# More Money More Progress? School Improvement Grants and Educational Success in Struggling Public Schools

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**Abstract**

School Improvement Grants (SIG) gave some of the United States' most poorly performing schools a second chance at success by infusing them with a major investment of new capital. However, evaluations of the SIG program have found its effectiveness to have been mixed. This paper uses variation in the amount of per-pupil grant dollars awarded to different schools to investigate the important impact that grant size had on the effectiveness of SIG, finding that larger grants led to greater improvements in educational outcomes, but also led to changes in school demographics.

## 1 Introduction

The benefits that quality and quantity of education bring to students are well established and include reduced likelihood of living in poverty, higher adult income (Chetty et al. 2011), and even extend to improved later in life health outcomes (Hahn & Truman, 2015). Furthermore, education spending accounts for more than 8% of total government expenditures in the United States (U.S. Office of Management and Budget, 2018), making the evaluation of educational expenditures a highly relevant topic for policymakers. Because of how effective education is at producing meaningful improvements in individuals' lives and what a sizeable portion of governmental expenditures are embodied by education spending, evaluating the returns of school expenditures is an extremely important topic in the realms of education, economics, and public policy. This paper evaluates the impact of increasing per-pupil funding at some of the United States' most poorly performing public schools by utilizing differences in the timing and size of School Improvement Grants (SIG) awarded over the years 2010-2014. This paper's findings indicate that when schools receive an increase in funding, school test scores increase as a result.

In order to shed light on the mechanisms by which increases in school funding lead to increases in test scores, this paper utilizes school-level enrollment, teaching staff, and student demographic data, as well as district-level financial data to show that increases in funding from SIG receipt are associated with increased total revenues and expenditures, increased number of teachers, and may be associated with increased teacher-student ratios.

Early work on this topic was done by Coleman (1966) and later reviewed by Hanushek (1986), concluding that educational outcomes are largely not improved by increases in school spending. Coleman finds that test scores are mostly determined by variation in family characteristics, rather by variation in school spending. However, Bowles and Levin (1968), Cain and Watts (1970), and Mosteller and Moynihan (1972) brought into question the results of Coleman by criticizing his empirical methods.

Since Coleman, the impact of school inputs on students' outcomes has been investigated by a large literature, establishing that class size (Krueger, 1999; Angrist and Lavy, 1999; Hoxby, 2000; Krueger and Whitmore, 2001; Chetty et al., 2011), and spending (Cellini, Ferreira, and Rothstein, 2010; Martorell, Stange, and McFarlin, 2016; Hong and Zimmer, 2016) produce meaningful improvements in student outcomes. Card and Payne (2002) find that equalization of school spending leads to a narrower gap between test score outcomes across family background groups. Similarly, Jackson et al. (2021) finds that cohorts exposed to spending cuts have lower test scores and college-going rates.

## 1.1 Background on the School Improvement Grant Program

The SIG program was established in 2001 by Title I section 1003(g) of the Elementary and Secondary Education Act. SIG consisted of approximately $500 million of annual formula-based grant funding that was distributed proportionately to states based on each state's number of students residing in impoverished households. State education agencies would then distribute this funding to school districts which, so long as they contained one or more SIG-eligible schools, could apply to receive SIG by submitting a plan of implementation for how the school district's grant funding would be distributed and spent among each of the district's SIG-eligible schools. A school's eligibility for the receipt of SIG is determined by three tiers, called Tier I, Tier II, and Tier III. Tier I and II schools consist of schools which are currently eligible to receive Title I federal aid, and score at or below the 5-th percentile (with regard to state standardized test scores) of all Title I-eligible schools in the same state. Tier III schools also must be eligible to receive Title I aid, but need not satisfy the 5-th percentile or below cutoff noted above. States were required to prioritize SIG funds for Tier I and II schools over Tier III schools; and in practice, Tier III schools rarely received SIG.[1]

In 2009, with the passage of the American Recovery and Reinvestment Act, the US Department of Education received an unprecedented, one-time increase in funding of $3 billion for the SIG program, which was distributed to SIG-eligible schools in two waves over the 2010-2011 through 2013-2014 school years. The first wave, called "cohort 1," was

[1] Over 91% of SIG funds distributed in the 2010-2014 period (the period of SIG funding examined by this paper) were distributed to schools classified as Tier I or II.

distributed over the years 2010-2013. The second wave, called "cohort 2," was distributed over the years 2011-2014. The sudden funding increase of $3 billion increased available SIG dollars six-fold for SIG-eligible schools. This $3 billion of SIG funding is the variation that I use to identify my results in this paper.

In addition to receiving an increase in funding over three years, schools that received SIG also were required to undergo one of four school-level interventions, which would require schools to overhaul their school governance and faculty; resulting in the replacement of the principal in most cases, and the replacement of at least 50% of teaching staff in about a quarter of cases. These interventions were called the Turnaround Model (replace principal, replace 50% or more of teachers), the Transformation Model (replace principal), the Restart Model (convert school into a charter school), and School Closure Model (close school and move students to other schools in school district).[2]

The positive impact of SIG on school performance in specific geographic subsets of schools (i.e. schools in a single state, schools in a single school district, or schools in a single city) has been documented by numerous papers. Carlson & Lavertu (2018) find that SIG receipt improved math and reading scores by 0.2 standard deviations on average in Ohio schools that received SIG. Penner & Loeb (2017) find that SIG improved test scores at SIG-receiving schools in the San Francisco Unified School District. LiCalsi et al. (2015) find that SIG improved school performance in Massachusetts. Dee (2012) finds that SIG improved school performance in California. However, Dragoset et al. (2017) use a fuzzy regression discontinuity design over a set of schools from over 20 states to show that SIG receipt is not statistically significantly associated with improved student outcomes among schools at or near the 5-th percentile cutoff for high SIG eligibility (though the sign of their estimates is positive).

## 2 Data

This paper relies primarily on panel data at the school-by-year level, though some supplementary analysis is done at the district-by-year level regarding school finances, which are not available at the school level. This paper's primary data providers are the National Center for Education Statistics' CCD (Common Core of Data), and the State Education Agencies of California, Massachusetts, Louisiana, and Illinois. From the CCD, this paper uses school by year level data on math and reading proficiency scores (the percent of students at a given school that scored proficient or higher on their state's standardized test), enrollment counts, demographic statistics (share white, share black, share Hispanic, share nonwhite), and teacher counts (number of full-time equivalent teachers). CCD data on demographic information and teacher counts have national coverage, and extend back to time periods

[2]Note that the School Closure Model was almost never implemented, accounting for fewer than 1% of SIG interventions.

over a decade before the initial 2010 roll-out of School Improvement Grants. However, CCD data on school proficiency scores only extend as far back as 2009 in the case of math scores, and 2008 in the case of reading scores. Since the School Improvement Grants distributed as parts of cohorts 1 and 2 were distributed beginning in 2010 and 2011 respectively, math and reading scores from the CCD only include, at best, two to three years of pre-treatment data. This lack of pre-treatment data from the CCD motivates a need for data on proficiency scores that extend further back in time. From the State Education Agencies of California, Massachusetts, Louisiana, and Illinois, proficiency scores for math and reading were gathered at the school-by-year level extending to years 2004 and later.

## 2.1 Data on SIG Receipt

Data on cohort 1 and 2 SIG receipt, as well as number of SIG dollars received, were obtained from the Department of Education. The sample of schools used in this paper's analysis are the 2,979 schools that were classified as Tier I or II SIG-eligible schools in the 2010 (cohort 1) or 2011 (cohort 2) SIG eligibility periods, and for which the amount of SIG received by that school is not missing in the Department of Education's SIG dataset (there are 117 Tier I/II schools whose amount of SIG received, be it zero or nonzero, is not reported; these schools are not included in this paper's analysis). Of these 2,979 schools, 1,193 received SIG. Of the total 2,979 schools I use for this paper's analysis, there are 300 lower schools of which 175 received SIG, 497 middle schools of which 212 received SIG, 1,237 high schools of which 477 received SIG, 217 mixed lower through high schools of which 51 received SIG, 369 mixed lower/middle schools of which 162 received SIG, and 358 mixed middle/high schools of which 116 received SIG.

To calculate per-pupil SIG dollars received by each school, the total SIG dollars received by a school was divided by that school's 2009 enrollment. While data on SIG receipt in cohorts 3 and 4 are available, these data are limited, and do not include information on SIG tier status, nor on actual amount of SIG dollars received. Due to these limitations, only cohorts 1 and 2 are used in the analysis section of this paper, and observations from schools which later received funding in cohorts 3 and 4 are dropped from the analysis.[3]

## 2.2 Summary Statistics

In table (1), I report means and standard deviations of my outcome variables from the year 2009, which is the final year in my dataset in which no schools have yet received cohort 1 or 2 SIG.

[3]Versions of any of this paper's results generated from a sample of schools that does not exclude cohort 3 and 4 SIG schools are available upon request, and are not meaningfully different from the results reported in this paper.

| | Full Sample | SIG | No SIG |
|---|---|---|---|
| Share Free/Reduced-Price Lunch Eligible | 73.56<br>(22.15)<br>N=1,872 | 77.45<br>(20.13)<br>N=1,167 | 70.89<br>(23.06)<br>N=1,705 |
| Share Non-Hispanic White | 24.21<br>(29.26)<br>N=2,936 | 19.18<br>(26.43)<br>N=1,180 | 27.59<br>(30.56)<br>N=1756 |
| Proficient in Math | 42.29<br>(20.37)<br>N=2,453 | 40.16<br>(19.76)<br>N=890 | 43.50<br>(20.61)<br>N=1,563 |
| Proficient in Reading | 48.72<br>(21.64)<br>N=2,469 | 46.29<br>(21.05)<br>N=895 | 50.10<br>(21.86)<br>N=1,574 |
| Teacher-Student Ratio | .077<br>(.031)<br>N=2,835 | .074<br>(.026)<br>N=1,148 | .080<br>(.034)<br>N=1,687 |
| Total Enrollment | 582<br>(593)<br>N=2,940 | 662<br>(604)<br>N=1,181 | 529<br>(580)<br>N=1,759 |

Standard deviations shown in parenthesis.

Table 1: Summary Statistics

## 3 Methodology

To estimate the impact of SIG on school test scores, this paper's primary analysis uses stacked differences in differences as well as stacked event studies as suggested by Goodman-Bacon (2018), supplemented by basic comparison of means to establish the existence of parallel trends among the treated and control groups. I define the treated group as Tier I and II schools which received a School Improvement Grant(s) in cohorts 1 and/or 2. I define the control group as Tier I and II schools in cohorts 1 and/or 2 that did not receive a School Improvement Grant. The following equation describes this paper's main school-level event study:

$$Y_{ist} = \mu_{is} + \mu_{ts} + \gamma X_{it} + \sum_{\tau=-7,\tau\neq-1}^{8} \gamma_\tau SIG_i \times \mathbb{1}\{\tau = T\} + \varepsilon_{it} \tag{1}$$

where $Y_{ist}$ is the outcome of interest at school $i$ in stack $s$ in treatment year $t$ (treatment year differs from calendar year because cohort 1 schools received SIG beginnning in 2010-2011, whereas cohort 2 schools SIG beginnning in 2011-2012). $\mu_i s$ are school-by-stack level fixed effects. $\mu_t s$ are year-by-stack level fixed effects. $SIG_i$ is the amount of *per-pupil* SIG funding received by school $i$, measured in thousands of dollars.

An identifying assumption of this paper's analysis is that SIG receipt among Tier I and II schools is plausibly exogenous to the outcome variables being examined (test scores, share eligible for federal reduced-price lunch, share non-Hispanic white, teacher-student ratio). The comparison of means graphs in this paper's Appendix section show that school characteristics (test scores, demographics, teacher-student ratios) follow parallel trends among the treated and control groups. Thus, observable characteristics among the treated and control groups do trend alongside each other until the roll-out of SIG, meaning that differences between the treated and control groups are largely fixed at the school level, and can be captured by school fixed effects $\mu_i$.

# 4 Results from National Sample

This section reports results from estimating event study equation (1) over the data I obtained from the CCD. All standard errors shown in the figures in this section are robust, calculated at the 95% confidence level, and are clustered at the level of the school district. First, I show the results from estimating equation (1) over percent proficient in reading, and percent proficient in math.

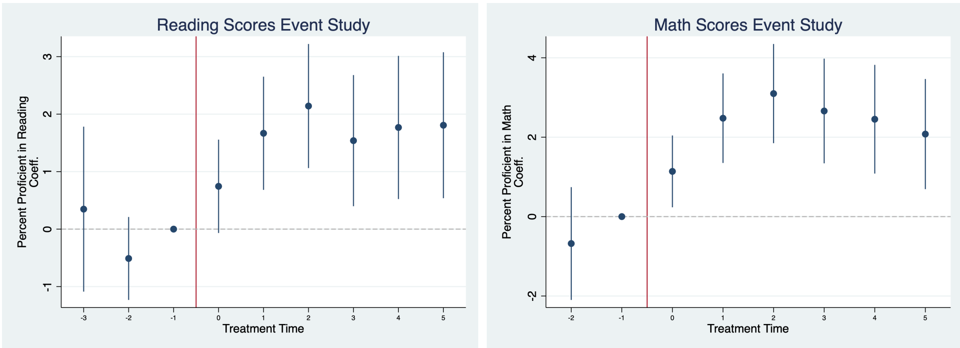


Figure 1: Receipt of a School Improvement Grant Improved Math and Reading Scores

The results shown in figure (1) show that receipt of a School Improvement Grant is associated with an improvement in school test scores by 2 to 3 percentage points relative to Tier I/II schools that did not receive SIG. Next, I estimate the impact of SIG receipt on school demographics.

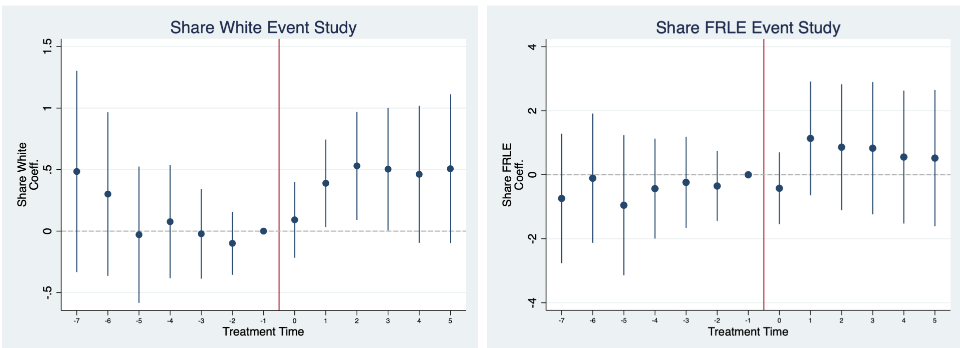


Figure 2: Schools that Received SIG Became, and Stayed Significantly Whiter Compared to Tier I and II Schools that Did Not Receive SIG

The results shown in figure (2) show that receipt of a School Improvement Grant is associated with a significant shift in racial and/or ethnic demographics, with recipient schools becoming significantly whiter in the years immediately following SIG receipt. However, I find no evidence using equation (1) that the economic characteristics of students attending SIG schools changes after a school receives a grant, as can be seen by the lack of any significant coefficients in the event study measuring Share Federal Reduced-Price Lunch Eligible (FRLE). Next, I estimate the impact of SIG receipt on schools' total number of full-time equivalent teachers, and teacher-student ratios.

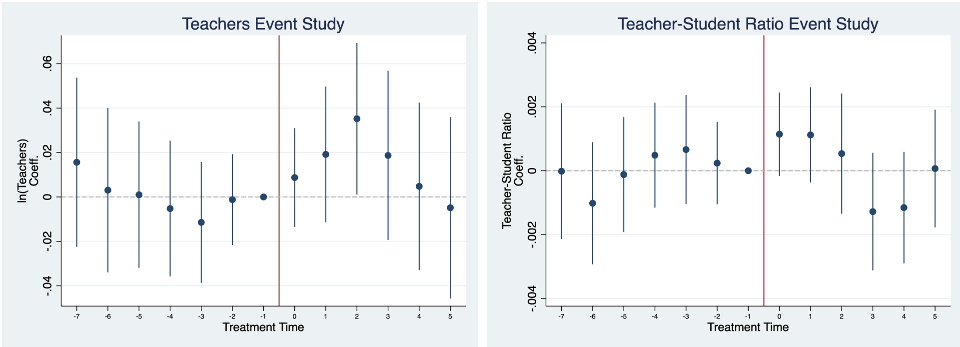


Figure 3: Receipt of a School Improvement Grant Did Not Significantly Change Total Teachers or Teacher-Student Ratios at an Average School that Received a Grant

The results shown in figure (3) show that receipt of a School Improvement Grant is associated with a marginally significant increase in the number of teachers working at an SIG-receiving school, but that on average schools which received SIG did not see a significant increase in their teacher-student ratios in the immediate years following their receipt of SIG.

## 4.1 Event Study Results Stratified by Funding Quartile

In this section I further develop my event study results by re-estimating equation (1) over four subsets of my data. These subsets are (1) the set of schools that received either 0 SIG dollars (i.e. the control group), or received an amount of per-pupil SIG dollars in the bottom quartile in their state, (2) the set of schools that received either 0 SIG dollars, or received an amount of per-pupil SIG dollars in the second-lowest quartile in their state, (3) the set of schools that received either 0 per-pupil SIG dollars, or received an amount of SIG dollars in the second-highest quartile in their state, and (4) the set of schools that received either 0 SIG dollars, or received an amount of per-pupil SIG dollars in the highest quartile in their state. Each of these restricted models estimates the local effect of receiving an SIG award in the X-th quartile in terms of per-pupil funding. On average, the amount of per-pupil SIG dollars received by schools in these quartiles was \$2,233, \$3,561, \$5,612, and \$12,659 respectively. By plotting these restricted models together, I shed light on the intensive margin of SIG receipt. I show a clear positive relationship between per-pupil SIG funding and increases in test scores, and shifts in school demographics.

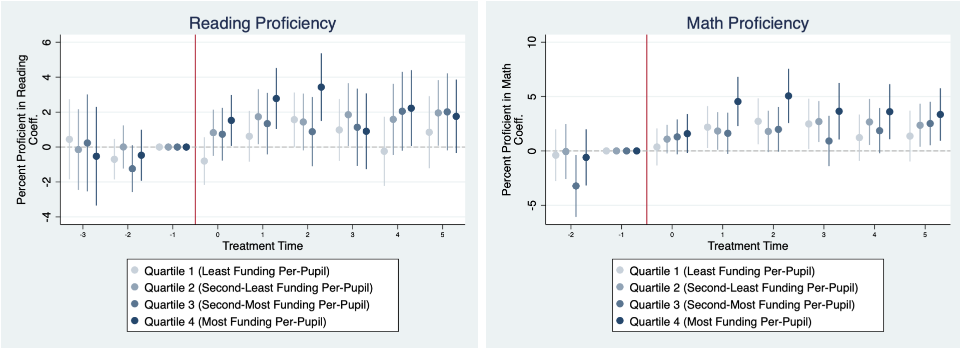


Figure 4: Receipt of a School Improvement Grant Improved Math and Reading Scores

Figure (11) shows a clear relationship between SIG funding quartile, and how successful SIG was at improving test scores. This result is unique to this paper, and to this author's knowledge no other paper has examined the relationship between SIG grant size and SIG effectiveness.

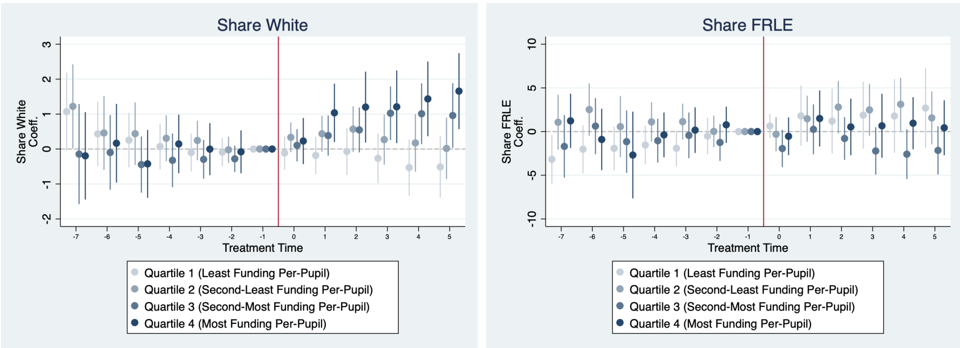


Figure 5: Schools that Received More SIG Dollars Became, and Stayed Significantly Whiter Compared to Tier I and II Schools that Did Not Receive SIG, or Received Fewer SIG Dollars

Figure (5) shows (on the left) that schools which received the most per-pupil SIG dollars saw the greatest increase in share non-hispanic white over time, whereas schools which received very little funding (per-pupil funding quartiles 1 and 2) show no significant impact of SIG receipt on share non-Hispanic white. These results indicate that schools which received the largest per-pupil SIG awards saw either (1) an outflow of nonwhite students following the implementation of their SIG intervention, (2) an influx of white students after the implementation of their SIG intervention, or (3) a combination of (1) and (2).

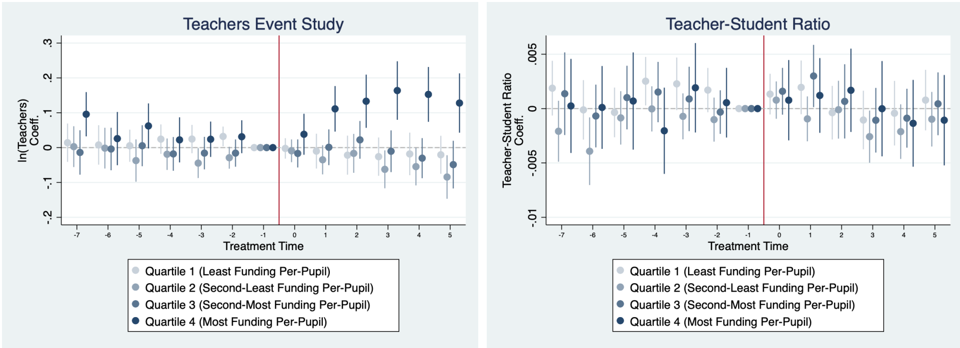


Figure 6: Under Equation (1), Receipt of a School Improvement Grant Significantly Increased the Number of Teachers on Staff, but Did Not Significantly Change Teacher-Student Ratios at SIG Schools Receiving Large (i.e. Highest Quartile) Per-Pupil Grant Amounts

Figure (6) shows that the number of teachers employed at SIG-receiving schools only significantly changed at schools in the top per-pupil funding quartile.

## 4.2 District-Level Finances

The results shown in this section also estimate equation (1), but instead of the subscript $i$ denoting school $i$, it denotes school *district* $i$. This is because financial data are only available from the CCD aggregated at the district level. Hence, my regressions on financial outcomes are done at the level of the school district. In the case of these regressions, the treatment group are school districts containing one or more Tier I/II SIG-eligible schools that received SIG, and the control group are school districts containing one or more Tier I/II SIG-eligible schools, none of which received SIG. As with the school level outcomes, I also report results stratified by quartile of per-pupil SIG funding. Districts with the highest funding show, predictably, the greatest increases in revenue and expenditures as a result of SIG receipt.

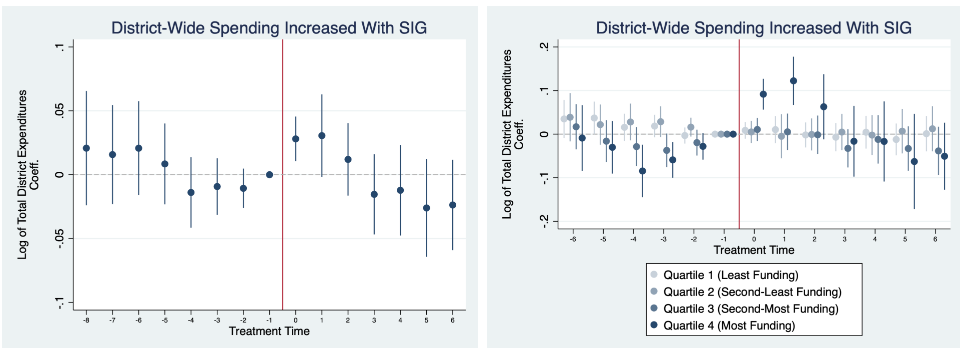


Figure 7: Receipt of a School Improvement Grant Significantly Increased District-Wide Total Expenditures

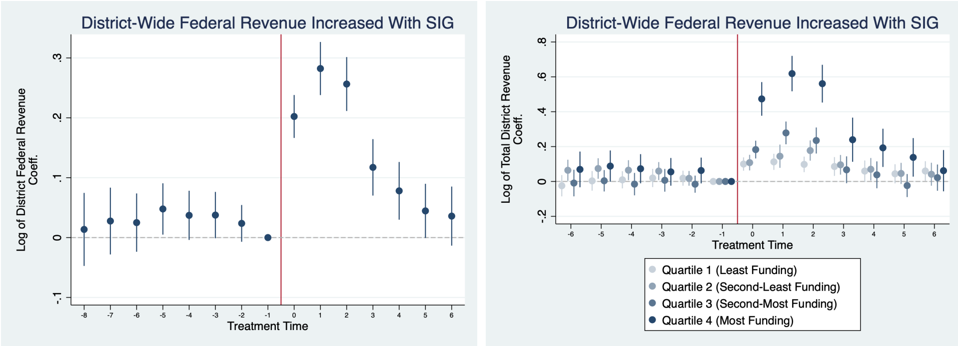


Figure 8: Receipt of a School Improvement Grant Significantly Increased District-Wide Federal Revenue

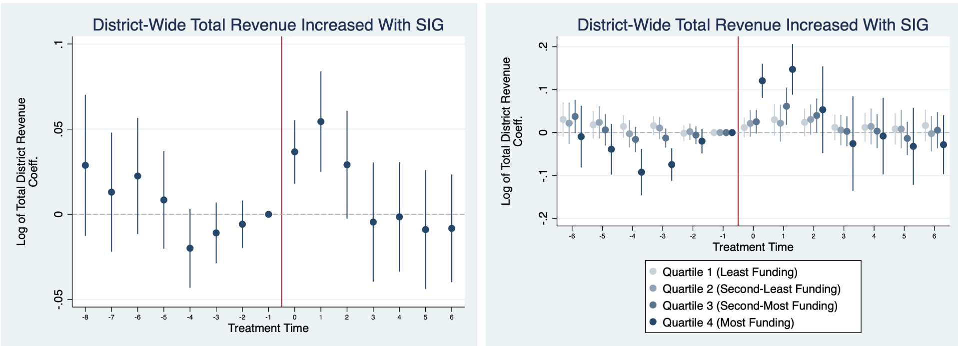


Figure 9: Receipt of a School Improvement Grant Significantly Increased District-Wide Total Revenue

### 4.3 Test Results Restricted to Black Students

I have shown that SIG precipitated a shift in school demographics at schools that received grants, and that this shift was responsive to the size of the grant received. I have also shown similar results with regards to improvements in math and reading test scores. It is possible that the increase in test scores I observe at schools which received SIG was in fact caused by this shift in school demographics. Under such a scenario, receipt of SIG would induce some parents of students from a relatively higher socio-economic background (which is proxied-for by race in this case) to send their children to an SIG-receiving school. If the increases in school-level math and reading proficiency that I have documented in this peper were due to an influx of new students, then my findings could be due to the sorting of new children into SIG schools, rather than an actual improvement in learning for students already attending SIG-receiving schools. To address this concern, I re-estimaste the results shown in figures (1) and (11) on black student proficiency rates, rather than the proficiency rates of all students. These estimation results are shown below:

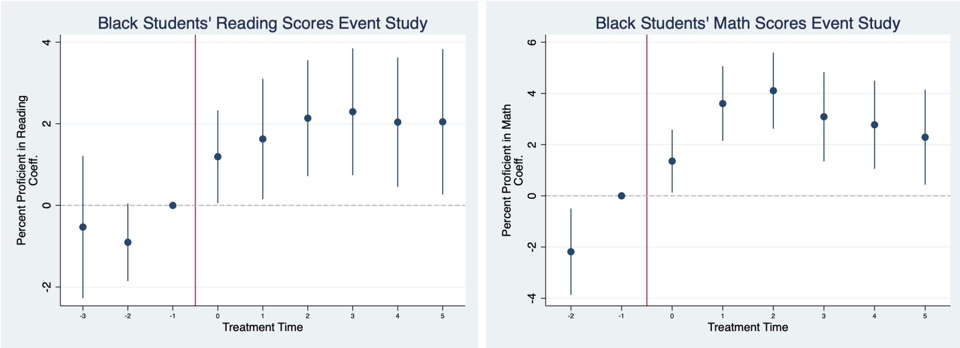


Figure 10: Receipt of a School Improvement Grant Improved Black Students' Math and Reading Scores

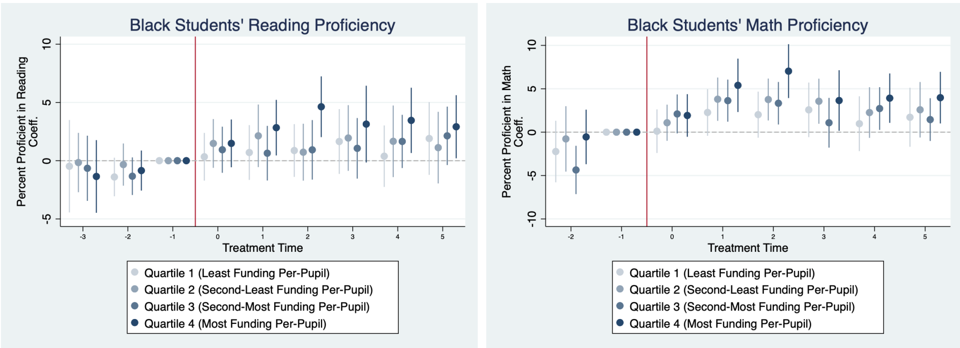


Figure 11: Receipt of a School Improvement Grant Improved Black Students' Math and Reading Scores

# 5 Results from Four State Subsample

In this section, I show results from estimating equation (1) using school-level math and reading proficiency data gathered from the state education agencies of California, Illinois, Louisiana, and Massachusetts. These estimations allow me to re-create Figure (1), but with more than just one or two pre-periods, since these data extend farther back in time than the CCD data. The results are again consistent with my findings that SIG receipt significantly increased math and reading proficiency.

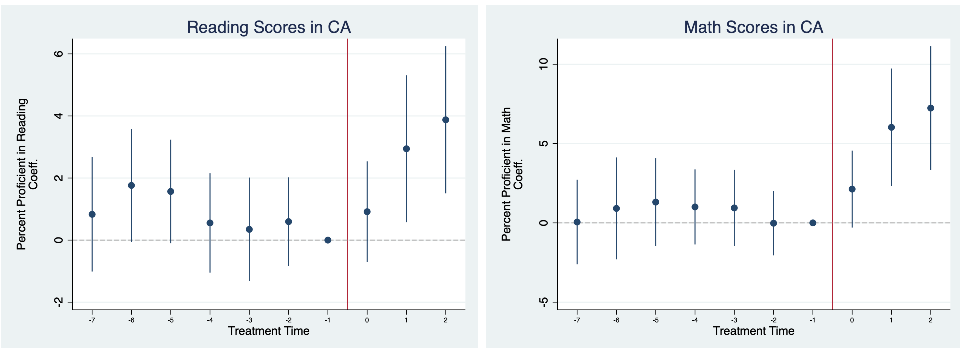


Figure 12: Receipt of a School Improvement Grant Significantly Increased Reading and Math Scores in CA, MA, IL, and LA

There were major changes to these states' testing regimes that occurred in 2013, which resulted in test scores before 2013 not being comparable to test scores after 2013. Because of this change in testing regimes, I am only able to include three post-treatment periods of data in my regressions. Of most importance in the results shown in figure (12) is the fact that there are no apparent pre-trends in the data, which means that SIG receipt was (at least in these four states) not significantly associated with a change in test scores before the rollout of cohort 1 and 2 SIG funding. This helps bolster the believability of the claim that SIG receipt represents an exogenous shock to test scores among SIG-eligible Tier I/II schools.

# 6 Summary Results

## 6.1 Basic Differences in Differences Results

Stacked differences in differences results summarize my findings from the previous two sections. First, I employ the following equation to identify my summary differences in differences results:

$$Y_{ist} = \beta[\text{Post}_{it} \times \mathbb{1}\{\text{RecSIG}\}] + \mu_{is} + \mu_{ts} + \gamma X_{ist} + \varepsilon_{it} \tag{2}$$

where $\mu_{is}$ and $\mu_{ts}$ are school-by-stack and year-by-stack fixed effects. Controls $X_{it}$ contain year fixed effects, state-by-year fixed effects, or state-by-year-by-school level fixed effects (school level is determined by an indicator variable that takes a different value depending on whether a school is a lower school, middle school, high school, mixed lower through high school, mixed lower/middle school, or mixed middle/high school). $\text{Post}_{it}$ denotes an indicator variable that equals 1 in post-treatment years, and 0 in all other years. Observations from never-treated schools (i.e. control schools) are stacked for as many SIG cohorts that school was classified as a Tier I/II school. The estimation results are reported below:

| | Reading | | | Math | | |
|---|---|---|---|---|---|---|
| VARIABLES | (1) | (2) | (3) | (1) | (2) | (3) |
| Post x (Rec. SIG) | 2.204*** | 0.691 | 0.978** | 0.275 | 1.385** | 1.515** |
| | (0.727) | (0.498) | (0.490) | (0.859) | (0.625) | (0.606) |
| Observations | 50,648 | 50,648 | 50,648 | 43,979 | 43,979 | 43,979 |
| R-squared | 0.744 | 0.884 | 0.890 | 0.723 | 0.857 | 0.864 |
| Treatment Time FE | X | X | X | X | X | X |
| School FE | X | X | X | X | X | X |
| State-by-Year FE | | X | | | X | |
| State-by-Year-by-School Level FE | | | X | | | X |

Robust standard errors in parentheses, clustered at the school district level.
*** p<0.01, ** p<0.05, * p<0.1

Table 2: Summary Differences in Differences Results: The Average Treatment Effect of Receiving a School Improvement Grant on Test Scores

The preferred specifications (columns listed (3)) in Table 2 show that both math and reading scores improved at schools which received SIG. On average at schools that received SIG the number of students scoring proficient on reading tests increased by 0.978 percentage points, and the number of students scoring proficient on math tests increased by 1.5 percentage points.

Below, I run the same regressions as estimated in Table 2, but also show results for black students' reading and math scores. Observations are restricted to school-years where observations are available for both overall scores and black students' scores, so these regressions are run over a subset of the overall sample that generate Table 2's results.

| | Reading | | | Reading (Black) | | | Math | | | Math (Black) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABLES | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) |
| Post x (Rec. SIG) | 1.125 | 1.010 | 1.392** | 1.059 | 1.053 | 1.522** | 1.549 | 2.791*** | 2.623*** | 1.493 | 2.477*** | 2.455*** |
| | (0.865) | (0.631) | (0.614) | (0.892) | (0.681) | (0.666) | (1.036) | (0.754) | (0.741) | (1.050) | (0.778) | (0.758) |
| Observations | 30,967 | 30,967 | 30,967 | 30,967 | 30,967 | 30,967 | 26,495 | 26,495 | 26,495 | 26,495 | 26,495 | 26,495 |
| R-squared | 0.749 | 0.890 | 0.898 | 0.705 | 0.855 | 0.865 | 0.712 | 0.865 | 0.873 | 0.668 | 0.830 | 0.840 |
| Treatment Time FE | X | X | X | X | X | X | X | X | X | X | X | X |
| School FE | X | X | X | X | X | X | X | X | X | X | X | X |
| State-by-Year FE | | X | | | X | | | X | | | X | |
| State-by-Year-by-School Level FE | | | X | | | X | | | X | | | X |

Robust standard errors in parentheses, clustered at the school district level.
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Summary Differences in Differences Results: The Average Treatment Effect of Receiving a School Improvement Grant on Test Scores of Black Students as Compared to All Students

The results of the preferred specifications (3) in Table 3 show that Black students' scores improved by similar margins to overall school improvement. Coefficients for overall improvement and black students' improvement are not significantly different.

Below I again estimate equation 2, but for non-testing related variables. The results of this estimation are shown below:

| | Teachers | | | Teach-Stud. Ratio | | | Share FRLE | | | Share White | | | Enrollment | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABLES | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) |
| Post x (Rec. SIG) | -2.305*** | -1.382* | -1.609** | -0.00089 | -0.00046 | 0.00021 | -0.231 | 0.111 | 0.873 | 1.298*** | 0.941** | 0.710* | -50.002*** | -39.199** | -47.108** |
| | (0.764) | (0.775) | (0.814) | (0.00069) | (0.00076) | (0.00073) | (0.680) | (0.668) | (0.672) | (0.389) | (0.388) | (0.383) | (15.281) | (19.242) | (20.482) |
| Observations | 71,801 | 71,801 | 71,801 | 70,025 | 70,025 | 70,025 | 71,080 | 71,080 | 71,080 | 73,880 | 73,880 | 73,880 | 74,204 | 74,204 | 74,204 |
| R-squared | 0.811 | 0.821 | 0.822 | 0.75181 | 0.76874 | 0.77299 | 0.705 | 0.746 | 0.752 | 0.971 | 0.974 | 0.974 | 0.901 | 0.910 | 0.911 |
| Treatment Time FE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| School FE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| State-by-Year FE | | X | | | X | | | X | | | X | | | X | |
| State-by-Year-by-School Level FE | | | X | | | X | | | X | | | X | | | X |

Robust standard errors in parentheses, clustered at the school district level.
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Summary Differences in Differences Results: The Average Treatment Effect of Receiving a School Improvement Grant on School Demographics

The preferred specifications shown in Table 4 are in columns (2). Results shown in Table 4 are difficult to interpret because outcomes were highly heterogeneous by SIG grant amount, which will be adressed in the next section.

## 6.2 Differences in Differences With Quantile of Funding

Below, I define a re-specification of equation (2) that allows for a differential effect of funding. In the following design I use the quartile of per-pupil dollars each school received within their state:

$$Y_{ist} = \delta_1[\text{Post}_{it} \times Q1] + \delta_2[\text{Post}_{it} \times Q2] + \delta_3[\text{Post}_{it} \times Q3] + \delta_4[\text{Post}_{it} \times Q4] + \mu_{is} + \mu_{ts} + \gamma X_{ist} + \varepsilon_{it} \tag{3}$$

Below I report the estimated coefficients of interest $\delta_1$, $\delta_2$, $\delta_3$, $\delta_4$:

| | Reading | | | Math | | |
|---|---|---|---|---|---|---|
| VARIABLES | (1) | (2) | (3) | (1) | (2) | (3) |
| Post x (Quartile 1) | 1.926* | 0.797 | 0.613 | -0.145 | 0.342 | 0.556 |
| | (1.091) | (0.805) | (0.703) | (1.200) | (0.935) | (0.954) |
| Post x (Quartile 2) | 2.098** | 1.168 | 1.258* | 0.035 | 1.610* | 1.881** |
| | (1.065) | (0.721) | (0.697) | (1.219) | (0.860) | (0.788) |
| Post x (Quartile 3) | 2.271** | 0.772 | 0.922 | 0.620 | 1.821** | 1.597** |
| | (1.076) | (0.715) | (0.731) | (1.266) | (0.848) | (0.806) |
| Post x (Quartile 4) | 2.562** | -0.072 | 1.164 | 0.631 | 1.822* | 2.170** |
| | (1.206) | (0.916) | (0.727) | (1.279) | (0.977) | (0.967) |
| Observations | 50,648 | 50,648 | 50,648 | 43,979 | 43,979 | 43,979 |
| R-squared | 0.744 | 0.884 | 0.890 | 0.723 | 0.857 | 0.864 |
| Treatment Time FE | X | X | X | X | X | X |
| School FE | X | X | X | X | X | X |
| State-by-Year FE | | X | | | X | |
| State-by-Year-by-School Level FE | | | X | | | X |

Robust standard errors in parentheses, clustered at the school district level.
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Summary Differences in Differences Results by Quantile of Per-Pupil Funding

Table 5 shows that math scores did not significantly improve at schools which received lowest-quartile SIG funding, as compared to non-SIG-receiving schools. However, schools which received per-pupil funding in quartiles 2 through 4 saw significant improvements in math proficiency, with the highest estimated coefficient seen in quartile 4 (an estimated increase of 2.17 percentage points).

Below, I re-estimate equation (3) over observations that include data for both all students, and for just black students in order to compare results for overall students and black students.

| | Reading | | | Reading (Black) | | | Math | | | Math (Black) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABLES | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) |
| Post x (Quartile 1) | 0.381 | 0.917 | 0.715 | 1.224 | 1.891* | 1.827* | 0.694 | 1.517 | 1.288 | 1.807 | 2.410** | 2.174* |
| | (1.323) | (1.054) | (0.886) | (1.398) | (1.095) | (0.948) | (1.452) | (1.156) | (1.182) | (1.433) | (1.159) | (1.173) |
| Post x (Quartile 2) | 0.917 | 1.847** | 1.872** | 0.320 | 1.240 | 1.344 | 1.880 | 3.772*** | 3.627*** | 1.315 | 2.952*** | 2.854*** |
| | (1.233) | (0.901) | (0.880) | (1.331) | (1.013) | (1.009) | (1.296) | (0.962) | (0.951) | (1.308) | (1.001) | (0.986) |
| Post x (Quartile 3) | 1.651 | 1.239 | 1.378 | 1.148 | 0.895 | 1.089 | 1.837 | 3.123*** | 2.731*** | 1.572 | 2.574** | 2.251** |
| | (1.285) | (0.865) | (0.866) | (1.298) | (0.885) | (0.901) | (1.519) | (0.988) | (0.929) | (1.537) | (1.021) | (0.999) |
| Post x (Quartile 4) | 1.723 | -0.222 | 1.803* | 1.648 | -0.160 | 1.873* | 1.886 | 2.859** | 3.076** | 1.215 | 1.873 | 2.594** |
| | (1.513) | (1.218) | (0.921) | (1.497) | (1.241) | (0.961) | (1.622) | (1.246) | (1.209) | (1.652) | (1.318) | (1.231) |
| Observations | 30,967 | 30,967 | 30,967 | 30,967 | 30,967 | 30,967 | 26,495 | 26,495 | 26,495 | 26,495 | 26,495 | 26,495 |
| R-squared | 0.749 | 0.890 | 0.898 | 0.713 | 0.869 | 0.913 | 0.712 | 0.865 | 0.873 | 0.661 | 0.829 | 0.890 |
| Treatment Time FE | X | X | X | X | X | X | X | X | X | X | X | X |
| School FE | X | X | X | X | X | X | X | X | X | X | X | X |
| State-by-Year FE | | X | | | X | | | X | | | X | |
| State-by-Year-by-School Level FE | | | X | | | X | | | X | | | X |

Robust standard errors in parentheses, clustered at the school district level.

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Summary Differences in Differences Results by Quantile of Per-Pupil Funding, Comparing Black Students and Overall Students

As with the results previously shown in Table 3, proficiency scores improved significantly for both black students and the overall student body. Next, I estimate impacts of SIG by quartile of funding for non-testing related outcomes:

| | Teachers | | | Teach-Stud. Ratio | | | Share FRLE | | | Share White | | | Enrollment | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABLES | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) |
| Post x (Quartile 1) | -4.427*** | -3.999*** | -3.998*** | -0.00057 | -0.00045 | -0.00049 | 4.504*** | 4.708*** | 4.744*** | -0.435 | -0.739 | -0.654 | -95.920*** | -95.639*** | -96.094*** |
| | (1.407) | (1.360) | (1.387) | (0.00081) | (0.00087) | (0.00091) | (1.207) | (1.143) | (1.148) | (0.573) | (0.551) | (0.565) | (35.953) | (34.583) | (35.368) |
| Post x (Quartile 2) | -4.155*** | -3.335*** | -3.541*** | -0.00130 | -0.00079 | 0.00018 | 0.008 | -0.018 | 0.676 | 1.033* | 0.657 | 0.405 | -90.487*** | -81.364*** | -91.008*** |
| | (1.101) | (0.983) | (0.998) | (0.00087) | (0.00094) | (0.00089) | (0.886) | (0.858) | (0.843) | (0.543) | (0.571) | (0.557) | (20.871) | (22.993) | (22.492) |
| Post x (Quartile 3) | -1.694** | -0.648 | -0.757 | -0.00037 | 0.00015 | 0.00079 | -2.246** | -1.819** | -1.124 | 2.115*** | 1.788*** | 1.518*** | -36.146** | -23.483 | -26.519 |
| | (0.860) | (0.935) | (0.982) | (0.00102) | (0.00107) | (0.00105) | (0.982) | (0.887) | (0.875) | (0.515) | (0.512) | (0.514) | (14.134) | (21.504) | (22.795) |
| Post x (Quartile 4) | 1.453* | 2.957*** | 2.710*** | -0.00139 | -0.00078 | 0.00040 | -3.418*** | -2.730*** | -1.291 | 2.572*** | 2.177*** | 1.791*** | 29.680** | 52.937** | 41.144 |
| | (0.794) | (1.031) | (1.049) | (0.00137) | (0.00134) | (0.00134) | (1.092) | (0.994) | (1.006) | (0.568) | (0.555) | (0.508) | (12.635) | (24.761) | (25.692) |
| Observations | 71,801 | 71,801 | 71,801 | 70,025 | 70,025 | 70,025 | 71,080 | 71,080 | 71,080 | 73,880 | 73,880 | 73,880 | 74,204 | 74,204 | 74,204 |
| R-squared | 0.811 | 0.822 | 0.823 | 0.75182 | 0.76875 | 0.77300 | 0.706 | 0.747 | 0.752 | 0.971 | 0.974 | 0.974 | 0.902 | 0.911 | 0.912 |
| Treatment Time FE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| School FE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| State-by-Year FE | | X | | | X | | | X | | | X | | | X | |
| State-by-Year-by-School Level FE | | | X | | | X | | | X | | | X | | | X |

Robust standard errors in parentheses, clustered at the school district level.

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Summary Differences in Differences Results by Quantile of Per-Pupil Funding: School Demographics

The preferred specification shown in columns (2) in Table 7 show that SIG funding amount is strongly associated with shifts in the share of the student body that is white (which increased with funding), and the share of the student body that is eligible for reduced-price lunch (which decreased with funding). Furthermore, enrollment increased at highly-funded schools while it decreased at least-funded schools. Similarly, the number of teachers at lowest-funded schools decreased, but increased at the most highly-funded schools.

# 7 Conclusion

I find that School Improvement Grants increased test scores at struggling U.S. public schools. I also find that School Improvement Grant receipt led to a gradual shift in school demographics, causing schools to become whiter over time. My findings indicate that SIG receipt was associated with an overall increase in math and reading proficiency rates of about 0.1 standard deviations when effects are averaged over all post-treatment years. However, my event study results in figures (1) and (11) show that the impact of SIG on test scores was most pronounced in the final (third) year of funding and attenuated in the following years. Thus, my findings are consistent with those of Carlson & Lavertu (2018) who find that SIG improved test scores by 0.2 standard deviations among Ohio schools, but whose analysis used a shorter time horizon than that of my analysis. This paper also builds on existing findings by showing that SIG funding amount was an important determinant of the likelihood that a SIG intervention would succeed. An important policy implication of these findings is that the gains in test scores seen by some SIG-receiving schools may be due in-part to the school-level SIG interventions described in Section 1.1, however my findings show no significant relationship between SIG receipt and test scores in the lowest per-pupil funding quartile (see figure 11). My findings indicate that adequate funding is critical for efforts to improve struggling schools.

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# 8 Appendix

## 8.1 Comparison of Means Graphs

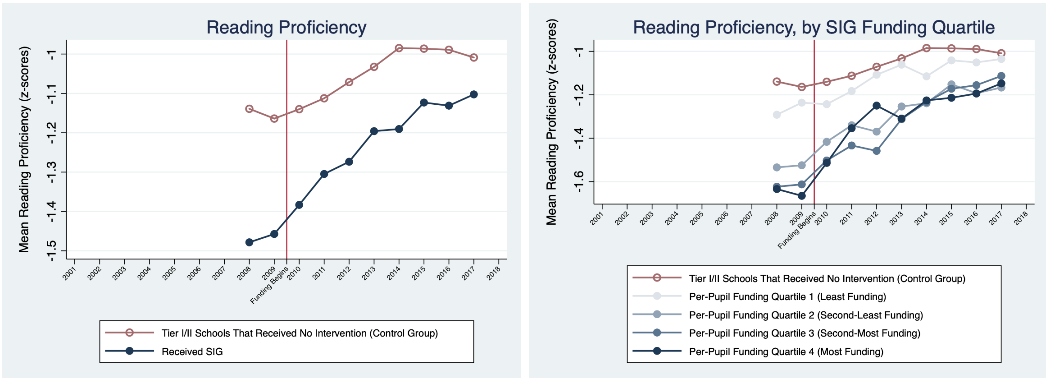


Figure 13: Reading Proficiency Means

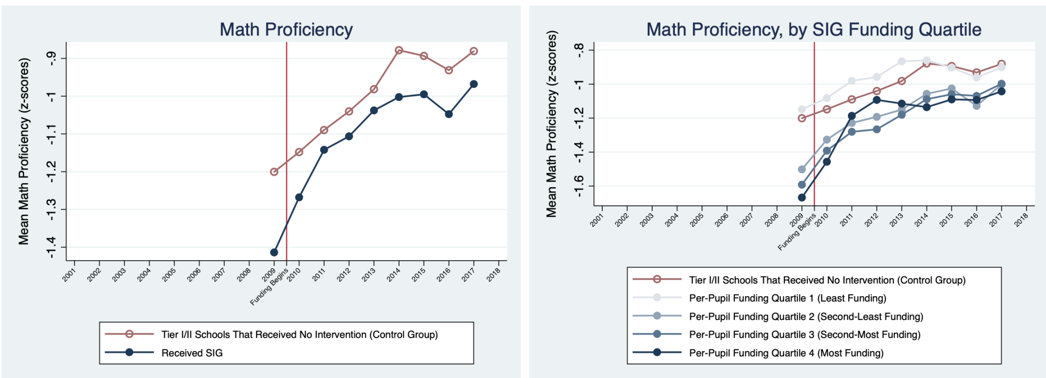


Figure 14: Math Proficiency Means

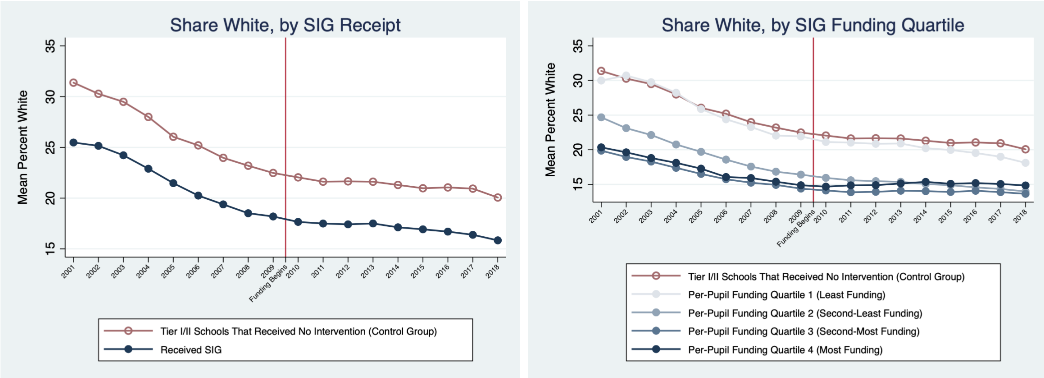


Figure 15: Share White Means

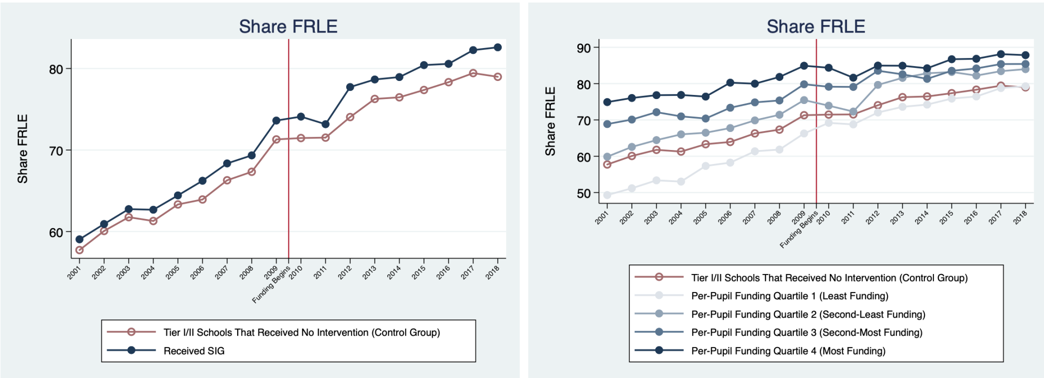


Figure 16: Share White Means


Figure 17: Teacher-Student Ratio Means