The Cost of the Cap: The Impact of Education Expenditures on Graduation Rates

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Abstract

As a result of the Coleman Report in 1966 and subsequent research, policy makers have struggled to understand the impact of instruction expenditures on education outcomes. This paper makes use of local expenditure data and both local and federal matriculation data from five counties in Illinois and Indiana. With these data, I estimate the impact of per-pupil instruction expenditures on graduation rates using district and year fixed effects in an OLS model. I also estimate a two-stage least squares model based on the work of Jackson et al. in 2015. This research suggests that increasing per-pupil instruction expenditures by 10% would lead to an increase in graduation rates between 1.5% and 3.6% in these districts.

Since the Civil Rights Movement, researchers and policy makers have struggled with the question of how to address inequality in public education. In response to the Civil Rights Act of 1964, James S. Coleman undertook a nationwide study to determine the extent to which public schools were unequal. The resulting report concluded that "schools are remarkably similar in the way they relate to the achievement of their pupils when the socioeconomic background of the students is taken into account."[1] This finding implied that most students' achievements could be predicted by their socioeconomic background, and this achievement had little to do with the qualities of the schools themselves.

Through the end of the 20th century, the question of how education expenditures impacted school outcomes plagued researchers. Intuitively, policy makers anticipated that they could decrease inequality in education by increasing education expenditures in under-performing schools. Nevertheless, subsequent research in the 1990s confirmed Coleman's initial finding. In his 1996 paper entitled "Measuring Investment in Education," Erik Hanushek found that "variations in resources devoted to schooling are not the primary factor for determining student performance."[2] This result fueled arguments that the public school system had become overrun with administrators and inefficient teachers, and this was the real cause of stagnation and inequality in public schools.

In the early 2000s however, new research indicated that previous findings suffered from numerous analytical problems. This body of work suggested that school finance does matter, and in fact changes in school funding could have large impacts for low-income students. This paper analyzes education expenditure and graduation rate data between 2007 and 2020 to understand the relationship between instruction expenditures and graduation rates. By analyzing granular data from 21 school districts, this research suggests that increasing per-pupil instruction expenditures by 10% would lead to an increase in graduation rates between 1.5% and 3.6%.

1 Background

This field of research has its roots in the Civil Rights Movement of the 1960s. In response to accusations of inequality in public schools, policy makers endeavored to answer the question of how schools differed in their treatment of students. The so-called Coleman Report of 1966 represented the result of this inquiry. Coleman undertook one of the most data driven projects ever in the field of education by analyzing survey data from over 645,000 students.[3] This study revealed extreme segregation and inequality in public schools, and played an important role in both the landmark Supreme Court case *San Antonio Independent School District et al. vs. Rodriguez et al.* and in other major education reform court cases in the 1970s and 1980s.[4] In *Rodriguez*, Justice Stewart wrote that the "system of public education can be fairly described as chaotic and unjust."[5] This quote reflected the inherent inequality in public schools in that era.

[1] Coleman 1966, p. 21
[2] Hanushek 1996, p. 1
[3] Coleman 1966, p. 8
[4] Coleman 1966, p. 1, 21
[5] San Antonio 1972, p. 59

In addition to finding that public schools remained highly segregated, the Coleman Report was notable for what it did not find. The Coleman Report determined that education outcomes were most strongly influenced by the socioeconomic status of students rather than by the level of per-pupil spending. This finding was crucial as numerous courts cited the results of the Coleman Report in their opinions on education inequality cases[6]. These opinions referred to findings from the Coleman Report including that the connection between education expenditures and education outcomes in public schools was hazy at best.[7] These rulings effectively stalled school finance equalization movements in the court system.

In addition to Coleman, Hanushek found a similar result in his 1996 research. There, Hanushek reported that while real per-pupil expenditures had risen by almost 3.5% each year on average, "student performance has at best stayed constant, and it may have fallen."[8] Hanushek thus corroborated that education expenditure changes have little real impact on education outcomes.

While these and other studies reported that education expenditures had little if any relation to education outcomes, this directly conflicted with policy makers' intuitions on how to improve public education. Furthermore, these results did not address the root question of how to improve student achievement in public schools.

New research approached this question from different angles and identified other mechanisms by which spending might impact education outcomes. In 1999, Sandra Black noted that parents valued higher test scores by observing differences in local property tax rates. Black found that school district test scores were positively correlated with local taxes. Similarly, Caroline Hoxby considered the question of how school finance equalizations impacted education expenditures. In her 2001 article entitled "All School District Equalizations are Not Created Equal", she found that when states attempted to equalize education spending due to reforms, they sometimes had unintended consequences on education outcomes. The results consisted of "levelling up" or "levelling down" effects by which school districts caused real per-pupil expenditures to rise or fall depending on their particular funding scheme.

Hoxby contended that these unexpected impacts were the results of school finance equalization being "based on property values, which are *endogenous* to schools' productivity, taste for education, and the school finance system itself."[9] This finding implied that by modifying school funding schemes, school districts were also changing the schools themselves. This quality of schools shifted not just because of the raw funding changes but also as a result of other aspects of the reforms as well.

Hoxby's finding was particularly interesting in that it identified a practical flaw in the assumptions of the Tiebout model of 1965 with respect to education finance. One key assumption of the Tiebout model is that citizens vote with their feet.[10] Implicit in this assumption is that families may move to other school districts in response to changes in school financing schemes. This aspect could in turn change some indices of education outcomes as a result.

This issue gives rise to several paradoxes in education finance. For example, a school district with high per-pupil expenditures might attract under-performing students because of its stronger remedial programs. The entrance of these students into the district could lead researchers to find an incorrect correlation between high education expenditures and lower graduation rates, particularly in a short time frame. Conversely, a wealthy district may lose funding as a result of school district tax changes or other economic factors. As education spending decreases in the district, parents may invest more in tutoring services or even leave the district in favor of private schooling. This pattern could lead researchers to find a spurious correlation between low education expenditures and high graduation rates for the students that remain. Hoxby explains that "households can react to aid by changing their preferred district."[11] As a result, changing the input of school aid could impact the makeup of the district population.

As a result of these correlations, it is extremely difficult to measure the pure impact of school finance reforms. Any increase in school expenditures on students could be correlated with education outcomes, and thus one would need to control for innumerable, unobservable factors to see the pure impact of a spending increase on education.

Despite these endogeneity challenges, Jackson et al. found that increases in school financing did have positive, statistically significant impacts on education outcomes. Here, the authors suggested that as a result of the numerous changes to school finance schemes since the 1970s, any study of student outcomes since 1950 would need to consider whether school finance reforms could bias results.

To address the endogeneity issues, Jackson et al. used a two-pronged approach. First, they structured their sample to include a time period of 30 years with over 15,000 students.[12] The authors amassed a large amount of data that made this possible, and a key aspect of their research was implementing a large set of dummy variables over this time period to control for changes in school spending due to education reforms.[13] This allowed them to track the impacts

[6] See Rodriquez 1977, Texas Education 1972 fn 21, Hart 1974 Section III
[7] Rodriquez 1977 p. 43
[8] Hanushek 1996, p. 13
[9] Hoxby 2001, p. 1, emphasis in original
[10] Hoxby 2001, p. 10; Tiebout 1956, p. 5
[11] Hoxby 2001, p. 10
[12] Jackson et al 2015, p. 2
[13] Jackson et al. 2015, pp. 13-14

of spending changes while controlling for as much endogeneity as possible. Additionally, Jackson et al. employed a two-stage least squares (2SLS) regression methodology. This approach addressed endogeneity in another way by predicting the coefficient on spending based on other exogenous variables first. Then, the model separately estimated the impact of spending on graduation rates.

This paper adds to this body of research by investigating whether Jackson et al.'s methods yield similar results when using local district data rather than national survey data. Using local school district expenditure data, I estimate the impact of an increase in per-pupil instruction expenditures on graduation rates. I first consider this question using federal Department of Education (DOE) matriculation data between 2011 and 2020. Similar to Jackson et al., I examine this relationship in both an OLS and a 2SLS model. Additionally, I review the results of the 2SLS model using school district level graduation rate data as well.

2 Methodology

Similar to Black's work in 1999, I first estimate the basic relationship of interest:

$$ln(grad_{ij}) = \beta_0 ln(PP\_INSTEXP_{ij}) + \beta_1 ln(PP\_STATEREV_{ij}) + \beta_2 ln(PP\_FEDREV_{ij}) + \epsilon_{ij} \quad (1)$$

Here, $grad$ represents the graduation rate of each district i in year j, $PP\_INSTEXP$ represents the per-pupil instruction expenditures for the district, $PP\_STATEREV$ represents the per-pupil revenue the school district received for instruction from the state, and PP_FEDREV represents the per-pupil amount of revenue the district received from the federal government for instruction.

Notably, this equation does not account for the total expenditures of each district. Rather, our primary variables of interest relate to the expenditures dedicated to the instruction of students. Instruction expenditures are comprised of "expenditures for activities related to the interaction between teachers and students. [These] include salaries and benefits for teachers and teacher aides, textbooks, supplies and purchased services. These expenditures also include expenditures relating to extracurricular and cocurricular activities."[14] Instruction expenditures are separate from support expenditures which are provided for the purpose of funding administration and guidance counselors, and they are also separate from capital project expenditures. Similar to instruction expenditures, state and federal revenues are also categorized as either instruction revenues or other types of revenues.

With this structure, we can isolate the impact of the money spent purely on education, rather than money spent on school lunches, bus maintenance, or other expenses not directly related to education. This paper does not consider the impact of other types of expenditures on education outcomes, but this would be an interesting area of future study.

Another exclusion from the equation above is per-pupil instruction revenue from local sources. This avoids issues of collinearity in our sample. Local instruction revenue, state instruction revenue, and federal instruction revenue comprise the total instruction expenditures for each district, and including all three of these variables would lead to collinearity in the estimation.

In addition to an OLS model, I estimate the impacts of per-pupil instruction expenditures using district and year fixed effects, as well as controls for the percentage of the graduating class that is classified as low income, Black, Hispanic, and female. This takes the form of the following equation:

$$ln(grad_{ij}) = \beta_0 ln(PP\_INSTEXP_{ij}) + \beta_1 ln(PP\_STATEREV_{ij}) + \beta_2 ln(PP\_FEDREV_{ij}) + \beta_3 X_{ij} + \alpha_i + year_j + \epsilon_{ij} \quad (2)$$

Here, X_{ij} is a vector of graduating cohort population characteristics, α_i is a vector of district fixed effects, and $year_i$ is a vector of year fixed effects.

In addition to the equations presented above, I also estimate a 2SLS model as described by Jackson et al. This methodology aims to reduce endogeneity between instruction expenditures and graduation rates. To this end, I estimate the following equations in addition to the OLS model:

$$ln(PP\_\widehat{INSTEXP}_{ij}) = \beta_0 ln(PP\_STATEREV_{ij}) + \beta_1 ln(PP\_FEDREV_{ij}) + \epsilon_{ij} \quad (3)$$

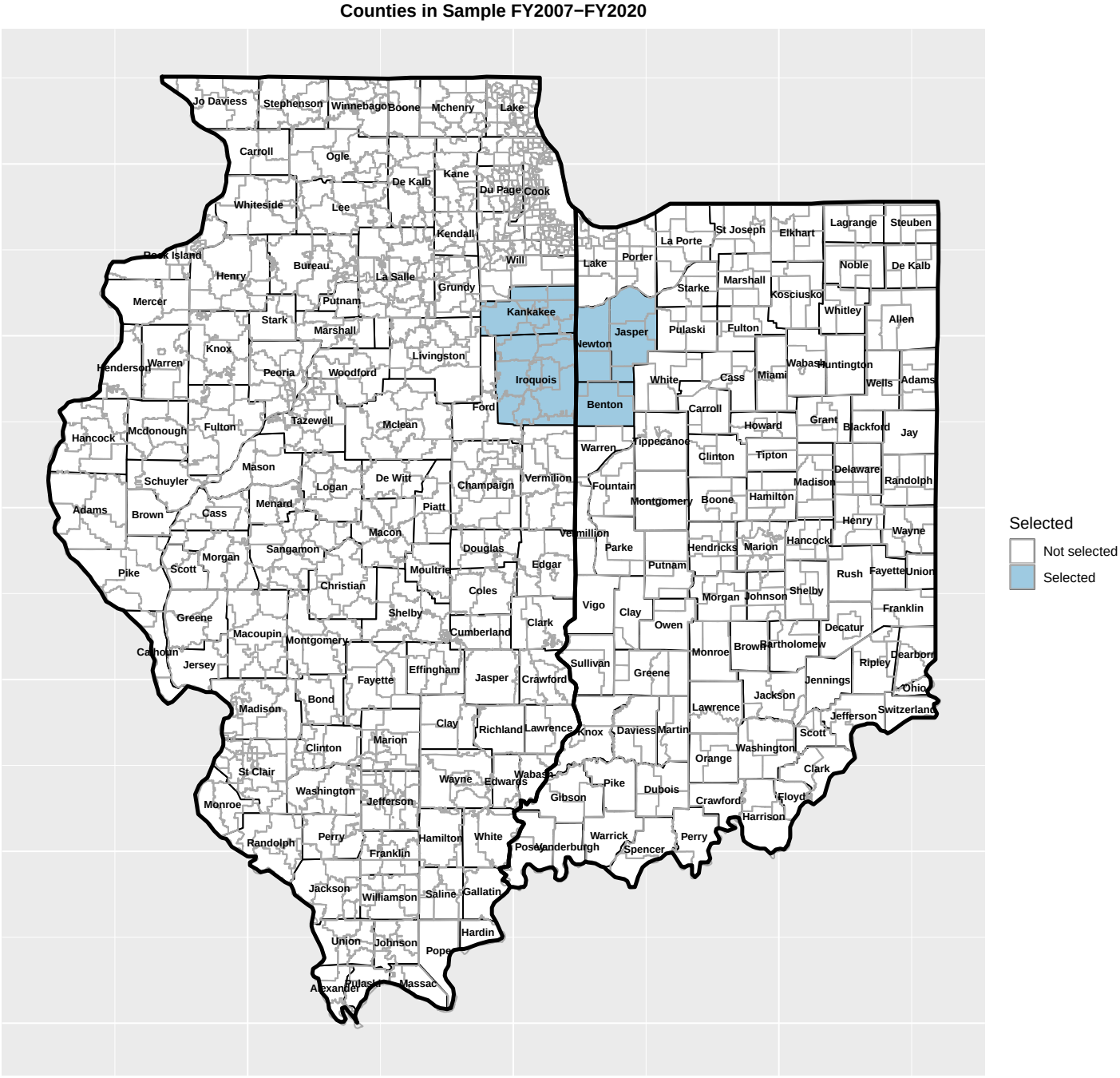
$$ln(grad_{ij}) = \beta_3 ln(PP\_\widehat{INSTEXP}_{ij}) + \beta_4 ln(PP\_STATEREV_{ij}) + \beta_5 ln(PP\_FEDREV_{ij}) + \epsilon_{ij} \quad (4)$$

Here, $PP\_\widehat{INSTEXP}$ represents the per-pupil instruction expenditures predicted by the first stage estimation. Similar to the OLS model, I also estimate equations (3) and (4) using district and year fixed effects.

[14] NCES

3 Data

The Illinois and Indiana State Boards of Education provided the majority of the data to be used in these estimates. Illinois makes detailed school district budgets available to the public starting in 2007, and Indiana completes biennial financial audits of each school district. Each of these audits contains data from two years, which provides a complete panel for each district. My sample contains data from 21 districts in five counties: Iroquois County and Kankakee County in Illinois, and Benton County, Jasper County, and Newton County in Indiana. These counties were selected based on their relative comparability in terms of socioeconomic status, geographic proximity, and lack of proximity to major cities.



In addition to expenditure data, the Illinois and Indiana State Boards of Education also provided district population characteristics. These included the total enrollment of the district, as well as the number of low-income, Black, Hispanic, and female students in each class. From these variables, I create indicators for each classification as a percentage of the total enrollment in each district.

The DOE provided the graduation rate data used in the first part of this analysis. These data were available by school district from 2011-2018, and they provided a granular view and reasonable time frame for my first analysis.

In the second part of this analysis, I use matriculation data from the Illinois and Indiana State Boards of Education. Illinois provided graduation cohort information by county, and because this wasn't as granular as the DOE district level data, it didn't offer as precise coefficient estimates. Furthermore, the Indiana State Board of Education provided graduation rates at the district level only as recently as 2014, and this short time period didn't provide as much confidence in the results. Nevertheless, the second part of this analysis makes use of this limited district level data from 2007-2020 to estimate suggestive impacts of instruction expenditures on locally reported graduation rates.

The following table presents summary statistics for my sample at the district level. All enrollment variables reflect the size of the entire school district. Notably, there is a very wide range of instruction expenditures and total enrollment sizes in our sample. Expenditures are positively correlated with total enrollment in each district, so this is an effect of some school districts being larger than others.

Table 1: Summary Statistics

	Mean	S.D.	Min	Max
Per-pupil instruction exp.	$5,125.72	$770.86	$3,749.99	$7,069.41
Per-pupil local revenue	$3,130.02	$2,084.04	$42.78	$6,842.75
Per-pupil state revenue	$4,344.70	$1,735.15	$1,419.96	$7,008.24
Per-pupil federal revenue	$756.00	$556.53	$166.19	$3,141.22
Total enrollment	1,685	1,515	278	6,015
Grad rate	85.99%	7.31%	55.00%	95%
Percent Black	6.54%	13.03%	0%	56.19%
Percent Hispanic	10.78%	8.57%	1.93%	33.78%
Percent low income	49.39%	16.82%	3.25%	97.09%
Percent female	50.70%	1.85%	46.78%	55.05%

Another point of interest is the Percent low income variable. This variable ranges from 3.25% to 97.09%. One of the key questions for this research is to determine how education finance impacts outcomes for low income students, and with this range, we would expect to see different outcomes for low-income students.

4 Results

Given this data structure, I estimate the results of equations (1) and (2) using federal graduation rate data in Table 2 below. Here, I use an OLS regression to see the effects of the log of per-pupil instruction expenditures on the log of graduation rates. The first three columns of Table 2 reflect the impact of instruction expenditures while varying our use of control variables. When using all control variables, we find that increasing education expenditures by 10% increases graduation rates by 1.5%.

Nevertheless, when I include fixed effects in this equation, the only statistically significant coefficient is on the percentage of low-income students. This result suggests that once socioeconomic status is considered, other variables have less explanatory power over the impact on education outcomes. This comports with Coleman's finding, and this result can be replicated with a relatively small sample. These results mirror Jackson et al.'s results using an OLS methodology as well.[15]

Following Jackson et al.'s work, I estimate equations (3) and (4) using a 2SLS approach, again using federal graduation rate data. The results of these regressions are given in Table 3.

When the regression is completed in two stages, instruction expenditures are strongly explained by state and federal revenues. Per-pupil instruction expenditures are in fact collinear with state and federal revenues unless other explanatory variables are considered. This result is reasonable as the amount of state and federal revenue is likely endogenous with the total enrollment and the percentage of low-income students. In contrast, instruction expenditures also account for revenue from local sources which are determined by each district's funding scheme. Therefore, instruction expenditures reasonably become non-collinear once I apply total enrollment and the percentage of low-income students as instruments. Additionally, state and federal revenues appear to have negative impacts on graduation rates in some versions of the regression. I hypothesize that this may be a result of increased state and federal spending on low-income districts.

[15] Jackson et al 2015, p. 65

Table 2: OLS Regressions - Dependent Variable ln_grad_rate

	No Fixed Effects			**Fixed Effects**		
	(1)	(2)	(3)	(4)	(5)	(6)
Per-pupil instruction exp.	−0.0153	0.0253	0.149**	−0.0569	−0.0165	0.151
	(0.0546)	(0.0529)	(0.0717)	(0.0889)	(0.0894)	(0.112)
Per-pupil state rev.	−0.0122	0.0214	−0.0408	0.125*	0.0971	0.0818
	(0.0151)	(0.0169)	(0.0284)	(0.0673)	(0.0659)	(0.0788)
Per-pupil federal rev.	−0.0840***	−0.0520***	−0.000577	−0.0246	−0.0271	−0.0723
	(0.0148)	(0.0162)	(0.0303)	(0.0215)	(0.0211)	(0.0458)
Total enrollment		2.93e−06	1.13e−05**		−6.07e−05	−5.83e−05
		(4.34e−06)	(5.17e−06)		(0.000123)	(0.000151)
Percent low-income		−0.230***	−0.107*		−0.279**	−0.329**
		(0.0539)	(0.0606)		(0.110)	(0.127)
Percent Black			−0.409***			0.0590
			(0.115)			(0.873)
Percent Hispanic			0.128			−0.249
			(0.127)			(0.478)
Percent female			−0.238			−0.388
			(0.445)			(0.585)
Constant	5.224***	4.501***	3.665***	4.011***	4.170***	3.691***
	(0.464)	(0.483)	(0.615)	(0.674)	(0.755)	(1.286)
Observations	144	144	104	144	144	104
R-squared	0.277	0.367	0.511	0.697	0.719	0.724

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 3: 2SLS Regressions - Dependent Variable ln_grad_rate

	No Fixed Effects			**Fixed Effects**		
	(1)	(2)	(3)	(4)	(5)	(6)
Per-pupil instruction exp.			0.0142		0.191	0.413
			(0.246)		(0.337)	(0.663)
Per-pupil state rev.	−0.0111	0.0187	−0.0488	0.105*	0.0276	0.0185
	(0.0145)	(0.0159)	(0.0321)	(0.0595)	(0.131)	(0.193)
Per-pupil federal rev.	−0.0864***	−0.0491***	0.0157	−0.0276	−0.0389	−0.107
	(0.0120)	(0.0151)	(0.0434)	(0.0209)	(0.0280)	(0.0930)
Total enrollment		3.18e−06	1.27e−05**		−7.43e−06	1.17e−05
		(4.30e−06)	(6.03e−06)		(3.88e−05)	(3.23e−05)
Percent low-income		−0.225***	−0.122*		−0.341***	−0.413**
		(0.0526)	(0.0668)		(0.116)	(0.198)
Percent Black			−0.439***			0.113
			(0.122)			(0.906)
Percent Hispanic			0.230			−0.456
			(0.222)			(0.745)
Percent female						−0.628
						(0.799)
Constant	5.100***	4.718***	4.658**	3.725***	3.032*	1.933
	(0.136)	(0.164)	(2.023)	(0.504)	(1.699)	(3.536)
Observations	144	144	104	144	144	104
R-squared	0.277	0.366	0.489	0.696	0.719	0.717

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Both with and without fixed effects in the model, I find that spending has a non-statistically significant impact on graduation rates. In fact, per-pupil instruction expenditures are not significant in any version of the 2SLS model.

Furthermore, as I add more explanatory variables to the estimation, only the percentage of low-income students remains statistically significant with regard to graduation rates.

Similar to both Coleman's and Hanushek's findings, this indicates that instruction expenditures do not have a statistically significant impact on graduation rates. Notably, the significance of the percentage of low-income students is again suggestive of Coleman's result that the socioeconomic status of students is a strong predictor of education outcomes.

In an effort to more accurately simulate Jackson et al.'s analysis, I also use local district matriculation data to estimate the impact of instruction expenditures on graduation rates. Jackson et al.'s dataset was large enough such that the authors were able to see long term impacts of spending on graduation rates. Making using of local district data allows me to expand my sample period to 2007-2020 for most school districts, and this reveals stronger impacts of spending. I estimate the results of equations (3) and (4) using local graduation rate data in Table 4 below:

Table 4: 2SLS Regressions - Dependent Variable ln_grad_rate

	No Fixed Effects			**Fixed Effects**		
	(1)	(2)	(3)	(4)	(5)	(6)
Per-pupil instruction exp.			−0.247		0.381*	0.365*
			(0.202)		(0.224)	(0.204)
Per-pupil state rev.	0.0239	0.00904	0.0174	0.0201	−0.0732	−0.102*
	(0.0154)	(0.0175)	(0.0471)	(0.0210)	(0.0550)	(0.0566)
Per-pupil federal rev.	−0.0227**	−0.0372***	0.0336	−0.0125	−0.0431*	−0.0401
	(0.00995)	(0.0129)	(0.0384)	(0.0120)	(0.0259)	(0.0309)
Total enrollment		−2.54e−06	−5.78e−06		−5.27e−05***	−9.91e−05***
		(4.04e−06)	(5.47e−06)		(1.72e−05)	(3.67e−05)
Percent low-income		0.0828*	0.166**		−0.250**	−0.0521
		(0.0451)	(0.0674)		(0.112)	(0.0889)
Percent Black			−0.127**			−0.506**
			(0.0644)			(0.226)
Percent Hispanic			−0.104			0.410
			(0.152)			(0.313)
Percent female						−0.554
						(0.339)
Constant	4.415***	4.596***	6.169***	4.334***	2.350*	3.216***
	(0.115)	(0.153)	(1.261)	(0.188)	(1.295)	(0.999)
Observations	204	204	176	204	204	176
R-squared	0.027	0.045	0.080	0.828	0.839	0.854

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

As in Table 3, the per-pupil instruction expenditures coefficient is collinear with state and federal revenue until other metrics are considered. Interestingly however, when I estimate the coefficient using Jackson et al.'s methodology including all control variables and fixed effects using the 2SLS regression, per-pupil instruction expenditures have a statistically significant impact of a 3.6% increase on graduation rates for every 10% increase in per-pupil instruction expenditures. This is somewhat lower than Jackson et al.'s lower bound estimate of a 4% increase on the graduation rates of low-income students for every 10% increase in spending.[16]

While this result is questionable due to my data limitations, it comports with Jackson et al.'s estimate and indicates that instruction expenditures do have a positive impact on graduation rates. This implies that when endogeneity is addressed within the model and the sample is large enough, the impact of spending on graduation rates becomes clear and follows policy makers' intuition.

Notably, the estimation results also indicate that the percentage of Black students in each district has a statistically significant negative impact on the graduation rate. I hypothesize that this is the result of correlation between the percentage of low-income students and the percentage of Black students in my sample. The percentage of low-income students in each district is a strong predictor of the graduation rate both in other versions of this regression as well as in other research in this field, and I find a positive correlation between the percentage of low-income students and the percentage of Black students. This suggests that were these variables not correlated in a larger sample, the percentage of low-income students would be a more accurate predictor of graduation rates than the percentage of Black students.

[16] Jackson et al. 2015, p. 26

5 Conclusion

Since the publication of the Coleman Report in 1966, policy makers have questioned the impact of education finance on education outcomes. In the early 2000s, Researchers such as Sandra Black and Caroline Hoxby emphasized that the original research on this topic was flawed due to endogeneity issues in the early 2000s. In attempting to measure the impact of spending, researchers neglected to consider that graduation rates might be endogenous with the amount of spending on students' educations.

New research used district fixed effects and instrumental variables to address endogeneity and to control for variation in school districts. This revealed a positive correlation between spending and education outcomes which was further developed by Jackson et al. in 2015. Using a 2SLS estimation technique, Jackson et al. found a positive correlation between education expenditures and graduation rates among other indices of school quality.

Using a 2SLS model with fixed effects, I estimated similar results to Coleman using DOE matriculation data, and similar results Jackson et al. drawing on local instruction expenditure data. This research suggests that with a larger sample using school district, these methods would reveal a positive correlation between instruction expenditures and graduation rates. This finding could have lasting education reform implications for local school districts, counties, and states.

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