HOW STATE K-12 SPENDING AFFECTS STUDENT LEARNING

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1 Introduction

This paper examines the question of whether increased K-12 public-school spending by states increases student learning. The conventional wisdom is that more spending leads to increased learning through smaller class sizes, higher teacher salaries and thus better retention of good teachers, and more opportunities to explore creative curricula. Still, more spending does not guarantee better student learning if resources are used or allocated inefficiently. My analysis uses eighth grade student test scores on a national standardized reading exam as the dependent variable that measures student learning and examines the effect of state K-12 educational spending on those test scores.

Understanding how K-12 spending affects student performance is crucial in terms of government policy. This is particularly true given that the United States public K-12 educational system is worsening by the year by most standards. U.S. rankings have been continuously dropping in the last few decades relative to other countries (Amadeo). A serious look at the reasons for this drop is urgent so that ways to counter it can be explored. The need to understand the drop is urgent as it is likely to take decades to implement changes and have them take hold. If spending improves student learning, this signals that resources can be successfully devoted towards K-12 education. Alternatively, if spending does not improve student learning, educational spending could be reallocated to better uses.

The paper is organized as follows. Section 2 introduces my theory and the hypotheses that follow regarding the relation between educational spending and student test score results. Section 3 discusses the research design used to empirically obtain results that can be used to test my hypotheses. This includes a presentation of my dependent, independent, and control variables, their sources, and how they are operationalized. These data are utilized in a linear

regression model, the results of which are presented in Section 4. The paper concludes with Section 5 which summarizes the results and discusses limitations of the analysis.

2 Theory and Hypothesis

This section presents the underlying theory that motivates my analysis and specifies the exact hypotheses that emerge from that theory.

2.1 *Theory*

The dependent variable in my analysis is an average of state publicly schooled student reading exam scores. Conceptually, this average is a proxy representing how much students in a state have learned in their public education. By collecting this information at the state level, students' learning in different states can be compared.

Traditionally, a motivating factor for increased spending on education is the idea that more spending on education leads to better student outcomes. Thus, the independent variable in my analysis is per student state spending on K-12 education. Conceptually, this provides a measure of the resources a state devotes to student learning which, if conventional wisdom is correct, should improve student learning.

The causal mechanism linking state K-12 educational spending and student test scores is the is the idea that by devoting more resources to education, students should learn more which should result in better test scores. At first glance, this may seem obvious, however, such a conclusion assumes that the resources are used efficiently and that diminishing returns to educational investment have not set in. The hypothesis tests herein will provide insight into this issue of resource allocation and the success of K-12 state educational spending as a means of increasing student learning.

Confounding my analysis is the presence of other factors that affect student learning. Clearly, family and demographic characteristics can influence student learning and performance. For example, parents in states like Massachusetts and Maryland are on average more affluent and better educated than parents in Tennessee and Mississippi. Thus, we might expect better educational outcomes from the children in Massachusetts and Maryland. It is also well known that Black and Hispanic students do not preform as well on standardized tests are their proteges and hence, racial characteristic might also confound the analysis.

General characteristics of a state like percentage of the state population that is K-12 aged, or party control of the state might also influence student learning. For example, if teachers in a state are unionized, resources that could be used in K-12 learning may instead be diverted to unions and work against student learning by protecting bad teachers. Or pro-school choice states might use K-12 funds towards non-traditional programs and miss out on synergies in traditional public schools (i.e. schools become spread too thinly). It follows that reputable analysis should control for these confounding factors. Section 3 below details these factors and discusses how they are operationalized into control variables.

2.2 *Hypotheses*

The first hypothesis to emerge from my theory is that that increased state spending per student on K-12 education leads to higher test scores than does lower government spending. Once again, the logic behind this hypothesis is based on the idea that more educational spending fosters better learning environments via smaller classes, attracting and retaining teachers through higher pay, and encouraging curricula innovations. Failure to reject this hypothesis would support this wisdom whereas rejection of the hypothesis might suggest that current spending is

inefficient, may be diverted to rent-seeking behaviors by political supporters, or perhaps that spending has been overly saturated to the level of diminishing returns per dollar.

The second hypothesis I consider is that school funding in Democrat controlled states will earn a greater "return" on educational spending, in terms of test scores, than in non-Democrat run states. I hypothesize this because Democrat states tend to be more supportive of healthcare, housing, and social services for poorer students. Although this type of spending is not directly on schooling, it improves the overall learning environment and is support that should have a positive impact on student success that works in tandem with direct school spending.

3 Empirical Research Design Section

The regression analysis that provides the basis for my hypothesis tests is based on observational data collected from several sources identified later in this section. Data are collected for all 50 of the United States and is cross-sectional. The sample of 50 comes from 2022 data or in the case of population data pulled from the census, it is Census Bureau 2022 forecasted levels based on the most recent 2020 census. All data contains state averages of the variables used in the regression or dichotomous variables constructed based on state characteristics.

The dependent variable (*Score*) in my regression is student test scores on a national standardized reading test. The idea is that these test scores provide a measure of student learning that can be compared across states. I operationalize this idea using publicly schooled eighth grade student scores on a 2022 national standardized reading test. This continuous variable data is available from the National Assessment of Educational Programs (NAEP) and was downloaded from NAEP - test scores. It is worth mentioning that I would have preferred to use

twelfth grade math/science scores, but they are only available as a national average and not by state. I will discuss this further in Section 5 below.

A motivating factor for increased spending on education is the idea that more spending on K-12 education leads to better student outcomes. Thus, my main independent variable is the dollar amount of per-student spending on education the government in each state (*Spend*). Ideally, I would like to perform my analysis using spending at the county or school system level, but the time limitations of this project negated that possibility. These state level data on spending per student are also available from NAEP and were downloaded from NAEP - spending.

Data on the confounding factors discussed in the previous section were also collected. Continuous variables on the percentage of the state population that is Black and the percentage that is Hispanic in 2022 were downloaded from Governing.com and serve as the variables $X_{\%Blk}$ and $X_{\%Hsp}$respectively. The percentage of the state's 2022 population under 18, X_{Age}, was estimated by the US Census Bureau based on the 2020 census and was downloaded from the Census Bureau. Continuous data of per-capita state income (in dollars), X_{Income}, in 2022 was downloaded from the Federal Reserve Bank. All data on percentages is measured in percent terms (not decimals).

Democratic control of a state in 2022 was operationalized using a dichotomous variable, X_{Dem}, based on information available from the National Conference of State Legislatures where a "1" was assigned if Democrats controlled both the state legislature and the Governorship. Union presence in a state is based on data downloaded from National Conference of State Legislatures about whether a state is "Right-To-Work" (*RTW)*. This was operationalized by creating a dichotomous variable, X_{RTW}, with "1" indicating that the state is RTW. Similarly, the number of school choice options in a state is a discrete variable, X_{Choice}, downloaded from

EdChoice. Finally, the level of parent education (*ParentEd*) was measured by the percentage of a state's adult population that had earned a bachelor's degree. It was downloaded from Parent Education.

Table 1 presents summary statistics for the data used in my analysis.

Table 1: Summary Statistics

	Score	*Spend*	*Income*	*%Blk*	*%Hsp*	*Age*	*ParentEd*	*Choice*	*Dem*	*RTW*
Mean	262.5	16,338.5	53,460	10.3	11.9	78.3	34.4	1.5	0.1	0.5
Std Dev	4.6	4,156	7,820	9.5	10.4	1.9	6.0	1.7	-	-
Min	251.7	10,261	39,143	0.4	1.3	72.4	24.1	0.0	0.0	0.0
Q1	259.1	13,322	48,295	3.1	5.1	77.0	30.6	0.0	0.0	0.0
Median	262.9	15,489	52,280	7.1	9.4	78.3	33.8	1.0	0.0	0.5
Q3	265.1	19,171	57,863	14.2	13.8	79.4	36.7	2.0	1.0	1.0
Max	273.1	28261	74,176	37.9	37.9	82.3	50.6	8.0	0.0	1.0
IQR	6	5,849	9,568	11.1	8.7	2.3	6.2	2.0	1.0	1.0
n	50	50	50	50	50	50	50	50	50	50

These data will be used to run a multivariate regression:

$$Y = \beta_0 + \beta_1 X_{Spend} + \beta_2 (X_{Dem})(X_{Spend}) + \beta_3 X_{Income} + \beta_4 X_{\%Blk} + \beta_5 X_{\%Hisp} + \beta_6 X_{Age} + \beta_7 X_{ParcntEd} + \beta_8 X_{Choice} + \beta_9 X_{RTW} + \beta_{10} X_{Dem}$$

where $(X_{Dem})(X_{Spend})$ is an interaction term, the coefficient on which will allow me to test my second hypothesis. In terms of this regression, my first hypothesis can be represented as $H_0: \beta_1 = 0$, $H_A: \beta_1 \neq 0$. Likewise, my second hypothesis can be represented as $H_0: \beta_2 = 0$, $H_A: \beta_2 \neq 0$.

4 Results

The results from the regression defined above are provided in Table 2.

Table 2: Coefficient Results of Regression Model

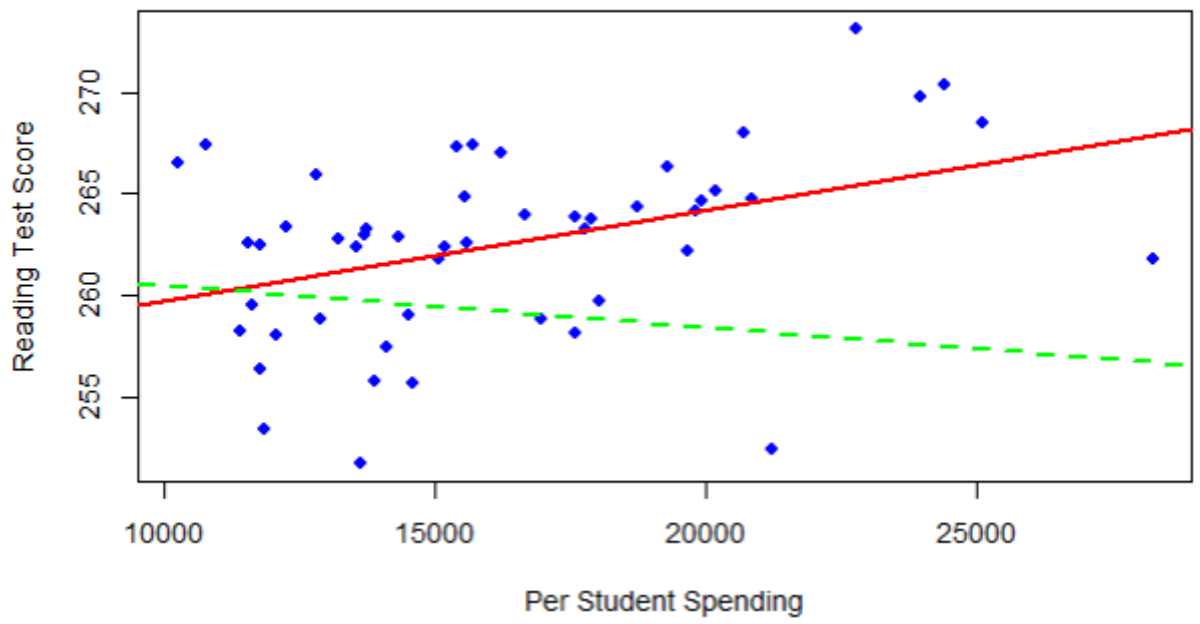
Variables	Model Coefficients (Std. Errors)
Spending	-2.047e-04 (2.1e-04)
Dem*Spending	-9.252e-04 (3.8e-04)*
Income	-0.1382e-04 (1.147e-04)
%Blk	-0.01578 (.0048)**
%Hisp	-0.1699 (0.0044) ***
Age	0.1771 (0.2883)
ParentEd	0.4798 (0.1255)***
Choice	0.6812 (0.2739)*
RTW	1.448 (1.271)
Dem	-1.662e+01 (6.981)*
Constant	230 (22.14)***
n	50
Multiple R^2	0.6908
p-value (for F)	2.769e-07

*** p < 0.001, ** p < 0.01, * p < 0.05, two-tailed.

The results found in Table 1 are interesting. The coefficient on *Spending* is statistically insignificant at the 95% confidence level and therefore I reject my hypothesis that higher K-12 spending levels increase student test scores. Even more surprising is that although the coefficient is statistically insignificant, the substantive effect is negative, the reverse of what was anticipated. Figure 1 more fully examines the substantive effect and highlights the importance of the control variables. The blue points are the scatterplot of K-12 state educational spending versus median state test scores. The red line of best fit was derived without the use of any control variables. It has a clear upward slope, suggesting that higher K-12 state spending on education leads to higher test scores. The green line, however, is based on the regression coefficients in Table 2. It was obtained by evaluating the control variables at their mean values

from Table 1. The slope of the green line is negative, indicative of the surprising substantive effect of K-12 educational spending detailed above.

Figure 1: Scatterplot with Line(s) of Best Fit



Regarding the second hypothesis, the coefficient on the term interacting *Spending* and *Dem* is statistically significant at a 95% confidence level, and I fail to reject it. This is important because the interaction coefficient contributes to the partial effect on *Spending*. Its statistical significance indicates that although spending does not seem to directly affect test scores, it does seem to have an impact in democrat-controlled states where other spending policies create synergies with educational spending.

Although not the dependent variable of interest, there are compelling intuitive interpretations of some control variable coefficients that have political and policy implications for education. First, and sadly, a one-percent increase in Black population in a state lead to a statistically

significant (at the 99% level) 0.01578 decrease in that state's average reading score. Similarly, a one-percent increase in Hispanic population in a state also leads to a statistically significant (at the 99.9% level) 0.1699 decrease in that state's average reading score. Together, these results indicate that although educational spending is not a statistically significant driver of student learning, it could perhaps be better targeted at improving the education of Blacks and Hispanics. Also important is that *ParentEd* was statistically significant at the 99% confidence-level which highlights the long-term gains to current education since better current learning leads to better graduates who are more like to graduate college and thus more likely to have learned progeny.

5 Discussion

The analysis in this paper suggests the idea that higher levels of K-12 spending per student increase student test scores be rejected. This can be attributed to several possibilities including inefficient allocation of funding, funding diverted to special interests, or simply diminishing returns to educational investment. One take away might be that K-12 spending might be effectively reallocated to focus on certain demographic groups, like Black and Hispanic youth who currently appear to have lower levels of learning that the peers. That said, there is evidence that educational spending in Democrat controlled states does positively affect test scores, possibly through synergies between other Democrat social spending programs that benefit lower income children, thus improving their learning environment.

Despite the intuitively appealing results, there are substantial limitations to this research that should be confronted by future research. To begin, the data used in this analysis is only at the state level, yet decisions about how to spend funds are often delegated to the county or school district. The analysis performed here would surely be more robust and accurate if done at that micro level and it appears that such data is available, given enough time and resources to collect

it. Another shortcoming is that educational decisions and implementations happen over time, yet this project only utilized cross-sectional data from 2022. Once again, time-series data are available and could be used to construct a more informative panel data set. Finally, the test scores I was able to obtain were only available at the state level for eighth grade reading. It would be preferable to use twelfth grade scores to fully capture what was learned throughout a student's time in public education.

6 Works Cited

Amadeo, Kimberly. "U.S. Education Rankings Are Falling behind the Rest of the World." *The Balance*, The Balance, 10 July 2024, www.thebalancemoney.com/the-u-s-is-losing-its-competitive-advantage-3306225#:~:text=Comparing%20Test%20Scores,-The%20Program%20for&text=around%20the%20world.-,The%20U.S.%20placed%2016th%20out%20of%2081%20countries%20in%20science,Singapore%3A%20575.