies. This was also in keeping with the trends observed for all districts previously. Significance was only observed once for each subject at the 10% significance level. The school districts with the wealthiest students appeared to see an increase in science test scores by approximately 0.3 points, and the second wealthiest school district appeared to see an increase in social studies points by nearly 0.4 points. While there were negative values found for social studies, these estimates had very high p values and thus are not statistically significant.

Significant improvement in test scores was not observed in the second poorest quartile of school districts for any subject or for the composite score. This demonstrates that there is a significantly larger impact of spending on the very poorest districts as compared even to other poor districts. The lack of improvement in the second poorest quartile of districts may be due to decisions to spend more money on non-instructional improvements such as busing or after-school care that may improve student quality of life without directly improving academic performance. The very poorest school districts may not have had this decision-making flexibility. Although individual budgets for each school district were not available for analysis, it is possible that the districts in the second poorest quartile decided to divert resources towards non-academic expenditures that may have had intrinsic value but were not effective in boosting test scores.

Size Quartiles of School Districts

Table 8. Panel Regression Results, by Size Quartiles

	Composite	Math	Science	Social Studies	Reading & Language Arts
PPE Smallest	0.679 (0.510)	0.259 (0.204)	0.250* (0.144)	-0.088 (0.122)	0.258 (0.193)
PPE 2nd Smallest	1.698** (0.820)	0.964*** (0.288)	0.164 (0.269)	0.069 (0.206)	0.501* (0.301)
PPE 2nd Largest	1.916*** (0.716)	0.586* (0.306)	0.340* (0.187)	0.393** (0.170)	0.596** (0.271)
PPE Largest	1.655* (0.885)	0.546 (0.344)	0.398 (0.265)	0.0265 (0.198)	0.685** (0.333)
R^2 Range (min, max)	(0.751, 0.845)	(0.594, 0.682)	(0.710, 0.893)	(0.791, 0.889)	(0.583, 0.688)

Discussion of Results for Size Quartiles

The most significant gains were seen by the midsized school districts. The quartile of school districts with the second largest student population demonstrated significant gains across the board and the second smallest quartile saw significant gains in composite test scores, math, and reading. The second largest quartile also had the biggest estimated coefficient on composite score with approximately 1.9 points of growth at the 1% significance level for every $1000 increase in per-pupil expenditure. This suggests that school districts in the second largest quartile saw the biggest gains in overall performance. The two midsized quartiles were the only quartiles to see growth in math, with the smaller quartile seeing an approximate increase of nearly a full point at the 1% significance level and the larger quartile seeing an increase of slightly over a half a point at the 10% significance level. The second largest quartile also saw an estimated gain of 0.34 points in science at the 10% significance level and approximately 0.39 points in social studies at the 5% significance level. Both midsized quartiles saw gains in reading of over a half a point at the 10% significance level for the second smallest districts and the 5% significance level for the second largest school districts. Overall, the midsized quartiles saw gains in the most areas.

In contrast, the largest school districts only saw significant improvements in composite scores and reading, and the smallest school districts only saw gains in science. The estimated coefficient for composite test scores in the largest school districts was 1.655 at the 10% significance level, which was smaller and less significant than the corresponding coefficients for the two midsized districts. The coefficient on per-pupil expenditure for the composite score regression was not significant for the smallest school districts. However, the largest school districts did see the largest estimated coefficient on per-pupil expenditure for reading test scores with an estimated value of 0.69 at the 5% significance level. No significant gains were seen in science, social studies, or math for the largest districts. Gains in the smallest school districts were only significant for science with an estimated growth of 0.25 points at the 10% level.

The concentration of improvement within the midsized districts may be a consequence of unique needs for extreme-sized school districts that may not be addressed by a simple funding increase. For example, the smallest school districts may have trouble attracting talent in teachers and administrators without the career appeal of a large school district. Because smaller school districts are also more likely to be rural, they may be unappealing destinations for the most talented instructors. This would limit their access to key instructional resources even if they were recipients of a funding increase.

Similarly, the largest school districts tend to fall in cities like Memphis, Nashville, Knoxville, and Chattanooga, and as such, these districts may face unique struggles. They may face higher administrative costs due to both their size and geographic location. For example, Metro Nashville Public Schools devote a portion of their non-instructional spending to security costs that smaller, rural school districts do not have to absorb. Urban school systems also face pressure to pay teacher salaries commensurate to the higher cost of living intrinsic to cities. Thus, an increase in $1000 of per-pupil expenditure may be more likely to be diverted to non-instructional costs in the largest school districts. This $1000 is also likely to have less real purchasing power due to higher costs of the area.

Analysis

Overall, increases in funding appear to have a positive effect on student performance. The coefficient on spending is positive and significant for all test scores in the panel regression run on all school districts at the 1% level except for social studies. This suggests that increased funding can be an effective tool in improving overall student performance as well subject-specific performance in math, reading, and science in Tennessee public schools.

The most economically disadvantaged quartile of districts had the largest estimated coefficient on per-pupil expenditure for composite test scores. This suggests that the funding increase from BEP 2.0 most benefitted the school districts with the poorest student populations. This carries substantial policy implications as the estimated coefficient on percentage of students eligible for free and reduced lunch programs was negative and very large, indicating that poorer students are likely to perform much worse than their wealthier counterparts. Thus, a funding increase like that employed in BEP 2.0 can be an effective tool in closing this achievement gap. Similar to the findings by Jackson et al., the panel regressions suggest that increases in funding have significant impact for school districts with concentrated low-income populations. The regression results also challenge the narrative in Coleman's assertion that differences in schools do not have an impact on student performance and cannot help close the achievement gap for low-income students.

The largest gains in academic performance across size appeared to be concentrated within the quartiles of school districts with medium-sized enrollment populations. The data suggest that the smallest school districts benefit the least from non-targeted increases in funding, contrary to the narrative advanced by the numerous *Small Schools* lawsuits. While the largest school systems appeared to benefit more than the smallest school systems, they still seemed to benefit less than the midsized quartiles. This finding also counters the current series of lawsuits advanced by some of the state's largest school districts in *Hamilton County Board of Education v. Haslam, Shelby County Board of Education v. Haslam,* and *Metro Nashville Board of Education v. Haslam*. While disparities may exist in these counties, they may need to be addressed by more specific programs to improve academic performance in testable student populations (i.e., not certain types of special needs children) instead of a broad funding increase like BEP 2.0. That approach does not appear to have benefitted testable student populations in extreme-sized districts as much as student populations in mid-sized districts in the past.

Limitations

Only four years of data with consistent test scoring calculations are available over this time period. Consequently, it is difficult to establish parallel trends to examine if the funding changes were the source of changes in student outcomes. This might impair any future efforts to use different modeling strategies attempting to examine trends over a longer period of time. Analysis over a longer period of time would need to appropriately adjust for changes in TCAP scoring methods that took place after the study window of 2005-2009.

Because my analysis employs TCAP scores as the sole measurement of student performance, it depends on the reliability of the TCAP exam as an accurate measurement. However, because all students are measured with the same tests, any inaccuracies are hopefully uniform across the state. This assumption could be threatened if there were biases within the exam that burdened certain student populations more than others if these populations were not evenly concentrated across all districts.

This study does not include analysis of expenditure type but examines the entire amount spent on each pupil. Some subcategories of expenditure may be more effective in improving student performance than overall per-pupil expenditure, which also takes into account such expenses as building maintenance and overall administrative costs. A more granular analysis of expenditure would be necessary to inform any future policy discussions surrounding types of funding increases to determine if certain components of per-pupil expenditure are more effective in improving student performance than others.

It is possible that reading and math are the two academic areas in which student performance is most easily influenced by funding increases. However, it is also possible that math and reading received a disproportionate amount of the funding increases in comparison to other subjects because school districts had discretion in spending the new funds. This would inflate the relationship between overall per-pupil expenditure and student performance in math reading. Without knowing how much money was diverted to each subject, it is difficult to fully ascertain the impact of funding increases on performance on a district-subject level. Thus, the observed growth in math and reading could be potentially mirrored in science and social studies if it is the case that the latter two subjects received a smaller share of the funding increase.

Although uniform graduation rates are not available, the improvement in test scores suggests that increased funding does improve student academic performance. Further research, potentially tracking graduation rates for groups of students and adult outcomes, would be useful to examine if funding increases have benefits beyond immediate improvements in student performance on standardized tests. This analysis would be particularly important for historically underachieving groups such as highly economically disadvantaged populations or minorities.

Appendix

Table A1. Inputs into BEP and Changes in BEP 2.0

Input Name	Explanation	Calculation Method	Change in BEP 2.0
Average Daily Membership (ADM)	Accounts for differences in size of school districts	Average of number of students enrolled in the district on each day school is in session	None
Cost Differential Function (CDF)	Accounts for differences in living costs for teachers, providing higher salaries for teachers in more expensive counties	Index based on ratio of non-governmental wages in the county to statewide average of wages	Goal of eventual elimination following efficacy concerns, currently compensating 20% of CDF
Salaries, Retirement, and Insurance	Compensation for instructor salaries and benefits. Districts may set alternative salary schedules that uses different criteria than that set forth by the state to compensate based on performance, etc.	Salaries are calculated based on a differentiated pay system, compensating based upon training level. Supervising teachers and principals are compensated based on number of supervisees. Additional funding is provided for teachers in areas where teachers are hard to recruit	Greater funding provided for rising health insurance premiums. Increased state share to 70%
Unit Cost	Cost to educate one child in that county. Unit Cost is multiplied by ADM to generate total cost of instruction in county	Based upon three-year weighted average of unit cost of education. It is the sum of individual costs paid by the school to educate each student	None
Fiscal Capacity	Amount the local education agency is expected to contribute to education costs	See below breakdown of TACIR*/GREEN and CBER**/FOX	Switch from 100% TACIR to 100% CBER. Currently use 50% TACIR, 50% CBER

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Table A2. Local Fiscal Capacity Calculation

Factor	TACIR GREEN Model	CBER FOX Model
Factor Weights	Determined by a linear regression model, average amount each factor that contributes to the expenditure budget of each county	Varies based on factor
Property	Property per Pupil. Calculated by finding total appraised value of property in county and dividing by ADM	Estimated average portion of property tax used for education across the state
Sales	Local sales tax base (amount of goods and services taxed) divided by ADM	Portion of the actual sales tax revenues in the county used towards education with adjustments to any rate changes during the year
Per Capita Income	Average county resident's per capita income. Proxy for all other revenue sources (e.g., parental contributions)	None
Industry	Ratio of Residential and Farm Land to Total Land. Measure of a county's ability to levy taxes on non-county residents (industry)	Proportion of estimated value of potential tax revenues on all industrial projects that can be used towards education
ADM	Average Daily Membership divided by total county population to measure funding needs	None

*Figure A1. Formulas for Local Fiscal Capacity**

TACIR GREEM Model Formula

Per Pupil Fiscal Capacity = y-Intercept*
+ β1 x Property per Pupil
+ β2 x Sales per Pupil
+ β3 x Per Capita Income
+ β4 x [Residential and Farm Assessment ÷ Total Assessment]
+ β5 x [ADM ÷ Population]

*β1-β5 are formula weights calculated by the model.

CBER FOX Model Formula

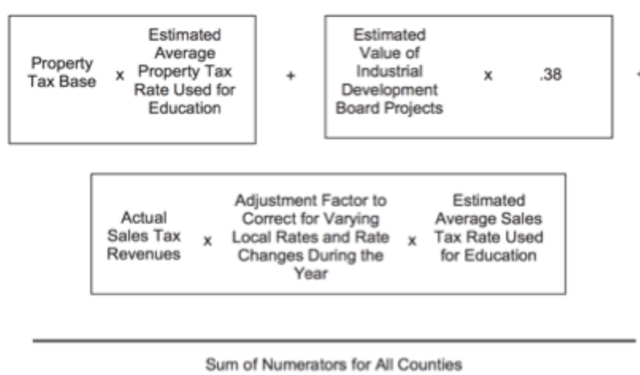

*image taken from Green, H. "Fiscal Capacity and Fiscal Equity"

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