WEIGHTED SCHOOL FUNDING FOR ECONOMICALLY DISADVANTAGED STUDENTS AND ACADEMIC ACHIEVEMENT: THE CASE OF THE EVERY STUDENT SUCCEEDS ACT IN MASSACHUSETTS' SCHOOL DISTRICTS

Koki Matsumoto
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Approvals:

ICE/IEPA Master's Program Director: ______________________________
Christine Min Wotipka, Ph.D., date

Advisor: ______________________________
Prashant Loyalka, Ph.D., date

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ABSTRACT

While much research examines education spending at the school district level in the United States, few studies analyze resource allocation to schools within districts and its relationship with educational outcomes. This study focuses on the relationship between "progressivity," which is the extent to which a district weighs funding allocation based on schools' poverty rates, and math and English test scores. Using school-level per pupil spending data from Massachusetts, I find that progressivity varies markedly across school districts: 96 of 220 school districts (44%) allocate more money to schools with less economically disadvantaged students. Regression results indicate that per pupil spending is positively associated with improvements in math achievement in progressive school districts and with English achievement in all school districts. These findings suggest that state policymakers should consider setting minimum spending requirements at the school level to offset current resource allocation decisions by districts. At the same time, these results also suggest that these improvements in achievement might be driven by improvements by non-economically disadvantaged students, implying that financial support to schools with disadvantaged students do not necessarily benefit those students. This study provides a steppingstone for future research on the effects of spending at the school level on student achievement.

1. INTRODUCTION

Does money matter for school quality? This has been one of the most frequently discussed questions in education. This question has particularly stood out as researchers have investigated inequalities in school resource allocation in the U.S. public education system and their effects on student achievement. For example, Moser and Rubenstein (2002) highlight unequal per pupil spending (PPS) among school districts in the U.S. in 1992. Verstegen (2015) finds that PPS is 20 times higher in some school districts compared to other school districts with higher rates of economically disadvantaged students (EDAs) within the same state. Furthermore, researchers have documented a positive correlation between PPS and student achievement in school districts and suggest that increases in PPS particularly benefit low-income students (Hægeland, Raaum, and Salvanes 2012; Jackson, Johnson, and Persico 2016; Neymotin 2010).

These studies mainly analyze PPS at the school district level because school districts are in charge of allocating and administering resources in the U.S. public education system. However, several studies suggest that research at the school level is also necessary. For example, Roza, Guin, Gross, and Deburgomaster (2007) underscore large variations in PPS across schools within Texas' large school districts despite relatively small gaps in PPS across school districts. Also, national test score variance in the U.S. is explained more by the differences between schools than the differences between districts (Hedges and Hedberg 2013). In other words, variation in both school funding and student achievement within a single school district can be high.

As school districts in the U.S. largely control the allocation of financial resources across schools (Shoked 2017), they can either create uniform or non-uniform distributions of resources among schools. They have decision-making authority over education policies while being under regulations from the state. However, discretion does not always mean that school districts allocate their financial resources most effectively to support student learning, because many factors such as administrative structure, politics, and parental involvement influence districts' decisions (Neymotin 2010). In particular, if school districts assume that resource allocation weighted for EDAs sacrifices other schools' or district-wide overall achievement, they might not allocate additional resources to EDAs. However, there is insufficient knowledge on the effect of school districts' decisions on educational achievement.

This study therefore examines the degree to which school resources are allocated equally or unequally across schools and the relationship between this inequality and educational achievement. More specifically, this study has four objectives. The first is to examine how large the imbalance of PPS between schools is. Second, I examine the extent to which school districts weigh PPS on schools with greater numbers of EDAs, which is defined as "progressivity" by Lee and Blagg (2018).[1] Third, I analyze the relationship between academic achievement and PPS at the school level. Fourth, I investigate the extent to which progressivity contributes to the improvements in district-wide academic achievement. To fulfill these objectives, I utilize multivariate regression analysis to analyze school-level spending data from the state of Massachusetts, one of only a few states to have adopted weighted school funding (Baker, Sciarra, and Farrie 2018).

[1] As progressivity is measurable only when there is more than one school for the same grade within a school district, I analyze schools at the elementary and lower-secondary level. Many school districts have more than one elementary or lower-secondary school and only one upper-secondary school.

Similar to previous studies that reveal variation in PPS across schools within relatively large school districts in Texas and California (Roza et al. 2007; Roza, Coughlin, and Anderson 2017a), I find a considerable gap in PPS across schools within school districts in Massachusetts: some schools spend up to four times the amount of other schools serving the same grade levels. Progressivity also varies markedly across school districts: 96 of 220 school districts (44%) allocate more money to schools with fewer EDAs. As an overall trend, results demonstrate that schools with higher rates of EDAs do not receive larger PPS. This tendency is explained by the differences in PPS across school districts rather than those within school districts. More importantly, although PPS has a significantly positive relationship with district-wide math achievement when school districts are progressive and with district-wide English achievement in all schools, these positive relationships seem to be driven by achievement of non-economically disadvantaged students (NEDAs) rather than of EDAs.

In the following sections, I first describe the general roles of school districts in the U.S. and their problems with inequality. I also explain how public school funding works in Massachusetts. I then review the extant literature on test scores, measures for educational inputs and discussions on equality in U.S. education to highlight the deficiencies in research on inequality across schools. Then in the data and methods section, I describe the research design, the data published by the Massachusetts state government, the "progressivity" index to measure the extent to which a school district weighs PPS on schools with greater numbers of EDAs, and the multivariate ordinary least squares (OLS) regression models. Results and policy implications follow: I discuss who benefits from school resource allocation and how the state policy should be improved.

2. BACKGROUND

Decentralized Public K-12 Education and Autonomy of U.S. School Districts

Public K-12 education in the U.S. has three main types of actors: the federal government, state governments, and local school districts. As in many countries, public education in the U.S is quite decentralized (Gaynor 1998). The U.S. federal government delegates responsibility for public education primarily to state and local governments (U.S. Department of Education 2019a). States and local institutions establish public schools, develop curricula, and set the criteria for graduation. This philosophy for role-sharing among these three primary actors is reflected in how public schools are funded. Figure 1 shows, for example, in the school year 2015-2016, that as much as 92 percent of funds were supplied by non-federal sources. As Figure 2 reveals, the percentage for which state governments account for non-federal revenues depends on the state.

[**Figure 1.** Revenue ratio for U.S. public K-12 schools by year, for the school years 2006–07 through 2015–16]

[**Figure 2.** The percentage by which U.S. state funds account for public K-12 non-federal revenues (2015–16)]

Decentralization is also observed within states. School districts, which are a kind of local government to serve the purpose of education, symbolize community involvement in education and are autonomous like other kinds of local governments such as towns or counties (Gamson and Hodge 2018; Shoked 2017). While role-sharing between the state, cities, counties, and school districts also varies across states, school districts are generally independent and even eligible for taxation as well as daily administration even though they are under states' regulations (Shoked 2017). For example, Table 1 displays how PPS varies across school districts within Massachusetts.

[**Table 1.** Per pupil spending at the school district level in fiscal year 2017, Massachusetts]

Historical Context of Inequality and the Every Student Succeeds Act

Local autonomy of school districts can engender unequal resources because school districts rely on local residents for funding (Kelly 2018). Data from the National Center for Education Statistics between 1992 and 1995 show that the states in which school districts were more dependent on local revenue had higher financial inequality across school districts (Moser and Rubenstein 2002). Since the 1970s, many state courts have concluded that such governmental funding systems were unconstitutional in terms of not providing an adequate and equal public education (Hoffman, Wiggall, Dereshiwsky, and Emanuel 2013; Jordan, Chapman, and Wrobel 2014; O'Reilly 2013).

Meanwhile, another crucial viewpoint on inequality has attracted attention: the achievement disparity by socioeconomic status (SES). Many states have reformed their school funding systems so that socioeconomically disadvantaged students can benefit more. However, the additional funds might not reach the targeted population because school districts still have control over the distribution of the funds to schools, and states' reforms furthermore do not necessarily make school districts change their resource allocation dramatically (Chingos and Blagg 2017; Roza, Coughlin, and Anderson 2017b).

The Every Student Succeeds Act (ESSA) signed by President Obama in 2015 has the potential to effect some changes in resource allocation across school districts. First, this Act stipulates that states must "Advances equity by upholding critical protections for America's disadvantaged and high-need students" (U.S. Department of Education 2019b); the premise of this act is that extra support for disadvantaged students, such as those in poverty and racial and ethnic minorities, is required to achieve equality. Second, ESSA mandates that each state and school district publishes a report, including per-school funding information.

Massachusetts' Public K-12 Education and Weighted School Funding

Massachusetts is one of few states that have already disclosed PPS at the school level at the request of ESSA. It offers an interesting case for assessing school districts' efforts to achieve equality across schools for several reasons. First of all, Massachusetts' Chapter 70 Aid of General Appropriations Act mandates that school districts spend minimum amounts, which are determined by the number of students at each school level (e.g., elementary and secondary), EDAs, English language learners (ELLs), and those who need special education. Figure 3 exemplifies these foundation rates corresponding to the type of students in fiscal year 2017 (through October 2016 to September 2017).

[**Figure 3.** Foundation rates in fiscal year 2017, Massachusetts ($/Enrollment)]

State funding makes up the difference between the mandated minimum amounts and local contributions by school districts (Massachusetts Department of Elementary and Secondary Education 2016). However, the law does not stipulate how funds are to be distributed within school districts. In addition, each school district in the state faces severe budget constraints because of increasing costs of special education and health care (Schuster 2011). Therefore, while the state provides progressive funds to support the needs of EDAs, it is unclear whether school districts spend these funds in schools with higher rates of EDAs.

Further, as Table 2 illustrates, there is an achievement gap in the Next-Generation Massachusetts Comprehensive Assessment System (MCAS), the statewide mathematics and English test, between EDAs and NEDAs (Massachusetts Department of Elementary and Secondary Education 2019a).

[**Table 2.** Math and English test scores of grades three to eight in 2018 Next-Generation Massachusetts Comprehensive Assessment System]

In Massachusetts, all students in the tested grades at publicly funded schools, including private schools, are required to take this test in spring. The only exception is for significantly disabled students who participate in an alternative test called MCAS-Alt. From grades three to eight and in grade ten, students take mathematics and English. For grades five and eight to ten, they also take a science, technology and engineering (STE) test. Massachusetts mandates that tenth grade students meet the Competency Determination requirement for mathematics, English, and STE. In MCAS math and English, each student can earn between 440 and 560 standardized points. Every year, the state government reports MCAS achievement results at the school and district levels.

3. LITERATURE REVIEW

Test Scores as Educational Achievement

It is important to describe how educational outcomes can be measured before discussing financial resource allocation. Test scores, in particular, can function as one indicator to predict children's future economic status.

Chetty, Friedman, and Rockoff (2011) show that (i) children's scores in grades three through eight explain their future earnings and that (ii) a one standard deviation increase in test scores is associated with an 11.6% increase in earnings. While we should recognize that test scores measure only some cognitive skills such as reading comprehension and calculation and that non-cognitive skills such as self-control are also important (Brighouse, Ladd, Loeb, and Swift 2018), test scores are still the most measurable explanatory variable for public education policy; cognitive skills are more strongly related to individual earnings, to the distribution of income, and to economic growth than mere school attainment (Hanushek and Woessmann 2008).

Test scores are important not only because they are associated with students' future life outcomes such as wages but also because they are related to students' SES. In a study by Magnuson and Duncan (2006), family socioeconomic resources appear to account for almost half a standard deviation of the Black–White gap in test scores. Examining U.S. nationwide data from 2008-2009 to 2014-2015, Fahle and Reardon (2018) discovered that larger socioeconomic segregation within school districts is strongly related to larger test score variation across school districts. Overall, test scores are compelling indicators of educational outcomes and the achievement gap relates to various measures of inequality.

Per Pupil Spending as an Educational Input Index

There are mainly two ways to analyze the relationship between educational inputs and student achievement. The first is called an Education Production Function, which analogizes the student learning process to the production process at an industrial firm (Todd and Wolpin 2003). This approach is suitable for examining the effects of specific school components that are likely to impact student achievement. Previous literature measures various kinds of school inputs. For example, in Project STAR in Tennessee, researchers analyze the effect of class size on student achievement by assigning students randomly to classrooms of 13 to 17 pupils or to those of 22 to 25 pupils (Mosteller 1995). Cobb-Clark and Jha (2016) examine allocation of ancillary teaching staff and its relationship with development in math and reading skills. This analysis is not limited to teachers and staff. Conlin and Thompson (2017), Hong and Zimmer (2016), and Martorell, Stange, and McFarlin Jr (2016) focus on the relationship between capital expenditures such as school facility construction and student academic achievement. Similarly, a study by Holden (2016) shows that student achievement in elementary school in California increases when textbook-specific funding is implemented, while achievement in secondary school is unchanged. In short, there are various kinds of components linked to school productivity.

The second way to analyze the relationship between educational inputs and student achievement is to conceptualize educational inputs more generally by utilizing the amount of expenditures rather than measuring numerous kinds of school components. In particular, researchers often employ PPS because it is a comparable measure across states (Baker et al. 2018). In the U.S., PPS also attracts attention from fiscal-policymakers because it is a litigious and political issue (Candelaria and Shores 2019; Hoffman et al. 2013).

Basically, statistical research should pursue either of these two approaches because including both variables of the school input components and PPS in regression models has a risk of bias (Todd and Wolpin 2003). That is, if the PPS variable is added to Education Production Function model, the effect size of other school input variables such as teacher salary would be biased because they are some of components that make up PPS; thus, the effect of an increase in a specific school input, controlling for PPS, would be offset by a decrease in other inputs. Conversely, adding school components to a PPS model leads to an underestimation of the effect size of PPS because added variables absorb the effect of PPS. This study employs the PPS model rather than the Education Production Function model mainly because of data availability.

Debate on Equality in U.S. Education

Researchers in the U.S. have debated equality in both educational inputs and outcomes described above since the well-known "Coleman Report" in 1966. In examining data for the U.S., this report concludes that the effect of school quality does not surpass that of the SES of families in terms of educational achievement (Coleman 1968). Based on this view, Hanushek (2003) argues that an increase in inputs to public schools without incentives, such as performance-based payment for teachers, does not improve school outcomes. He draws this conclusion by examining the relation between student achievement and a school production function, focusing on the teacher-student percentage in 23 countries.

Arguing against these studies, several analyses of school funding show that additional school funding is linked to student achievement such as test scores and educational attainment. One study reveals that a “10% increase in per pupil spending each year for all 12 years of public school” in U.S. K-12 education results in “0.31 more completed years of education, about 7% higher wages, and a 3.2% reduction in the annual incidence of adult poverty” (Jackson et al. 2016, p. 157). Other research also shows that there is a positive correlation between spending on school resources and educational attainment. For example, Michigan’s increased financial aid to its lowest-spending school districts has a positive effect on student performance on state tests, college enrollment rates, and attainment of postsecondary degrees (Hyman 2017; Roy 2011). Examining data in Missouri from 1990 to 2004, Venteicher (2005) shows that expenditures per pupil are positively and highly correlated with test scores and high school graduation rates.

In sum, there does not seem to be a consensus on the effect of school funding on educational outcomes, while researchers agree on the existence of an achievement gap between school districts.

Deficiencies in Previous Research; School Districts’ Decisions on Resource Allocation

Based on the extent of previous work, it is worthwhile to investigate further the relationship between spending on school resources and student achievement. To advance research on this topic, this study explores these two areas.

First, there are few studies that analyze inequity in PPS across schools within districts. Lafortune, Rothstein, and Schanzenbach (2018) argue that, while finance reforms are effective at diminishing between-district inequities, states will need other policies to close within-district achievement gaps and address overall equity concerns. Derby and Roza (2017) and Chingos and Blagg (2017) point out the same problem of within-district disparities. Miles and Roza (2006), Monk and Hussain (2000), and Roza et al. (2017a) conduct research on resource allocation within school districts, but such studies are not cross-jurisdictional or do not recognize the relation of the disparities in educational outcomes. Taken together, this suggests that more analyses are needed that focus on differences between, rather than within, school districts.

Second, there is little research on school districts' allocation of resources, given budget limitations. Indeed, the literature mentioned above focuses on the impact of additional funding gained by states' education reforms but does not discuss whether school districts facilitate or impede the impact of state funding policy. Some studies mention that school districts have a negative function in general. For instance Kelly's (2018) research on California's history of school finance, from 1850 to 1950, claims there is a mechanism of "engineering inequity" inside school districts. Likewise, Jordan et al. (2014) discussed Arkansas' educational reform in light of a lawsuit, deeming school districts a cause of regional inequality. Other studies refer to the possibility of a substantial effect of school districts' resource allocation on inequality. Neymotin (2010) makes this point by asserting that control over allocation of resources is not equivalent to the ability to utilize the resources effectively. In particular, if school districts assume that resource allocation weighing on schools in poverty sacrifices other schools' or district-wide overall achievement, they hesitate to allocate additional resources to EDAs. Jackson et al. (2016) expresses this apprehension by pointing out that more resources might be allocated to less disadvantaged schools, a pattern that I define as less progressive. However, it is still unclear how school districts' decisions on school resource allocation impact educational achievement. Even further, there is insufficient knowledge on the extent to which weighted funding for schools with higher rates of EDAs affects district-wide academic performance. In this paper, I analyze how school districts in one U.S. state allocate their resources to their schools and to what extent this allocation is correlated to test scores.

4. DATA AND METHODS

Research Design

These are the research questions examined in this study:

> RQ1. How large is the imbalance of PPS between schools in Massachusetts' school districts?
>
> RQ2. How progressive is each school district in Massachusetts?
>
> RQ3. Is there any correlation between academic achievement and PPS at the school level?
>
> RQ4. To what extent and in what way does progressive school resource allocation by school districts contribute to the improvement in district-wide academic achievement in Massachusetts?

I explore RQ1 and RQ2 using descriptive statistics. To address RQ3 and RQ4, this study employs a non-experimental correlational design simply because it is very difficult to manipulate the progressivity of some sampled school districts and there is no known exogeneous quasi-experimental shock that forces some school districts in Massachusetts to change their progressivity (allocation is under their control). I use a multivariate OLS regression model to estimate the correlation (Stock and Watson 2015). The units of analysis of RQ1, RQ2, and RQ4 are school districts and those of RQ3 are schools.

Data

Test Scores

I utilize data on MCAS math and English test scores of third to seventh graders in 2017 and fourth to eighth graders in 2018 to see improvements in academic achievement. I exclude charter schools and private schools because their funding is not under control of school districts. Schools for significantly disabled students do not take MCAS, so they are not included in this study's samples. One limitation is that the Massachusetts state government does not disclose test scores at the school grade level if fewer than ten students are enrolled in a grade. Also, the data on students' changes in schools or school districts are not available. However, aggregating five grades helps to reduce biases caused by such missing data to a certain extent and makes it possible to interpret more general patterns of academic achievement.

Per Pupil Spending

The state government published PPS at the school level in fiscal year 2017 at the request of ESSA. While PPS of all school districts has been available since 2008, PPS at the school level was not unveiled until February 2019. At that time, the state government published the PPS of all of the 1,833 public and charter schools in fiscal year 2017. All state governments are obliged to report this kind of data in their own way in 2018 or 2019. The revenue sources and functional categories counted within PPS in Massachusetts are listed in Table 3 and Table 4.

[**Table 3.** Funds composing per pupil spending in Massachusetts]

[**Table 4.** Functional categories counted in per pupil spending in Massachusetts]

As these tables show, PPS represents most expenditures comprised in a school production function such as class size. One limitation of the current study is that school districts do not disclose detailed calculation methods for PPS at the school level, and this might be different across school districts. For example, if a school district provides a district-wide teacher training program, it is unclear whether the expenditure is included in the PPS of each school. In addition, it is impossible to distinguish capital spending such as school facilities from other forms of spending. That is, PPS in one fiscal year does not perfectly reflect school resources available for students in that year. Students may benefit from textbooks purchased by the previous year's spending, for example, and spending on construction does not facilitate students' learning in the same year of construction. Even so, PPS is at least a good proxy of the school resources to which students in the school or school district have access.

When using PPS at the school district level in this study, I recalculate it based on PPS at the school level and enrollments of schools where third to seventh graders' test scores are available because extant PPS at the school district level often includes spending on early childhood education, high school, and special schools for significantly disabled students.

Socioeconomic Status

As a wide literature has demonstrated, SES strongly influences educational attainment and student achievement. As an index for SES, Massachusetts classifies students as EDAs when they participate in one or more of these state-administered programs: the Supplemental Nutrition Assistance Program, the Transitional Assistance for Families with Dependent Children, the Department of Children and Families' foster care program, and MassHealth (Medicaid).

EDAs are aided by at least one of these four programs in Massachusetts: Supplemental Nutrition Assistance Program, of which the target is broader than Free or Reduced-Price Lunch; a cash benefit program for pregnant women with children meeting income and asset limits; a foster care program; and the Medicaid program. In this study, the percentage of EDAs in 2018 at the school district and at the school level is obtained by the number of MCAS test takers in fourth through eighth grades.

Progressivity

Lee and Blagg (2018) measures Massachusetts' school funding equity between EDAs and NEDAs at the state level by calculating the difference between aggregated spending per EDA and aggregated spending per NEDA. Applying this method to the school district level, I define progressivity as the difference between spending per EDA and spending per NEDA at the school district level. Progressivity of school district *i* which has *j* schools is calculated by this equation:

$$Progressivity_i = \sum_{n=1}^{j} \frac{PPS_n * Enrollment\ of\ EDA_n}{Enrollment\ of\ EDA_i} - \sum_{n=1}^{j} \frac{PPS_n * Enrollment\ of\ NEDA_n}{Enrollment\ of\ NEDA_i} \quad (1)$$

The former sigma term is the aggregated portion of funds for EDAs, whereas the latter sigma term is the aggregated portion of funds for NEDAs. Figure 4 provides an example.

[**Figure 4.** Example of progressivity calculations for a school district]

In this study, enrollment is equal to the number of MCAS test takers in third through seventh grades in 2017 because the research question is the extent to which academic achievement of MCAS test takers in 2017 is improved by progressivity in the next year.

This equation assumes that spending for each student at the same school is identical because school level resources such as teachers, textbooks, facilities, and counselors are usually not separately allotted to EDAs. Rather, all students who go to the school benefit from these resources. A potential threat to this assumption is that schools can hire an instructor or any other staff member who meets the needs of particular children who are not necessarily EDAs. For instance, a school might deploy a special program or assistance for ELLs.

By definition, progressivity is always zero if a school district has only one school to be integrated into the equation above. It reveals nothing about resource allocation among EDAs and NEDAs within the same school or for districts that have only one school. Therefore, in the analysis of RQ4, I exclude school districts that only have one school where MCAS scores are available.

OLS Regression Model

While correlational research does not explain cause-and-effect relationships in general, I utilize value-added models so that I can estimate, as reasonably as possible, the effect of progressivity and PPS in a certain year on student achievement in the following year.

Relationship between Academic Achievement and PPS at the School Level

To address RQ3, I regress MCAS 2018 math and English, respectively, on the percentage of EDAs and PPS in fiscal year 2017, controlling for the previous year's test scores, demographic status in 2018, school characteristics in 2018, and school district fixed effects. Demographic status and school characteristics include the percentage of ELLs, disabled students, female, white, black/African American, Hispanic/Latino and Asian and the enrollments. I utilize PPS in fiscal year 2017 because the effect of PPS is more likely to be reflected by student achievement in the year after all spending is implemented. The units of analysis are schools. The scale of PPS is $1,000, that of MCAS is a standardized band score ranging from 440-560, that of enrollment is the number of test takers, and others are percentages.

$$MCAS_{2018ij} = \beta_0 + \beta_1 * EDA_{2018ij} + \beta_2 * PPS_{2017ij} + \beta_3 * MCAS_{2017} + \beta_4 * ELL_{2018ij} + \beta_5 * DisabledStudent_{2018ij} + \beta_6 * Female_{2018ij} + \beta_7 * White_{2018ij} + \beta_8 * Black_{2018ij} + \beta_9 * Hispanic_{2018ij} + \beta_{10} * Asian_{2018ij} + \beta_{11} * Enrollment_{2018ij} + \delta_i + \varepsilon \quad (2)$$

Relationship between Progressivity and Academic Achievement at the School District Level

To answer RQ4, I regress MCAS 2018 math and English, respectively, on the percentage of EDAs in 2018, PPS in fiscal year 2017, and progressivity, controlling for the previous year's test scores, demographic status, numbers of schools, and enrollments in 2018. The units in the model are school districts. The categories of demographic status are the same as the equation (2).

$$MCAS_{2018i} = \beta_0 + \beta_1 * EDA_{2018i} + \beta_2 * PPS_{2017i} + \beta_3 * Progressivity_{2017i} + \beta_4 * MCAS_{2017i} + \beta_5 * ELL_{2018i} + \beta_6 * DisabledStudent_{2018i} + \beta_7 * Female_{2018i} + \beta_8 * White_{2018i} + \beta_9 * Black_{2018i} + \beta_{10} * Hispanic_{2018i} + \beta_{11} * Asian_{2018i} + \beta_{11} * SchoolNumber_{2018i} + \beta_{13} * Enrollment_{2018i} + \varepsilon \quad (3)$$

This study takes the position that progressivity has the potential to improve average student achievement within school districts. Jackson at al. (2016) infer that additional school funding is more effective for advancing student achievement in school districts with higher levels of poverty. Roy (2011) finds that an increase in financial aid to the lowest-spending school districts improved students' test scores. In short, these studies suggest additional school funding is more effective for disadvantaged schools. These results are consistent with the Law of Diminishing Marginal Utility, in which Gossen (1983) advocates that the utility derived from additional input diminishes as the existing inputs increase. In short, additional spending for EDAs is likely to be more effective than for NEDAs, who have already benefitted from other educational resources such as families and communities. Based on this conceptual framework, I hypothesize that the more progressive a school district, the better the average test score of the school district.

5. RESULTS

RQ1: Gap in Spending across Schools

Table 5 summarizes descriptive statistics at the school level. PPS at the school level obviously varies. The minimum value is $10,215, and the maximum value is $41,140—four times the minimum. One should not conclude that this gap is problematic, because spending required for adequate education can vary across school districts (Satz 2008). As such, it is necessary to examine how large the gaps within school districts are. Table 6 and Figure 5 show that standard deviations of PPS within a school district also vary. In the school district where PPS at the school level is the most variant, its standard deviation is $5,601, while the smallest standard deviation is $15.

[**Table 5.** Per pupil spending at the school level in fiscal year 2017, Massachusetts ($1,000)]

[**Table 6.** Standard deviation of per pupil spending within Massachusetts school districts where there is more than one elementary/secondary school ($1,000)]

[**Figure 5.** Distribution of standard deviation of per pupil spending at the school level within Massachusetts school districts in fiscal year 2017]

This result demonstrates that a number of school districts embrace disparities in PPS, which are invisible in previous studies at the school district level. In other words, which school district a school belongs to does not necessarily reflect the PPS of the school. Some might think that the standard deviation becomes larger as the number of schools increases or that it is obvious that the three biggest school districts (Boston, Springfield and Worcester) have large standard deviations. However, Figure 6 shows that standard deviations are dispersed regardless of the number of schools, and the school district with the largest standard deviation is not Boston, Springfield or Worcester.

[**Figure 6.** The relationship between the number of schools and standard deviations of per pupil spending at the school level within Massachusetts school districts in fiscal year 2017]

RQ2: Weight on Schools with Higher Disadvantaged Rate

It is still difficult to tell, however, whether the gaps in PPS themselves are acceptable or not. For instance, it is sensible for school districts to fill gaps in educational outcomes stemming from SES differences by distributing more resources to underperforming schools (Sirin 2005). Therefore, to see if schools with higher proportions of disadvantaged students receive additional expenditures from school district, I regress PPS on the percentage of EDAs, ELLs and disabled students in 2017 at the school level, clustering by school district. I control for the percentage of ELLs and disabled students because Figure 3 shows that these two categories involve extra expenditures.

$$PPS_{2017ij} = \beta_0 + \beta_1 * EDA_{2017ij} + \beta_2 * ELL_{2017ij} + \beta_3 * DisabledStudent_{2017ij} + \varepsilon \quad (4)$$

As Column (1) in Table 7 shows, the percentage of EDAs is negatively associated with PPS at the school level even though the state's funding formula weighs EDAs more heavily. On the other hand, the percentage of disabled students and the percentage of ELLs are both positively correlated with PPS. The positive relationship between the percentage of disabled students and PPS is consistent with what Schuster (2011) points out; school districts in the state face severe budget constraints because of increasing costs of special education. At the same time, the negative relationship between the percentage of EDAs and PPS suggests that support for EDAs might not be prioritized.

To isolate the effect of the differences between school districts on PPS, I add the school district fixed effect.

$$PPS_{2017ij} = \beta_0 + \beta_1 * EDA_{2017ij} + \beta_2 * ELL_{2017ij} + \beta_3 * DisabledStudent_{2017ij} + \delta_i + \varepsilon \quad (5)$$

This model shows that the percentage of EDAs is positively associated with PPS (see Table 7, Column (2)), implying that between-district differences explain the negative relationship between PPS and the percentage of EDAs rather than within-district differences. That is, school districts in Massachusetts tend to put more weight on funding on schools with a higher percentage of EDAs, but some characteristics of school districts such as budget scales offset this. Besides, this result shows that the coefficient on the percentage of ELLs becomes nonsignificant when school district fixed effect is added, the support for ELLs is not weighted within school districts.

[**Table 7.** Association between each variable and per pupil spending ($1,000) at the school level in fiscal year 2017, Massachusetts]

To compensate for this gap across school districts in PPS, it is easy to advocate for additional financial support to the school districts where PPS is smaller and the percentage of EDAs is higher. However, the result above does not necessarily mean that all of the school districts put weight on schools with a higher percentage of EDAs. It only demonstrates an average tendency when examining all schools. It is worthwhile to scrutinize the difference in weights on EDAs across school districts.

Progressivity helps to examine the difference. As shown in Tables 8-1 and 8-2, progressivity differs across school districts, and it is noteworthy that 96 of 220 school districts (44%) are regressive (have a progressivity value that is smaller than zero). Based on the enrollments for MCAS 2017 math, the highest value of progressivity is $1,780; $16,827 is spent per EDA while $15,047 is spent per NEDA in the most progressive school district. In contrast, in the most regressive district, progressivity is -$1,207; it spends $21,738 and $22,944 per EDA and NEDA, respectively.

[**Table 8-1**. Descriptive statistics of MCAS math scores and independent variables at the school district level, Massachusetts]

[**Table 8-2**. Descriptive statistics of MCAS English scores and independent variables at the school district level, Massachusetts]

I also find that progressivity is not significantly linked to the percentage of EDAs in 2017 or PPS in 2017 (details are available by request), which implies that school districts can be either progressive or regressive regardless of the district's poverty level and budget scale. This result suggests that additional financial support to EDAs does not always reach the intended audience because school districts that receive the support might use it regressively.

RQ3 and 4: Relation between Academic Achievement and Progressivity

So far, I have analyzed the variation in school resource allocation across school districts from the viewpoints of PPS gaps and weights on EDAs. I now examine how this variation in PPS is linked to academic achievement.

Table 9-1, Columns (1) and (2), and Table 9-2, Columns (1) and (2) show that at both the school and district levels, there is no significant correlation between MCAS math test scores in 2018 and PPS in fiscal year 2017. As for the MCAS English test score, while PPS at the school level is nonsignificant (see Table 9-3), the coefficient on PPS at the school district level is significantly positive (see Table 9-4, Columns (1) and (2)). Progressivity in fiscal year 2017 has neither a positive nor negative impact on MCAS math or English scores in 2018, rejecting the hypothesis that the more progressive a school district, the better the average test score of the school district (see Table 9-2, Columns (1) and (2) and Table 9-4, Columns (1) and (2)).

[**Table 9-1**. Effects of each variable on MCAS 2018 math scores at the school level]

[**Table 9-2**. Effects of each variable on MCAS 2018 math scores at the school district level]

[**Table 9-3**. Effects of each variable on MCAS 2018 English scores at the school level]

[**Table 9-4**. Effects of each variable on MCAS 2018 English scores at the school district level]

To further investigate the association between MCAS math scores and PPS at the district level, I categorize school districts into two groups: progressive school districts (Group 1) and regressive or zero-progressivity school districts (Group 2). I then regress the MCAS math scores of the respective groups on the same variables as shown in equation (3). As shown in Table 9-2, Columns (3) and (4), the coefficient on PPS in Group 1 is significant while that in Group 2 is not significant. This difference between the two groups suggests that PPS at the district level matters for math achievement in progressive districts, but not in non-progressive or regressive districts. In other words, the results suggest that a progressive allocation of resources across schools is an effective way to improve math achievement.

However, what is also important to consider is who benefits in these progressive school districts. When I regress EDAs' average math achievement on the same independent variables as shown in equation (3), there is no significantly positive correlation between achievement and PPS, whether it is in Group 1, Group 2, or all school districts (see Table 10-1). On the contrary, when I regressed NEDAs' average math achievement on the same independent variables, I found that Group 1 has a significantly positive correlation between achievement and PPS (see Table 10-3, Column (3)).

[**Table 10-1**. Effects of each variable on MCAS 2018 math scores of EDAs at the school district level]

[**Table 10-2**. Effects of each variable on MCAS 2018 English scores of EDAs at the school district level]

[**Table 10-3.** Effects of each variable on MCAS 2018 math scores of NEDAs at the school district level]

[**Table 10-4**. Effects of each variable on MCAS 2018 English scores of NEDAs at the school district level]

There are some possible scenarios in which PPS is positively associated with math achievement of NEDAs when school districts are progressive. For instance, parents of high achievers, who are likely to be NEDAs, might be supportive of progressive resource allocation because they feel their children already have sufficient access to high-quality education and want the school districts to focus on struggling students. The higher their children's achievement, the more money they demand that school districts spend in public schools. In this case, progressivity is a result of other unmeasured variables of "philanthropic mind." Another explanation is that

NEDAs are benefitted more by utilizing school resources brought by PPS than EDAs. This is plausible because EDAs are likely to have more difficulties in learning attitudes or basic life habits. In this case, NEDAs can receive support for improving academic achievement while support for EDAs is directed to non-academic matters such as basic life skills or behavioral problems. The most pessimistic explanation is that school districts make efforts to enhance the academic achievement of NEDAs even though school resources are allocated to benefit EDAs. In fact, PPS at the school level, which is used to calculate progressivity in this study, tells us nothing about the allocation of resources within schools. It is possible that the school resources to which students have access, such as teachers, textbooks and counselors, are different across classes and grades.

The result of English achievement is simpler. As mentioned above, PPS is positively and significantly associated with MCAS English test scores at the school district level. In both Group 1 and Group 2, there is no significant relationship between PPS and MCAS English test scores, probably because the sample sizes are too small (see Table 9-4, Columns (3) and (4)). In addition, EDAs' English achievement is not associated with PPS (see Table 10-2), while NEDAs' English achievement is significantly and positively related to PPS (see Table 10-4). When I split school districts into Groups 1 and 2, PPS is neither significantly correlated with EDAs nor NEDAs' improvement in English achievement (see Table 10-2, Columns (3) and (4) and Table 10-4, Columns (3) and (4)).

6. POLICY IMPLICATION

PPS as an Indicator of School Resources

ESSA mandates that all states disclose PPS at the school level because PPS at the school district level veils the distributions within school districts. This policy seems successful in terms of uncovering the gap in PPS across schools, which would otherwise be invisible. In Massachusetts, some schools spend up to four times the funding per student of other schools serving the same grade levels. While it is difficult to define how much of a dollar gap is problematic because the needs and costs for each school's education vary, school districts should be accountable for their school resource allocation.

More importantly, this study reveals that 96 out of 220 school districts put no weight on funding on schools with higher rates of EDAs. This means that the state's additional funding, which aims to ensure the minimum amount of spending on EDAs, ELLs, and those who need special education, does not always reach its targets. Considering that ESSA declares the necessity for actions to make positive changes in low-performing schools (U.S. Department of Education 2019b), disadvantaged children should certainly receive additional educational support. Currently, Massachusetts' Chapter 70 Aid of General Appropriations Act obligates school districts to spend minimum amounts in total according to their student demographics and enrollments, but mandates nothing about how they should be distributed to each school. One possible way to secure funding on EDAs is to amend this act and impose minimum amounts of spending at the school level according to the number of EDAs and other students with high needs. Massachusetts already publishes data on yearly enrollments by EDAs/NEDAs, ELLs, and students with disabilities, and ESSA now requires states to disclose PPS at the school level each year. Therefore, it is feasible without large additional cost to legislate a new obligation on school districts.

Accountability for Improvement in Disadvantaged Students

However, mandating minimum spending might not be sufficient to ensure support for EDAs because this study's findings imply that allocating resources to a school does not necessarily mean that a student in the school has access to and benefits from allocated resources. Even though PPS at the school level is positively associated with MCAS math improvement when school districts are progressive, the progress is driven by not EDAs but NEDAs. Of course, not all PPS intends to improve student math achievement, so I cannot conclude that the increase in PPS benefits only NEDAs achievement. What is important here is that looking at performance at the school level is insufficient for discussing equality in education for all children, whether it is about educational inputs such as PPS or outcomes such as test scores. In other words, just like the argument that within-district inequalities should be examined as well as across-district ones, within-school inequalities are worth paying attention to as well as across-school ones.

It is quite difficult to calculate PPS at a more detailed level than the school because teachers often teach multiple grades, school facilities and staff are usually accessible to all students, and recording everything about who uses what school resources is almost impossible. Schools are too busy educating students to report everything happening at schools. Instead of increasing the burden to gather school input information, the state government should focus on the educational outcomes of disadvantaged students. To make schools and school districts conscious about educational outcomes of specific groups, schools' accountability system plays an important role.

In 2018, Massachusetts implemented an accountability framework to make schools responsible for not only MCAS test scores on average, but also those of disadvantaged groups specifically. In the newly established accountability system, all public schools and charter schools are accountable for academic achievement and the improvements of 11 subgroups in addition to average and lowest performing students; these subgroups include students with high needs, EDAs, ELLs and former ELLs, students with disabilities, and students of different racial groups (African American/black, American Indian/Alaska Nations, Asian, Hispanic/Latino, Multi-race, Nation Hawaiian/ Pacific Islander and White) (Massachusetts Department of Elementary and Secondary Education 2019b). This policy is in too early of a stage to be evaluated, but this strategy seems aligned with the concept that addresses an important issue on equality. However, there are at least two points to be improved.

First, these subgroups do not correspond to the groups for which the state government provides additional funding. The state only weighs on EDAs, ELLs, and those who need special education. If the state imposes accountability for schools based on specific racial/ethnic minority groups, assuming that extra care and considerations are needed to equalize their academic achievement, it should supply additional funds to school districts with higher rates of specific racial/ethnic minority groups. Accountability without support does not motivate schools and school districts unless they are already affluent in resources. Or, if it simply intends to declare the importance of equality, some other categories discussed frequently in the context of equality, such as gender, need to be included in the accountability system.

Second, schools with fewer than 20 students within a subgroup are not required to disclose test scores of these subgroups for the purpose of accountability. It is sensible to a certain extent because if the number of students is very small, unexpected errors that are unattributable to a school's efforts have a large impact on student performance. Even so, this rule has a risk to disincentivize schools to make efforts to enhance the achievement of students in marginalized groups that are likely to consist of less than 20 students. If this accountability system aims to diminish the achievement gap between advantaged and disadvantaged groups, this 20-student rule is unnecessary.

Future Research Directions

To elucidate a more sophisticated policy recommendation for school resource allocation and accountability, it is indispensable to further investigate the relationship between educational outcomes and PPS from a broader perspective with more reliable data, and by making causal inference. One of the main limitations of this study is that it cannot take longitudinal and cumulative effects of PPS and progressivity into consideration. Suppose PPS and progressivity do not take effect in the short term and have been basically constant because it is difficult for school districts to make a drastic change in their spending strategy for many political reasons (Roza et al. 2017a). If this is the case, then the lagged test scores variable (i.e., MCAS 2017) absorbs all of the longitudinal and cumulative effects of previous years' PPS and progressivity, making the relationship between them and the current test scores invisible.

To see these kinds of longitudinal effects, ideally, a study with an experimental design is needed. However, it is quite difficult to conduct an experimental study because school funding is such a political issue that assigning progressive allocation randomly to school districts is unrealistic. To get closer to causality, a Difference-in-Differences analysis is doable if there are some school districts that changed their progressivity or schools that experienced a drastic change in PPS rapidly in one year while other conditions remained identical. Such studies are currently unable to be conducted because fiscal year 2017 is the first year when ESSA requires all states to disclose PPS information at the school level, which is necessary to calculate progressivity at the school district level.

Another restriction is that data on MCAS test scores are incomplete because, as mentioned earlier, the Massachusetts state government does not disclose test scores if fewer than 10 students are enrolled in a grade and there are no data on students' changes in schools or school districts. In addition, if a household moves from the category of NEDAs to that of EDAs or vice versa, this move affects the average achievement of each group both at the school level and at the school district level. Considering these confounding factors, it would be ideal to collect individual test scores to see the added value of PPS and progressivity.

It is also necessary to consider omitted variables in the regression models because it is unclear whether larger PPS causes higher MCAS test scores, larger PPS is led by higher MCAS test scores, or other variables affect both PPS and MCAS test scores. If residents' attitudes toward public education have some influence both on PPS and the educational outcome as I described as "philanthropic mind" above, then qualitative research is needed to figure out what attitudes are the key components. Also, even after controlling for PPS, there still can be missing factors in school resources. Knight (2019) points out that, though school districts tend to allocate money to schools with higher poverty rates, the least-experienced teachers still tend to work in high-poverty and high-minority schools. This implies that school quality is not necessarily ameliorated by funding, or that increases in funding are not always large enough to enhance the level of education. If the latter is true and there is some threshold where an increase in PPS becomes effective, a non-linear regression model is able to examine the effects of increases in PPS more accurately. Further, school districts with larger PPS raise the tax by themselves, but the revenue sources might differ across school districts. This is likely to influence the behaviors of households because those who are subject to taxation have less abundant resources to educate their children at home.

In this study, I operationalize the criteria of poverty, using the categories of EDAs and NEDAs, but the coefficients on PPS and progressivity could be downwardly biased because the Massachusetts government provides households that are classified as EDAs with extra support, regardless of education policy. They are aided by at least one of these four programs:

Supplemental Nutrition Assistance Program, of which the target audience is broader than Free or Reduced-Price Lunch; a cash benefit program for pregnant women with children meeting income and asset limits; a foster care program; and the Medicaid program. If these supports outside of school play some roles in improving students' learning, effects of PPS could get smaller because the utility derived from PPS is diminished by the existing educational resources, as the Law of Diminishing Marginal Utility (Gossen 1983) asserts.

Finally, needless to say, the field of study does not have to be limited to Massachusetts, and there are a number of ways to measure educational outcomes other than MCAS test scores. Many states will disclose their data on PPS at the school level this year, 2019, at the request of ESSA. As discussed in the literature review, analyses of specific school components as well as PPS are possible if data are available. Studies in other states on various kinds of educational inputs and outcomes help to illustrate the roles and effects of expenditure for education in broader social contexts.

7. CONCLUSION

In conclusion, this study sheds light on school resource allocation within school districts and its relation to student academic achievement by examining data from the Massachusetts state government. I find that some schools have four times the PPS of other schools serving the same grade level in Massachusetts. Progressivity, which is the extent to which a school district weighs funding based on schools with higher rates of EDAs, varies across school districts even though Massachusetts' school funding formula aims to provide additional support to EDAs. 96 of 220 school districts allocate their school resources regressively. To ensure funding support reaches the intended audience, I suggest that Chapter 70 Aid of General Appropriations Act be amended in order to impose minimum amounts of spending at the school level according to the number of disadvantaged students.

While progressive school resource allocation does not seem to improve district-wide academic achievement, being progressive does not exacerbate it, either. Spending in school matters more for improvement in academic achievement for progressive school districts than regressive school districts. However, it is not EDAs who spearhead the improvement, implying that support to struggling schools does not necessarily benefit struggling students. The school accountability system should be modified such that it is more aligned with the concepts of the state funding formula and ESSA in which disadvantaged students need to receive extra supports.

As this is the first year for all states to report school-level spending from the request of ESSA, there is a deficiency in longitudinal information. After having data on multiple years for all states, we will be able to examine the effects of weighted funding on schools with higher rates of EDAs in a more elaborated way such as with Difference-in-Differences analyses and through measuring student-level educational outcomes. This study is therefore a first step for further investigations on the relationship between school resource allocation within school districts and educational achievement in the U.S.

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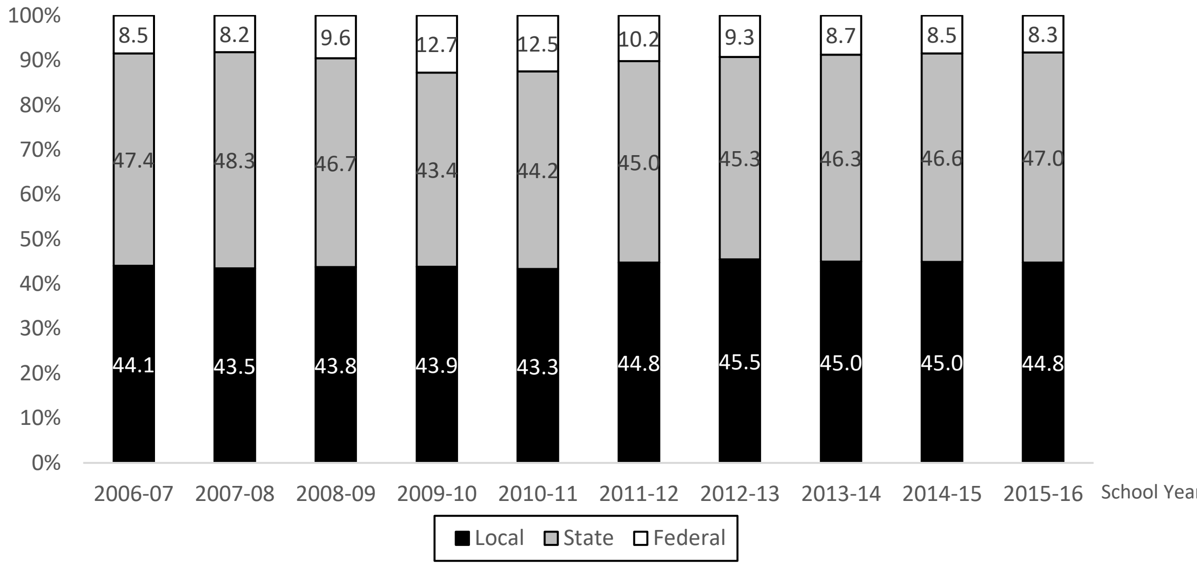
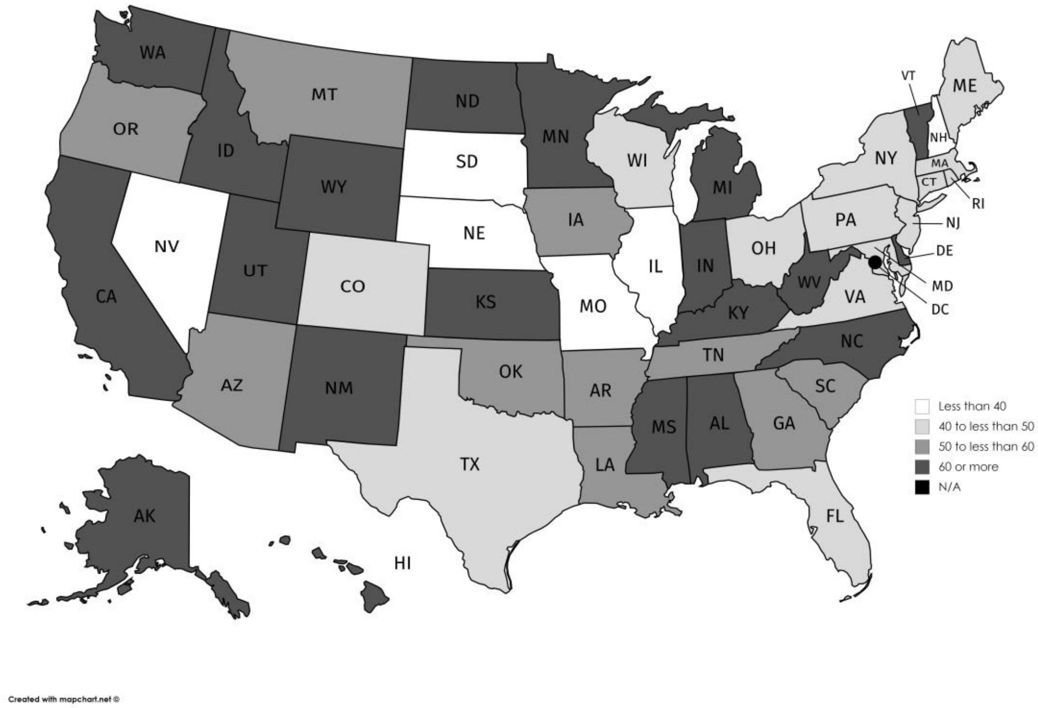
9. FIGURES AND TABLES



Notes: Revenues for state education agencies are excluded. Total sum may not add up to 100 because of rounding.
Source: National Public Education Financial Survey 2006-07 through 2015-16.

Figure 1. Revenue ratio for U.S. public K-12 schools by year, for the school years 2006–07 through 2015–16



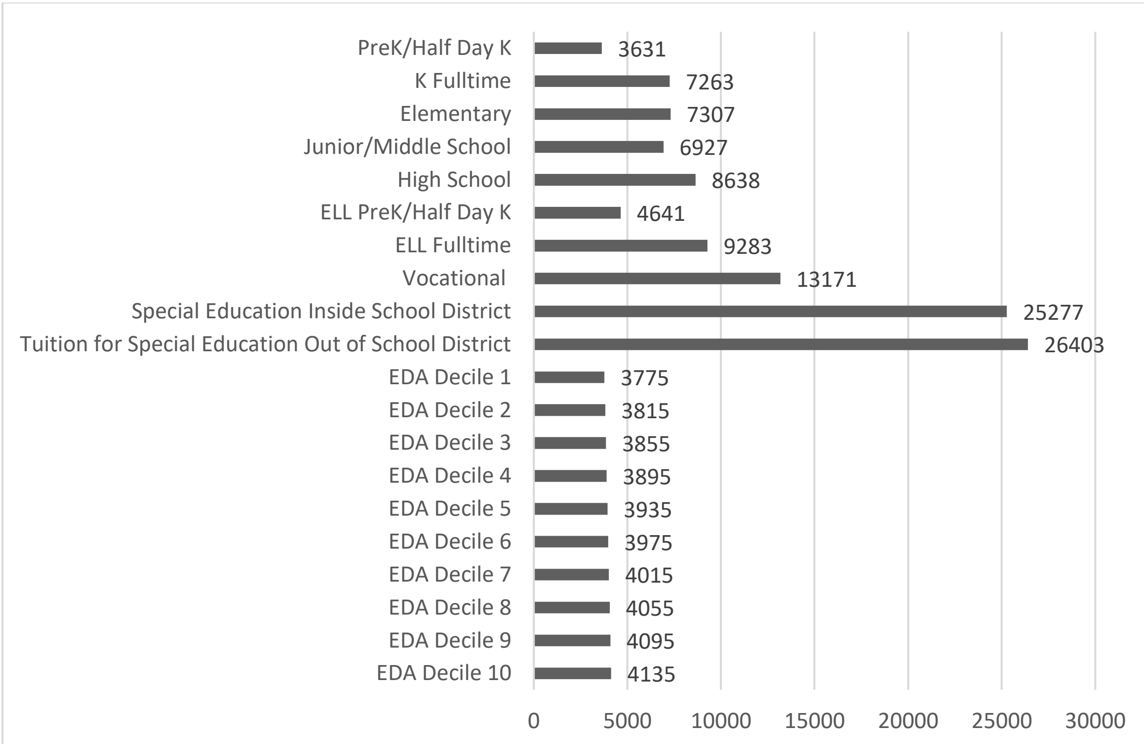
Source: National Public Education Financial Survey 2015-16.

Figure 2. The percentage by which U.S. state funds account for public K-12 school non-federal revenues (2015–16)

Table 1. Per pupil spending at the school district level in fiscal year 2017, Massachusetts

	PPS ($)
State total	16,014
Mean	16,702
Max	21,670
Min	11,363
Standard deviation	3,585

Notes: N = 322. PPS: Per pupil spending. State total is state total spending divided by state's number of students. Mean is sum of each district's per-pupil spending divided by number of school districts. *Source*: Massachusetts Department of Elementary and Secondary Education 2019.



Source: Massachusetts Department of Elementary and Secondary Education 2016.

Figure 3. Foundation rates in fiscal year 2017, Massachusetts ($/Enrollment)

Table 2. Math and English test scores of grades three to eight in 2018 Next-Generation Massachusetts Comprehensive Assessment System

	All students	NEDAs	EDAs
Math	498.4	504.1	487.7
English	500.5	506.0	490.2

Notes: The test score ranges from 440 to 560. NEDAs: Non-economically disadvantaged students. EDAs: Economically disadvantaged students.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 3. Funds composing per pupil spending in Massachusetts

• School committee appropriations
• Municipal appropriations outside the school committee budget that affect schools
• Federal grants
• State grants
• Circuit breaker funds
• Private grants and gifts
• School choice and other tuition revolving funds
• Athletic funds
• School lunch funds
• Other local receipts such as rentals and insurance receipts

Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 4. Functional categories counted in per pupil spending in Massachusetts

In-District Expenditures	• School Committee • Superintendent • Assistant Superintendents • Other District-Wide Administration • Business and Finance • Human Resources • Legal Service for School Committee • Legal Settlements • District-wide Information Systems
Administration	• Curriculum Directors (Supervisory) • Dept Heads (Non-Supervisory) • School Leadership • Curriculum Leaders (School Level) • Admin. Technology (School Level) • Instructional Coordinators
Instructional Leadership	• Teachers, Classroom • Teachers, Specialists
Teachers	• Medical/ Therapeutic Services • Substitute Teachers • Paraprofessionals • Librarians/Media Center Directors
Other Teaching Services	• Professional Development Leaders • Professional Days • Substitutes for Prof. Development • Professional Development Costs
Professional Development	• Textbooks, Software/Media/Materials • Instructional Materials (Libraries) • Instructional Equipment • General Classroom Supplies • Other Instructional Services • Classroom Technology • Technology (Libraries) • Instructional Software
Instructional Software	• Guidance/Adjustment Counselors • Testing and Assessment • Psychological Services
Guidance, Counseling, Testing	• Attendance and Parent Liaisons • Medical/Health Services • Transportation Services • Food Services • Athletics • Other Student Activities • School Security
Pupil Services	• Custodial Services • Heating of Buildings • Utility Services • Maintenance of Grounds • Maintenance of Buildings • Building Security System

	• Maintenance of Equipment • Extraordinary Maintenance • Networking/Telecommunications • Technology Maintenance
Operations and Maintenance	• Employer Retirement Contributions • Employee Separation Costs • Insurance for Active Employees • Insurance for Retired Employees • Other Non-Employee Insurance • Rental Lease of Equipment • Rental Lease of Buildings • Short Term Interest RANs • Other Fixed/Crossing Guards • School Crossing Guards
Benefits and Fixed Charges	-
Out-of-District Expenditures	• Tuition to Mass. Schools • Tuition for School Choice • Tuition to Commonwealth Charter Schools • Tuition to Horace Mann Charter Schools • Tuition to Out-of-State Schools • Tuition to Non-Public Schools • Tuition to Collaboratives • Transportation

Notes: Spending categories that are not included in the per pupil expenditure calculations are: community services, fixed assets, and debt service.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

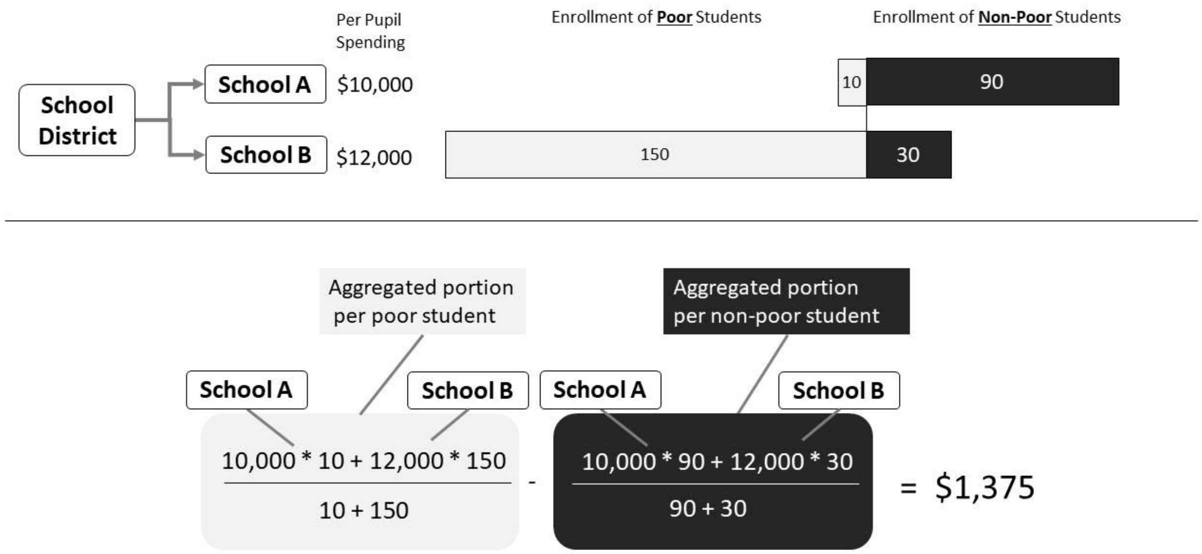


Figure 4. Example of progressivity calculations for a school district

Table 5**.** Per pupil spending at the school level in fiscal year 2017, Massachusetts ($1,000)

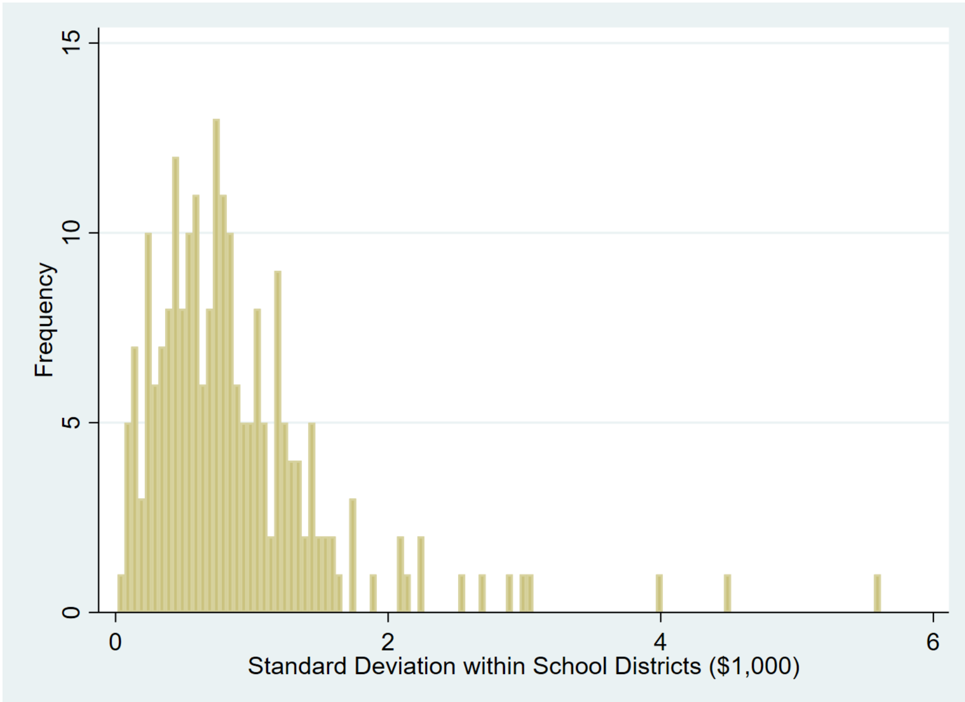
	All schools (1)	Schools in which grades three to seven take MCAS test in 2017, excluding charter schools (2)
State total	15.45	15.13
Mean	16.11	15.54
Max	82.48	41.14
Min	7.22	10.22
Standard deviation	4.79	3.57
Observations	1,834	1,275

Notes: State total is total spending divided by student number. Mean is sum of each school's per pupil spending divided by the number of schools.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 6. Standard deviation of per pupil spending within Massachusetts school districts where there is more than one elementary/secondary school ($1,000)

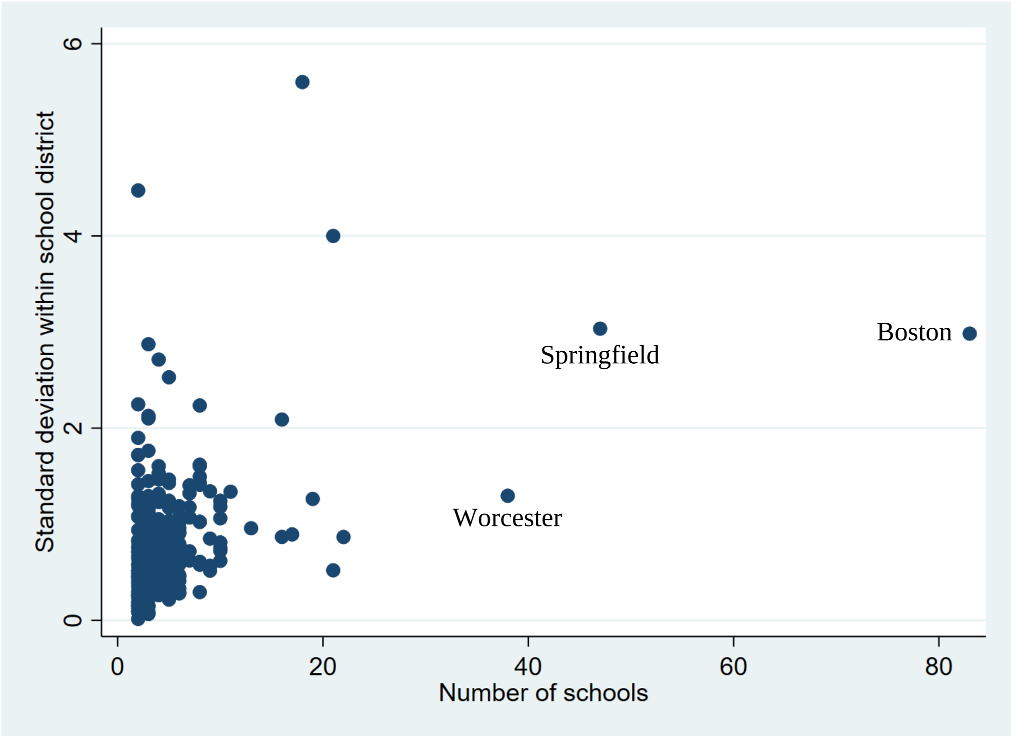
	Standard deviation of per pupil spending
Mean	0.88
Max	5.60
Min	0.015
Standard deviation	0.71
Observations	220

Notes: Only includes school districts which have more than one school, and where students in grades three to seven take the MCAS test in 2017. One school district is not included, because per pupil spending at the school level is unavailable. Charter schools are excluded.
Source: Massachusetts Department of Elementary and Secondary Education 2019.



N=220. Only includes school districts that have more than one school, in which students in grades three to seven take the MCAS test in 2017. One school district is not included, because per pupil spending at the school level is unavailable. Charter schools are excluded.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Figure 5. Distribution of standard deviation of per pupil spending at the school level within Massachusetts school districts in fiscal year 2017



N=220. Only includes school districts that have more than one school in which students in grades three to seven take the MCAS test in 2017. One school district is not shown, because per pupil spending at the school level is unavailable. Charter schools are excluded.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Figure 6. The relationship between the number of schools and standard deviations of per pupil spending at the school level within Massachusetts school districts in fiscal year 2017

Table 7. Association between each variable and per pupil spending ($1,000) at the school level in fiscal year 2017, Massachusetts

	(1)	(2)
Percentage of EDAs (%)	-0.030** (0.0079)	0.012** (0.0043)
Percentage of ELLs (%)	0.072** (0.027)	0.0043 (0.0034)
Percentage of disabled students (%)	0.22** (0.027)	0.17** (0.019)
Constant	12.09** (0.49)	12.18** (0.33)
R-squared	0.20	0.93
Number of school district	286	286
School District FE	NO	YES

Notes: N = 1,275. Schools in which students in grades three to seven take the MCAS test in 2017, excluding charter schools. Columns (1) and (2) correspond to equation (4) and (5) in the text, respectively. EDAs: Economically disadvantaged students. ELLs: English language learners. Clustered standard errors are in parentheses.
* p<0.05, ** p<0.01.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 8-1. Descriptive statistics of MCAS math scores and independent variables at the school district level, Massachusetts

	Mean	Standard deviation	Min	Max
MCAS 2018 math	499.93	7.62	475.70	519.56
Percentage of EDAs (%)	25.12	18.20	0.00	84.20
PPS ($1,000)	14.82	2.59	9.93	27.74
Progressivity ($1,000)	0.05	0.32	-1.21	1.78
MCAS 2017 math	500.41	7.50	475.90	518.33

Notes: N = 220. Only includes school districts that have more than one school in which students in grades three to seven take the MCAS test in 2017. One school district is not shown because per pupil spending at the school level is unavailable. Charter schools are excluded. MCAS: Test score of Massachusetts Comprehensive Assessment System, which ranges from 440 to 560. EDAs: Economically disadvantaged students. PPS: Per pupil spending. Percentage of EDAs is calculated based on enrollments (test takers) for math test from 4 to 8 grades in 2018. PPS and progressivity are calculated based on enrollments for English from 3 to 7 grades in 2017.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 8-2. Descriptive statistics of MCAS English scores and independent variables at the school district level, Massachusetts

	Mean	Standard deviation	Min	Max
MCAS 2018 English	502.24	7.47	479.17	519.85
Percentage of EDAs (%)	25.15	18.21	0.00	84.18
PPS ($1,000)	14.82	2.59	9.94	27.73
Progressivity ($1,000)	0.052	0.32	-1.21	1.78
MCAS 2017 English	501.02	6.63	479.75	517.65

Notes: N = 220. Only includes school districts that have more than one school in which students in grades three to seven take the MCAS test in 2017. One school district is not shown because per pupil spending at the school level is unavailable. Charter schools are excluded. MCAS: Test score of Massachusetts Comprehensive Assessment System, which ranges from 440 to 560. EDAs: Economically disadvantaged students. PPS: Per pupil spending. Percentage of EDAs is calculated based on enrollments (test takers) for English test from 4 to 8 grades in 2018. PPS and progressivity are calculated based on enrollments for English from 3 to 7 grades in 2017.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 9-1. Effects of each variable on MCAS 2018 math scores at the school level

	(1)	(2)
Percentage of EDAs (%)	-0.042** (0.0084)	-0.037** (0.014)
PPS ($1,000)	-0.041 (0.033)	-0.085 (0.080)
MCAS 2017 math	0.82** (0.021)	0.80** (0.024)
Observations	1,221	1,221
R-squared	0.90	0.93
Number of School districts	286	286
School district fixed effect	NO	YES

Notes: See equation (2) in the text. MCAS: Massachusetts Comprehensive Assessment System. EDAs: Economically disadvantaged students. PPS: Per pupil spending. Both columns control for the percentage of English language learners, students with disabilities, gender, racial/ethnic composition, and enrollments. For brevity, I do not report these coefficients. Clustered standard errors are in parentheses.
$*$ p<0.05, ** p<0.01.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 9-2. Effects of each variable on MCAS 2018 math scores at the school district level

	All school districts (1)	Excluding three largest districts (2)	Group 1 (3)	Group 2 (4)
Percentage of EDAs (%)	-0.083** (0.017)	-0.080** (0.018)	-0.051* (0.021)	-0.13** (0.030)
PPS ($1,000)	0.085 (0.047)	0.093 (0.048)	0.15* (0.062)	0.048 (0.099)
Progressivity ($1,000)	0.38 (0.25)	0.039 (0.26)	0.254 (0.394)	0.50 (0.80)
MCAS 2017 math	0.77** (0.034)	0.77 (0.035)	0.86** (0.043)	0.68** (0.046)
Observations	220	217	124	96
R-squared	0.96	0.96	0.97	0.95

Notes: See equation (3) in the text. MCAS: Massachusetts Comprehensive Assessment System. EDAs: Economically disadvantaged students. Column (2) excludes three largest school districts: Boston, Springfield and Worcester where there are apparently larger numbers of schools (see Figure 6). PPS: Per pupil spending. Group 1: progressive school districts. Group 2: regressive or zero-progressivity school districts. All columns control for the percentage of English language learners, students with disabilities, gender, racial/ethnic composition, numbers of schools, and enrollments. For brevity, I do not report these coefficients. Robust standard errors are in parentheses.

∗ $p<0.05$, ** $p<0.01$.

Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 9-3. Effects of each variable on MCAS 2018 English scores at the school level

	(1)	(2)
Percentage of EDAs (%)	-0.044** (0.011)	-0.052** (0.018)
PPS ($1,000)	-0.058 (0.055)	-0.12 (0.24)
MCAS 2017 English	0.88** (0.026)	0.83** (0.031)
Observations	1,221	1,221
R-squared	0.89	0.92
Number of School districts	286	286
School district fixed effect	NO	YES

Notes: See equation (2) in the text. MCAS: Massachusetts Comprehensive Assessment System. EDAs: Economically disadvantaged students. PPS: Per pupil spending. Both columns control for the percentage of English language learners, students with disabilities, gender, racial/ethnic composition, and enrollments. For brevity, I do not report these coefficients. Clustered standard errors are in parentheses.

∗ $p<0.05$, ** $p<0.01$.

Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 9-4. Effects of each variable on MCAS 2018 English scores at the school district level

	All school districts (1)	Excluding three largest districts (2)	Group 1 (3)	Group 2 (4)
Percentage of EDAs (%)	-0.084** (0.014)	-0.083** (0.14)	-0.072** (0.018)	-0.094** (0.025)
PPS ($1,000)	0.15** (0.055)	0.16** (0.055)	0.12 (0.063)	0.14 (0.12)
Progressivity ($1,000)	0.29 (0.38)	0.30 (0.39)	0.042 (0.54)	-0.73 (0.89)
MCAS 2017 English	0.85** (0.043)	0.85** (0.043)	0.93** (0.062)	0.80** (0.055)
Observations	220	217	124	96
R-squared	0.94	0.94	0.96	0.93

Notes: See equation (3) in the text. MCAS: Massachusetts Comprehensive Assessment System. EDAs: Economically disadvantaged students. Column (2) excludes three largest school districts: Boston, Springfield and Worcester, where there are apparently larger numbers of schools (see Figure 6). PPS: Per pupil spending. Group 1: progressive school districts. Group 2: regressive or zero-progressivity school districts. All columns control for the percentage of English language learners, students with disabilities, gender, racial/ethnic composition, numbers of schools, and enrollments. For brevity, I do not report these coefficients. Robust standard errors are in parentheses.
$*$ p<0.05, ** p<0.01.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 10-1. Effects of each variable on MCAS 2018 math scores of EDAs at the school district level

	All school districts (1)	Excluding three largest districts (2)	Group 1 (3)	Group 2 (4)
Percentage of EDAs (%)	-0.057** (0.017)	-0.057** (0.018)	-0.041 (0.025)	-0.096** (0.032)
PPS ($1,000)	0.097 (0.13)	0.11 (0.13)	0.084 (0.097)	0.21 (0.21)
Progressivity ($1,000)	-0.54 (0.86)	-0.55 (0.87)	-0.62 (1.1)	1.42 (1.48)
MCAS 2017 math of EDAs	0.68** (0.066)	0.68** (0.070)	0.65** (0.096)	0.65** (0.054)
Observations	214	211	123	91
R-squared	0.82	0.82	0.83	0.84

Notes: See equation (3) in the text. MCAS: Massachusetts Comprehensive Assessment System. EDAs: Economically disadvantaged students. Column (2) excludes three largest school districts: Boston, Springfield and Worcester, where there are apparently larger numbers of schools (see Figure 6). PPS: Per pupil spending. Group 1: progressive school districts. Group 2: regressive or zero-progressivity school districts. All columns control for the percentage of English language learners, students with disabilities, gender, racial/ethnic composition, numbers of schools, and enrollments. For brevity, I do not report these coefficients. Robust standard errors are in parentheses.
∗ p<0.05, ** p<0.01.
Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 10-2. Effects of each variable on MCAS 2018 English scores of EDAs at the school district level

	All school districts (1)	Excluding three largest districts (2)	Group 1 (3)	Group 2 (4)
Percentage of EDAs (%)	-0.076** (0.020)	-0.075** (0.020)	-0.060* (0.025)	-0.10** (0.036)
PPS ($1,000)	0.028 (0.12)	0.038 (0.12)	-0.020 (0.13)	-0.017 (0.22)
Progressivity ($1,000)	0.016 (0.82)	-0.0070 (0.82)	-0.17 (1.1)	-0.076 (1.9)
MCAS 2017 English of EDAs	0.65** (0.079)	0.65** (0.080)	0.59** (0.12)	0.71** (0.092)
Observations	214	211	123	91
R-squared	0.76	0.75	0.79	0.74

Notes: See equation (3) in the text. MCAS: Massachusetts Comprehensive Assessment System. EDAs: Economically disadvantaged students. Column (2) excludes three largest school districts: Boston, Springfield and Worcester, where there are apparently larger numbers of schools (see Figure 6). PPS: Per pupil spending. Group 1: progressive school districts. Group 2: regressive or zero-progressivity school districts. All columns control for the percentage of English language learners, students with disabilities, gender, racial/ethnic composition, numbers of schools, and enrollments. For brevity, I do not report these coefficients. Robust standard errors are in parentheses.

* p<0.05, ** p<0.01.

Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 10-3 Effects of each variable on MCAS 2018 math scores of NEDAs at the school district level

	All school districts (1)	Excluding three largest districts (2)	Group 1 (3)	Group 2 (4)
Percentage of EDAs (%)	-0.051** (0.015)	-0.048** (0.016)	-0.022 (0.018)	-0.091** (0.029)
PPS ($1,000)	0.084 (0.043)	0.091* (0.044)	0.16* (0.061)	0.015 (0.088)
Progressivity ($1,000)	0.37 (0.28)	0.39 (0.28)	0.065 (0.45)	0.52 (0.79)
MCAS 2017 math of NEDAs	0.81** (0.036)	0.82** (0.037)	0.92** (0.042)	0.71** (0.050)
Observations	220	217	124	96
R-squared	0.94	0.94	0.96	0.93

Notes: See equation (3) in the text. MCAS: Massachusetts Comprehensive Assessment System. EDAs: Economically disadvantaged students. NEDAs: Non-economically disadvantaged students. Column (2) excludes three largest school districts: Boston, Springfield and Worcester, where there are apparently larger numbers of schools (see Figure 6). PPS: Per pupil spending. Group 1: progressive school districts. Group 2: regressive or zero-progressivity school districts. All columns control for the percentage of English language learners, students with disabilities, gender, racial/ethnic composition, numbers of schools, and enrollments. For brevity, I do not report these coefficients. Robust standard errors are in parentheses.

∗ p<0.05, ** p<0.01.

Source: Massachusetts Department of Elementary and Secondary Education 2019.

Table 10-4. Effects of each variable on MCAS 2018 English scores of NEDAs at the school district level

	All school districts (1)	Excluding three largest districts (2)	Group 1 (3)	Group 2 (4)
Percentage of EDAs (%)	-0.066** (0.014)	-0.064** (0.014)	-0.062** (0.017)	-0.065* (0.027)
PPS ($1,000)	0.18** (0.060)	0.19** (0.061)	0.15 (0.077)	0.19 (0.12)
Progressivity ($1,000)	0.37 (0.42)	0.38 (0.43)	-0.071 (0.64)	-0.26 (0.88)
MCAS 2017 English of NEDAs	0.87** (0.044)	0.87** (0.044)	0.965** (0.069)	0.81** (0.056)
Observations	220	217	124	96
R-squared	0.91	0.91	0.93	0.90

Notes: See equation (3) in the text. MCAS: Massachusetts Comprehensive Assessment System. EDAs: Economically disadvantaged students. NEDAs: Non-economically disadvantaged students. Column (2) excludes three largest school districts: Boston, Springfield and Worcester, where there are apparently larger numbers of schools (see Figure 6). PPS: Per pupil spending. Group 1: progressive school districts. Group 2: regressive or zero-progressivity school districts. All columns control for the percentage of English language learners, students with disabilities, gender, racial/ethnic composition, numbers of schools, and enrollments. For brevity, I do not report these coefficients. Robust standard errors are in parentheses.

∗ p<0.05, ** p<0.01.

Source: Massachusetts Department of Elementary and Secondary Education 2019.