Incomplete Grade:
Massachusetts Education Reform at 15

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May 2009

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Dear Friend:

MassINC is proud to present *Incomplete Grade: Massachusetts Education Reform at 15*, a report made possible by the generous support of the Bank of America Charitable Foundation and Bank of America, N.A., Trustee of the Lloyd G. Balfour Foundation.

In a world defined by rapid change and increasing global competition, education must be a top priority for Massachusetts and the nation. Fifteen years ago, Massachusetts made a bold commitment to raise the educational standards of all children in Massachusetts with the passage of the 1993 Massachusetts Education Reform Act (MERA). Since then, the state has more than doubled its investments in local aid to schools while also creating standards and assessments to measure the progress. These standards have become national models of rigor and quality.

Today, as the nation is looking to replicate the successes of Education Reform in Massachusetts, the time is ripe to analyze the results of the state's investment, while also asking what the priorities of the next generation of education reform should be.

This research provides new evidence that the state's investment has had a clear and significant impact on student achievement. Education Reform has been successful in raising the achievement of students in previously low-spending districts. Without Education Reform, the achievement gap would be larger than it is today. Nonetheless, the achievement gap still looms large. We have yet to reach the goal of educating every student to achieve high standards. Given the scale of the state's investment, these findings suggest that doing more of the same will not close the achievement gap.

Over the last 15 years, there have been significant changes in the characteristics of Massachusetts public school students. Most notably, the share of low-income students has grown considerably. Increasingly, low-income students are becoming concentrated in certain school districts. In some districts, more than three-quarters of the students are low-income. There has been the growth of Limited English Proficient (LEP) students in some districts as well. Education leaders face important questions about how public policy can most effectively help these students succeed at higher levels.

As Education Reform has been implemented, there has been an accumulating body of evidence about successful practices of high-performing schools that educate predominantly low-income students. In general, these schools use different methods from those of the typical public school. Their guiding premise is that low-income students will require a more intensive education experience than middle-class students. They need more time in class, better-trained teachers, and a rigorous curriculum to enable them to achieve at high levels.

Even with all of these reforms, there are still tough questions to be asked about the limits of schools. No school, principal, or teacher can substitute for a child's parents and their responsibilities. Education begins at home, and unless we can bring parents and communities into the process, the impact of any reforms will be limited.

We are grateful to Tom Downes and Jeff Zabel of Tufts University. As this project turned out to be more complicated than we imagined, they helped us understand its complexity, while pushing the project to completion. We would also like to thank the many reviewers whose critical insights have strengthened this report and our thinking about Education Reform. Finally, we would like to thank our sponsors at Bank of America, who have been generous partners.

We hope you find *Incomplete Grade* a timely and provocative resource. As always, we welcome your feedback and invite you to become more involved in MassINC.

Sincerely,

Greg Torres
President

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Research Director

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EXECUTIVE SUMMARY

Massachusetts lives by its wits. The state's competitive advantage is its skilled and educated workforce. The advantages of a highly educated population will likely be even more important in the future. Education is the lifeblood to economic growth. It is also the key for families' ability to succeed economically. In a world defined by rapid change and increasing global competition, educating more people and arming them with a stronger set of skills and an advanced degree must be one of the state's and nation's top priorities.

Recognizing the importance of a strong education, Massachusetts made a bold commitment to raise the education standards for all children with the passage of the 1993 Massachusetts Education Reform Act (MERA).[1] As part of the reform efforts, the state has more than doubled its investment in local aid to schools while also holding local entities accountable by creating standards and assessments to measure the progress of students. These standards have become national models of rigor and quality.

Fifteen years after the passage of this landmark legislation, at a moment when the nation is looking to replicate the successes of education reform in Massachusetts, the time is ripe to analyze the results of the state's investment coupled with high standards and accountability measures. This research seeks to answer three questions that are at the core of the state's education reform efforts.[2] Did the Massachusetts Education Reform Act:

1. Provide adequate funding to all school districts and reduce disparities in spending between districts;
2. Raise the level of achievement for all students; and
3. Close the achievement gap, so that a student's chance for success does not depend on his or her zip code?[3]

The state's success in meeting these goals is mixed, with both clear progress and also goals not realized. The disparities in spending per pupil between different districts have been reduced, although some of the gains were lost following the economic downturn of 2001. In terms of achievement, the state ranks at the top of the states on the national standardized test, National Assessment of Education Progress (NAEP). Further, Massachusetts is at or near the top globally in science and math, based on the results of the Trends in International Mathematics and Science Study (TIMSS). At the same time, the achievement gap between different students and schools still looms large.

The achievement gap notwithstanding, this research provides new evidence that the state's investment has had a clear and significant impact. Specifically, some of the research findings show

1 Education reform was also the consequence of the 1993 court case of *McDuffy v. Robertson,* where the state's Supreme Judicial Court ruled that the Commonwealth had failed to meet its obligation to provide equal educational opportunity in the public schools for every child.

2 To answer these questions, we rely on several data sets. Our analysis of spending is based on CCD data, which include all spending. Our analysis of performance is based on comparing results from the Massachusetts Educational Assessment Program (MEAP) exams that were a statewide exam from 1986 to 1996 and MCAS scores. Because the tests are not directly comparable, we standardize the test scores for each year. This allows us to compare performance of districts across years and across the MEAP and MCAS tests. This means that the estimates of the impact of Ed Reform are measured in standard deviations of test scores. Finally, it also means the majority of our analysis is measuring relative rather than absolute changes in performance.

3 There are a number of ways in which impact could be measured, including share of students graduating from high school in four years or enrolling higher education (without need for remediation) or some other measures of learning. We choose to focus on achievement as measured by MEAP and MCAS test scores in part because other data are not available across districts over time. While test scores do not capture the full learning experience, they do allow us to make reliable comparisons between school districts and over time. Because we are relying on scores of many tests over many years, we believe this analysis accurately captures achievement levels.

how education reform has been successful in raising the achievement of students in the previously low-spending districts.[4] Quite simply, this comprehensive analysis documents that without Ed Reform the achievement gap would be larger than it is today.

Our analysis reveals that there has been a growing concentration of low-income students – those who are eligible for free or reduced-price lunches – in some school districts. In the districts that received the largest amount of state aid post-MERA, the growth of low-income students has been dramatic. As of 2006, in these districts, more than half of all students, on average, were low-income, which was a 23 percent increase since 1992. There have been similar trends in the share of Limited English Proficient (LEP) students, as well. Even with an additional infusion of resources, questions remain about the true impact of concentrated poverty on student achievement. As the state and nation debate the direction of education reform, urban education must be at the top of the agenda. While education reform in Massachusetts has raised the level of achievement across the board, our findings provide strong evidence that doing more of the same will not close the achievement gap.

Have Disparities in Spending Been Reduced?

A key element of Ed Reform was the creation of a new Chapter 70, which codified a new system of school financing. Prior to MERA, the amount of money that communities received was not determined by a consistent calculation of the need and fiscal capacity of a city or town.[5] In contrast, under MERA, Chapter 70 established a foundation budget system, which attempted to define both the minimum amount of funding that a community needed to provide an adequate education and the community's capacity to contribute to that amount. State aid became the difference between the foundation amount and the amount that the locality was expected to contribute.[6] The redesign of the financing system increased state aid to low-income and low-wealth communities.

The goal of MERA was to create a funding mechanism in which all districts had adequate funding to meet new higher standards of student achievement. As a matter of practice, achieving a consensus on adequacy of spending is difficult, and the courts and others use disparities in spending between different districts as a way of assessing adequacy of spending. Thus, in determining the impact of MERA, a central question is whether the disparities in spending were reduced after the law's enactment in 1993. Because there is no simple way to measure equality of spending, we use six different spending inequality measures. By every measure, spending was equalized throughout the 1990s.[7] This finding is consistent with other research that has found that implementation of court-ordered finance reforms, such as MERA, lead to more equal spending. These analyses generally conclude that the equalization occurs by bringing up the spending of districts at the bottom – often referred to as a leveling-up of low-spending districts.

The main beneficiaries of the increased state spending have been districts that educate large

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4 The term "low-spending" refers to the level of spending at the time of Ed Reform. One goal of MERA was to raise the level of achievement in low-spending districts by providing adequate funding and rigorous standards.

5 In this research, we use the terms Ed Reform and MERA interchangeably. It is also important to note that because the additional money and the introduction of standards happened simultaneously in Massachusetts, we are not able to separate their effects. When we refer to education reform, we are referring to both the additional resources and the introduction of high standards and accountability.

6 The funding formula was revised in 2007. Among other changes, the new formula increased money for English language learners and low-income students.

7 These measures include all spending by school districts, including privately raised money.

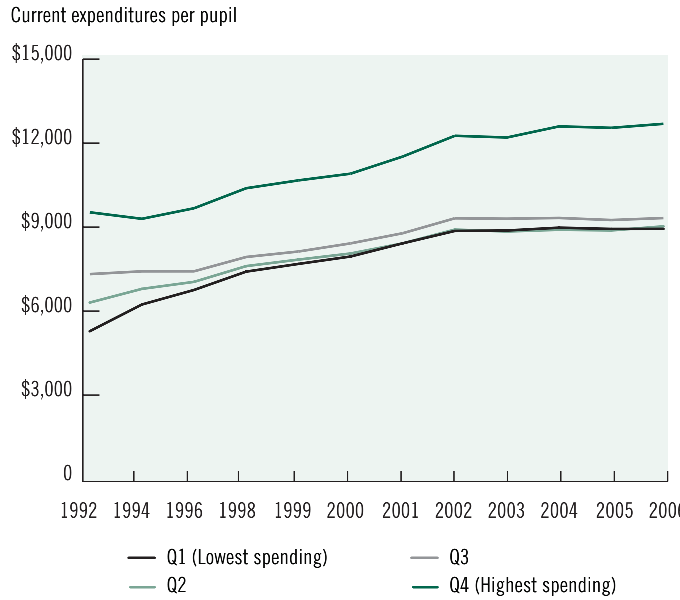
shares of low-income students (those who are eligible for free or reduced-price school lunches) and those that educate large shares of students who have limited English proficiency (LEP). State aid also grew the most in districts that had the lowest test scores at the time of Ed Reform. It is important to note that Ed Reform – responding to the court order of *McDuffy v. Robertson* – focused on making certain that low-spending districts had adequate funding to educate their students.[8] Low spending is not always the same as low performing or low income. In Massachusetts, as in other states, there are some districts, such as Boston and Cambridge, that are both relatively high spending and relatively low performing.

Although average spending per student has been equalized, a gap in spending remains between the highest-spending districts and other districts. We divide districts into quartiles based on the level of their spending in 1992. There has been a convergence in spending between the lowest three quartiles. Increases in state aid played a crucial role in bringing the average spending level of the lowest quartile up to those of the middle two quartiles. But, at the same time, a gap remains between the average of the highest spending quartile and the lowest three quartiles, and the size of this gap has remained essentially unchanged in real dollars since 1992 (ES Figure 1).

The recession in the early years of this decade led to declines in state aid for K-12 education in Massachusetts, and consequently, some of the initial gains in spending equality were lost. The districts that were most dependent on state aid suffered from the cuts, while the districts less dependent on state aid were able to continue at their previous funding levels. Despite this lost ground, as of 2005-06, the extent of spending inequality was still less than it was before Ed Reform. Yet, as the state and nation currently face a more severe and prolonged recession, there is a risk of additional cuts in state aid for K-12 education. Depending on the nature of these potential cuts and depending on the allocation of the federal stimulus money, we could return to greater inequality in the level of spending between districts, possibly back to the levels of inequality at the time of education reform.

ES Figure 1:

Trends in real spending per pupil (by quartiles of 1992 spending)



Where the Money Went

The districts that received the largest amount of state aid used the majority of these new dollars to increase spending on classroom services. This finding is consistent with research on education reforms nationwide. Classroom services

[8] With its 1993 decision in *McDuffy v. Robertson*, the Supreme Judicial Court in Massachusetts provided the impetus for major reforms in K-12 education. Within days of the court decision, the Massachusetts Education Reform Act (MERA) was signed into law. In the court decision, the court concluded that the Commonwealth had failed to meet its financial obligations, and that the state's fiscal support, or the lack of it, significantly impacts the quality of education that a child receives. The court found that "the reality is that children in the less affluent communities (or in the less affluent parts of them) are not receiving their constitutional entitlement of education as intended and mandated by the framers of the Constitution."

KEY FINDINGS

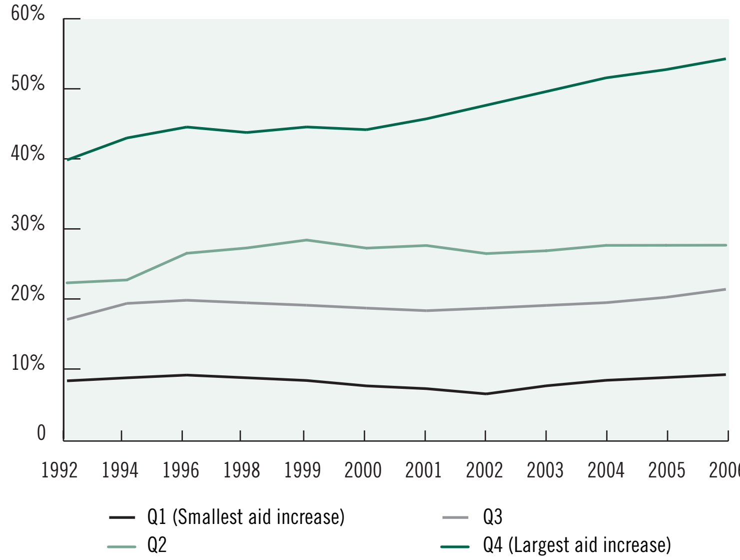
- Spending per student was equalized throughout the 1990s. Some of these gains have been lost because of cuts in state aid following the 2001 recession. Nonetheless, the extent of spending disparities is less than it was at the time of education reform.
- There is still a gap between the highest spending quarter of districts and the bottom three quartiles, while there has been a convergence among districts in the bottom three quartiles since 1992. The gap between the top quartile and the bottom three has remained essentially unchanged in real terms.
- The majority of the new money has been spent on classroom services.
- There has been a dramatic growth in the share of low-income students – those students eligible for free or reduced-cost lunch – in the quartile of districts that received the largest amount of state aid post-MERA. In 1992, nearly 40 percent of students in these districts were low-income. By 2006, more than half (54%) were low-income. In some districts, such as Chelsea, Lawrence, Springfield, and Holyoke, more than three-quarters of the students are low-income.
- In 2007, Massachusetts ranked first among all states on three of the four national NAEP exams. In an international standardized test (TIMSS), Massachusetts students ranked at or near the top in science and math in 2007.
- If the simple question – has the achievement gap between low-spending and high-spending districts closed – is asked, the answer is no. But that question does not take into account the performance trends of the different districts. At the time of education reform, the performance trends of districts appear to be on different tracks.
- If we account for these baseline trends, we see a positive and significant impact of education reform on the relative performance of the low-spending districts. In all of the 4th grade exams, we find evidence of increasing impact over time, which suggests a cumulative positive impact on student performance. Without education reform, the achievement gap would be wider than it is today.
- In order to compare results across time and different tests, the impact is measured in units of standard deviations. In general, economists tend to see an impact of 0.5 standard deviation or greater as evidence of a meaningful impact. The magnitude of the impact of education reform has been considerable, measuring from 0.7 to 1.4 standard deviations (depending on the grade and test).
- There are only two statistically significant differences in the characteristics of the low-spending districts that made the largest gains since the implementation of education reform compared with those that did not: growth in district size and declines in the percentage of limited-English-proficient (LEP) students between 1992 and 2006.

refer to instructional expenditures. In the Common Core of Data, which is our source of data on expenditures, instructional expenditures are "current operation expenditure for activities dealing with the interaction of teachers and students in the classroom, home, or hospital as well as co-curricular activities." Districts are asked to "[r]eport amounts for activities of teachers and instructional aides or assistants engaged in regular instruction, special education, and vocational education programs. Exclude adult education programs."

At the same time, there is a statewide trend of growing special education costs. These costs have grown across low-spending districts as well as high-spending districts. In 1998, 16.7 percent of all education spending in the Commonwealth was devoted to special education. By 2006, that number had increased to 19.1 percent of all education spending. Since costs have grown everywhere, they do not explain differences in performance between the different districts. Nonetheless, it is noteworthy to flag special education costs as an issue that constrains districts' abilities to provide other services.

ES Figure 2:

Trends in Percent of Low-Income Students (by quartile of change in state aid)



Changing Student Demographics: Rising Number of Low-Income Students

Over the last 15 years, as education reform has been implemented, there have been significant changes in the characteristics of Massachusetts public school students. Most notably, the share of low-income students in the state's public schools has grown considerably. Between 1992 and 2006, the state average of low-income students increased from 22.3 percent to 28.0 percent. The increase, however, has not occurred equally across school districts. Rather, low-income students have increasingly become concentrated in the districts that received the largest increases in state aid post-MERA.[9] The concentration could be a result of increased poverty among new students or the loss of middle-class students. Most likely, it is a combination of both these factors. Between 1992 and 2006, the share of low-income students in these districts as of 1992 increased from nearly 40 percent to 54 percent (ES Figure 2). That is, more than half of the students in these districts are low-income.

The quartile with the largest increases in state aid consists of 53 school districts. While the average share of low-income students is 54 percent among these districts, large differences exist among these communities. In 2008, Chelsea, with 87 percent of the students qualifying for free or reduced-cost lunch, had the highest share of low-income students in the Commonwealth. It was followed by Lawrence, Springfield, Holyoke, and Lynn, districts in which three-quarters or more of students were low-income (ES Table 1).

INCREASINGLY, LOW-INCOME STUDENTS HAVE BECOME CONCENTRATED IN CERTAIN DISTRICTS

Other cities had high shares of low-income students at the time of education reform and have also experienced significant growth in low-income students since that time. Consider Brockton: Seventy-two percent of its students in 2008 were low-income, which was an increase of 103 percent since 1992. Everett and Randolph

9 State aid changes were measured from fiscal year 1992 to fiscal year 1996.

ES Table 1:

Top 10 Districts with the Highest Share of Low-Income Students, 2008

	PERCENT
Chelsea	86.8
Lawrence	82.9
Springfield	78.5
Holyoke	76.7
Lynn	75.4
Brockton	71.5
Boston	71.4
Lowell	66.6
Fall River	66.5
New Bedford	66.0

Source: Massachusetts Department of Elementary and Secondary Education website
Note: These tables exclude vocational technical schools and charter schools because they were not included in our analyses.

ES Table 2:

Ten Districts with the Largest Percentage Point Increase of Low-Income Students, 1992 to 2008

	1992	2008	PP CHANGE*	%CHANGE
Brockton	35.2	71.5	36.3	103%
Everett	29.7	63.8	34.1	115%
Randolph	11.6	43.1	31.5	272%
Lynn	46.1	75.4	29.3	64%
Greenfield	28.3	55.6	27.3	96%
Springfield	51.5	78.5	27.0	52%
Southbridge	38	64.4	26.4	69%
Malden	27.4	52.8	25.4	93%
Somerville	39.8	64.9	25.1	63%
Revere	37.5	62.3	24.8	66%

* Percentage Point Change
Source: Massachusetts Department of Elementary and Secondary Education website
Note: These tables exclude vocational technical schools and charter schools because they were not included in our analyses.

are other school districts which experienced large increases in low-income students over the last 16 years (ES Table 2). Several towns in the lowest-spending quartile saw declines in the share of low-income students, but these towns were the exception. Overall, there has been a dramatic rise in the share of low-income students in certain school districts.

National and Global Leaders in Achievement

The backdrop for debates about education reform is a changing economy, with rising skill standards and heightened global competition. As a state with limited natural resources, the competitive advantage of Massachusetts has been the knowledge and skills of its workforce. In order for the state to keep its edge, rigorous standards calibrated to meet the changing demands of the global economy were a must. For some, this was the key goal of education reform. By this measure, Ed Reform has been remarkably successful. At the time of education reform, the proficiency levels of Massachusetts students were above the national average. But, the gains in performance of Massachusetts students as education reform has been implemented have outpaced those of their national peers.[10] Massachusetts leads the country in its performance on the national standardized test (National Assessment of Education Progress or NAEP). In 2007, Massachusetts ranked first among all states on three of the four tests and tied for first place on the fourth NAEP test. Moreover, Massachusetts students are getting stronger. Since 2005, Massachusetts students improved in three of the four tests. Average SAT scores of

[10] Charles D. Chieppo and James T. Gass, "Accountability Overboard," *Education Next*, Spring 2009, no. 2. In their article, they also note that during the 1980s, the average verbal and math scores on the SAT by Massachusetts students were below the national average. Math scores were below average as late as 1992.

Massachusetts high school graduates have also increased.

In an international standardized test, Massachusetts students also stood out for their performance. The Trends in International Math and Science Assessment (TIMSS) exam is administered every 4 years in 59 countries around the world. In 2007, Massachusetts students tied for first on the grade 8 science exam, while the United States as a whole ranked only eleventh. Massachusetts 8th grade students were sixth in math; 4th graders were also near the top in both science and math.

At home, Massachusetts students have also shown gains in the Massachusetts Comprehensive Assessment System (MCAS) tests. The share of 10th graders passing MCAS on their first try has increased significantly. Nearly 90 percent (87%) of the class of 2009 passed on their first try, compared with only 47 percent of the class of 2000. Nationwide and worldwide, Massachusetts student are leaders in achievement and have gotten stronger since education reform has been implemented.

Closing the Achievement Gap

As impressive as the state's overall performance has been, there are wide gaps in performance. A central goal of education reform was to raise the achievement level in previously low-performing school districts and, by implication, to close the achievement gap between different groups of students. The idea that the relationship between a student's zip code and his or her level of achievement would be substantially reduced was a truly bold vision. At 15 years into the work of reaching that vision, the results are decidedly mixed – with both evidence of Ed Reform's impact in raising the level of achievement of the students in the low-spending districts and a confirmation that a substantial achievement gap remains.

If the simple question – has the achievement gap closed – is asked, the answer is no. Controlling for student demographics that are known to influence student achievement, we isolate the impact of Ed Reform, which includes both additional dollars and accountability measures.[11] We compare the performance of low-spending districts with high-spending districts – seeking to answer the question of whether the money invested in low-spending districts coupled with the accountability measures had an impact on achievement in relative terms.

A SUBSTANTIAL ACHIEVEMENT GAP REMAINS

That is, compared with the performance of high-spending districts, did the performance of low-spending districts improve? We analyze all available results for 4th and 8th grade math and English tests. The initial analysis shows that the relative performance in districts that had relatively low spending prior to MERA was, at best, unchanged after MERA.

This simple question is, however, misleading, because it does not take into account the baseline trends in performance of the different districts. When we look at the average scores between 1988 and 2006, we find that the relative performance of the high-spending districts was on an upward trajectory at the time of education reform. At the same time that the trajectory of 4th grade exams in the high-spending districts was upward, there appears to be a slight decline in the relative performance of the low-spending on the 4th grade exams (ES Figures 3 and 4). If

[11] Because the infusion of funding and the introduction of standards occurred simultaneously, we cannot separate their impacts and we consider them together as Ed Reform.

ES Figure 3:

Performance Trends of Top and Bottom Quartiles, Grade 4 Math

ES Figure 4:

Performance Trends of Top and Bottom Quartiles, Grade 4 Verbal

we want to truly isolate the effects of Ed Reform, it is important to control for these trends.

When we take into account these trends, the results are striking and demonstrate the significant impact of Ed Reform. These results indicate that the impact of education reform on the relative performance of low-spending districts has been positive. In fact, the results of three of the four exams (all tests except 8th grade math) show evidence of a positive impact of Ed Reform on the performance of low-spending districts. In the 4th grade exams, we find evidence of increasing impacts over time, which suggests a cumulative positive impact on student performance.

The magnitude of the impact is large and, in some cases, statistically significant. In order to be able to compare results across years and between two different tests (MEAP and MCAS), we measure the impact in units of standard deviations. To give a sense of scale, one standard deviation is roughly the size of the national black/white achievement gap. The difference between the achievement of the Brookline and the Boston public schools is slightly more than one standard deviation. More generally, economists tend to see an impact of 0.5 standard deviation or greater as evidence of a meaningful impact.

By 2006, the lowest-spending districts showed relative increases of 0.7 to 1.4 standard deviations when we account for baseline trends. These are all very large impacts. These findings provide evidence that education reform in Massachusetts had a positive impact on raising the performance of the lowest-spending districts.[12] The results do indicate that, because of the dramatically different trends of high- and low-spending districts at the time of Ed Reform, the achievement gap stubbornly persists. Yet, our analysis makes it clear: Without education reform, the achievement gap in Massachusetts today would likely be wider.

What are the Characteristics of the Top Performing School Districts?

Looking to the future of education reform, we ask whether there are any lessons to be learned from the districts that made the greatest improvements in achievement. For this analysis, we divide all the districts in Massachusetts into the top 25 percent and the remaining 75 percent of districts. The school districts in the top 25% made the largest gains in performance since the implementation of education reform. We compare the characteristics of the top performers (of the previously low-spending districts) with the characteristics of all the other previously low-spending districts, asking the question: Are there any statistically significant differences between the top performers and the other districts? We find two significant differences, which are: Growth in District Size and Share of Limited English Proficient (LEP) students.

Growth in District Size

The top-performing school districts had greater growth in student enrollment between 1992 and 2006 than the other districts. This finding suggests that larger districts are not a barrier to gains in performance. Our findings are consistent with other research that argues that districts can take advantage of the benefits of scale without sacrificing performance. District consolidation allows districts to streamline administration and management structures and thus reduce costs. Our findings also highlight an important caution concerning consolidation. The gains from consolidation are achieved through reducing administrative costs. We find that larger schools were less likely to be the top performers. Thus, if policies encouraging consolidation of administration are pursued, a focus should be on the consolidation of districts, not schools. Merging schools can reduce or eliminate the gains from consolidation.

[12] These results are likely an upper bound on the impact of MERA since the linear trends are based on only a few data points and the impacts themselves are generally not individually significant at the 5% level.

ES Table 3:

Top 10 Districts with the Highest Share of LEP Students, 2008

	PERCENT
Lowell	30.4
Lynn	25
Holyoke	24.2
Lawrence	23.5
Worcester	20.6
Boston	19.1
Chelsea	18.8
Somerville	17.7
Brockton	14.8
Framingham	14.7

Source: Massachusetts Department of Elementary and Secondary Education website
Note: These tables exclude vocational technical schools and charter schools because they were not included in our analyses.

ES Table 4:

Ten Districts with the Largest Percentage Point Increase of LEP Students, 2001 to 2008

	2001	2008	PERCENTAGE POINT CHANGE
Lowell	13.4	30.4	17
Worcester	6.5	20.6	14.1
Lynn	13.3	25	11.7
Quincy	3.3	12.5	9.2
Tisbury	0	8.9	8.9
Brockton	7.6	14.8	7.2
Edgartown	0	7.1	7.1
Revere	4.6	10.2	5.6
Provincetown	0	5.6	5.6
Randolph	3.5	8.7	5.2

Source: Massachusetts Department of Elementary and Secondary Education website
Note: These tables exclude vocational technical schools and charter schools because they were not included in our analyses.

Limited English Proficient (LEP) Students

The growth or decline in limited English proficient students is the other significant characteristic. The top-performing districts experienced a **decline** in the percentage of limited- English-proficient (LEP) students, while the remaining districts experienced an **increase** in the percentage of LEP students during the same time period.

Across the state, there are large differences between school districts regarding the share of the students with limited English proficiency. At 30.4 percent, the Lowell school district has the highest share of LEP students, followed by Lynn (25%), Holyoke (24.2%), and Lawrence (23.5%) (ES Table 3). Some schools districts have also experienced large changes in the share of LEP students over the last seven years.[13] Consider the Lowell school district, where the share of limited English proficient students increased from 13.4 percent to 30.4 percent. Worcester, Lynn, and Quincy have also experienced large increases as well (ES Table 4).

Previous MassINC research, in *The Changing Face of Massachusetts,* has documented the increase in the number of immigrants in Massachusetts, their importance to the economic health of the state, and the increasing numbers that have limited English speaking abilities.[14] In that research, we quantify the economic importance of the ability to speak English for workers participating in the labor market. For workers in the Massachusetts economy, we find that a good education alone is not enough. The ability to speak English well has also become a key ingredient for economic success. Immigrant youth (those between the ages of 16 and 24) who did not speak English well or at all were more likely to be high school dropouts than those immigrants who spoke English proficiently. Similarly, a recent study found that in Boston Public Schools

13 Districts started consistently reporting the share of Limited English Proficient Students in 2001.

14 Andrew M. Sum *et al., The Changing Face of Massachusetts.* Boston: MassINC, June 2005.

there has been a widening of the achievement gap between English learners and native English speakers.[15] This research shines a light on the need to think about the expanded role of K-12 schools and ways that English language classes can be integrated into the public schools. These findings also raise questions about the adequacy of resources for schools that educate large shares of LEP students.

Opportunities for Cost Savings

The passage of education reform triggered a huge state investment in K-12 education. Previous MassINC Research, in *Point of Reckoning: Two Decades of State Budget Trends,* identified education as one of the state's key spending priorities over the last 20 years. Between 1987 and 2006, state aid to schools climbed 44 percent to a total of $4.3 billion in 2006. State leaders kept their promise to provide an additional $1.1 billion of additional education aid annually by the year 2000. Despite the declines in spending in the early years of this decade, annual spending for K-12 education in 2006 was still more than $1 billion above 1987.[16]

Going forward, unless the state is prepared to write a blank check for education, attention to opportunities for cost savings is as important as strategies to increase performance levels. This was true even before the current economic downturn. The current recession and the state's large budget gap have, however, intensified the need for immediate cost-saving actions. In June 2008, the Administration assembled the Readiness Finance Commission, a group of business leaders, elected officials, and education experts and charged them with finding ways to fund education. As part of its charge, the Commission identified six specific opportunities to save costs. Our research adds evidence to their recommendations around regionalization and consolidating costs. Their other recommendations offer a good starting point for identifying cost savings opportunities. Specifically, the Commission recommends:

1. Reducing municipal employee health insurance costs by moving municipalities into the Group Insurance Commission (GIC) or programs with equivalent or better rates and enabling this action by granting plan design authority to municipal managers;
2. Reducing retiree benefit costs by moving retired teachers into Medicare;
3. Increasing efficiency and capacity through regionalization;
4. Maximizing federal Medicaid reimbursements for special education costs and exploring other avenues to reduce or spread costs;
5. Reducing procurement costs through procurement reform, enhanced use of collaboratives, and coordinated purchasing; and
6. Reducing energy costs through the use of energy savings companies (ESCOs), conservation campaigns, and better purchasing.[17]

The longer that the state waits to enact cost savings, the more severe the spending cuts will have to be. Thus, there is a real urgency for policymakers to take immediate action on cost-saving measures.

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15 Miren Uriarte, Rosann Tung, *et al., English Learners in Boston Public Schools in the Aftermath of Policy Change: Enrollment and Educational Outcomes, AY2003-AY2006*, Mauricio Gaston Institute for Latino Community Development and Public Policy, University of Massachusetts Boston, April 2009

16 Cameron Huff, "Point of Reckoning: Two Decades of State Budget Trends," MassINC, March 2008, especially pp 12-13.

17 The full Readiness Finance Commission report can be accessed at: http://www.mass.gov/Eeoe/Readiness%20Finance%20Commission%20 Final%20Report.pdf

Concluding Thoughts

This research provides evidence that education reform has made a positive difference in raising the achievement of the previously low-spending districts. Without Ed Reform, the achievement gap in Massachusetts would likely be larger than it is today. At the same time that we acknowledge the accomplishments resulting from the state's investment and accountability measures, the existing achievement gap still looms large. We have yet to reach the goal of educating every student to achieve high standards. Given the state's significant investment in K-12 education, the reality is that doing more of the same will not close the achievement gap. This conclusion leads to difficult questions regarding what should be the priorities of the next generation of education reform. The findings of this research should create an urgency and renewed commitment to K-12 education, especially in districts with large numbers of low-income students.

DOING MORE OF THE SAME WILL NOT CLOSE THE ACHIEVEMENT GAP

During the past 15 years, as education reform in Massachusetts has been implemented, there has also been a body of evidence accumulating from across the nation about successful practices. Nationally, researchers have sought to understand the key elements of high-performing schools in poor communities, and their findings must inform state policymakers. Our state's future prosperity depends on it, and so do our families. To close or narrow the achievement gap, we must be willing to place different ways of thinking on the table for immediate action. More targeted spending and additional resources may be necessary, but without dramatically new approaches, more money will not be sufficient to close the achievement gap.

There are real cost savings opportunities that should be enacted immediately, so that money can be strategically redirected. The findings of this research support efforts to consolidate districts without sacrificing the quality of education. In addition, others have identified ways that the Commonwealth can save significant dollars, including reducing health insurance costs by moving municipalities into the Group Insurance Commission (GIC) or programs with equivalent rates. While these issues are politically charged, they must be addressed in order to maximize the impact of the public's dollars. The money gleaned from these cost-saving measures should be directed toward policies and practices that will narrow the achievement gap.

Progress on student achievement will ultimately be limited until a central issue is truly addressed: the growing concentration of low-income and/or limited-English-proficient students in certain school districts. While the original state aid formula was designed to provide more resources to districts with growing share of low-income students, the adjustment is generally regarded as insufficient.

Richard Kahlenberg, a leading proponent of socioeconomic integration, argues that "students in middle-class schools are much more likely to be exposed to peers with high aspirations, teachers with high expectations, and parents who will ensure high standards."[18] He finds that a small number of school districts have begun using a student's family income as a factor in deciding where a student attends school. As of 2007, there were roughly 40 districts nationwide that took into account family income in school assignment. In Massachusetts, the city of Cambridge uses a system of "controlled choice" for school

[18] Richard Kahlenberg, "Economic School Integration," The Century Foundation, Idea Brief No. 2, February 2000, p. 4.

assignment, and this system integrates students primarily by family income.

In December 2001, the Cambridge school committee changed its requirements so that all public schools were within 15 percentage points of the district-wide percentage of students eligible for free or reduced-cost lunch. For instance, if 30 percent of students in Cambridge are eligible for free or reduced-price lunch, then all schools must have between 15 and 45 percent low-income students. The change in policy has led to greater socioeconomic integration. Because the change has been recent and the plan is being phased in one grade at a time, the full effects of socioeconomic integration are not yet known. But early indications suggest the plan is working well.[19] As positive as the Cambridge outcomes may turn out to be, the reality is that in Massachusetts there are huge limits on the potential of this approach within district lines because of the economic homogeneity of most school districts.

Education leaders must ask how public policy can address the challenges of concentrated poverty in schools. Are there ways in which the state can create incentives for cities and towns to integrate by family income? In the school districts with the high levels of poverty, it will be impossible to create middle-class schools within existing district lines. In those districts, are there lessons to be learned from the Metco Program, which sends students from Boston and Springfield schools to more affluent suburbs?[20] The state might consider creating a new obligation to provide more resources and services while also better integrating existing resources for low-income students and their families.

In general, high-performing schools that teach high-poverty students use radically different methods than those of the typical public school. In his article *What It Takes to Make a Student*, Paul Tough sums up the characteristics of the most successful schools: They set rigorous standards, keep students in school longer, and create a disciplined "can-do" culture.[21] A longer school day is essential, plus additional time for tutoring after a longer day and/or on the weekends, as well as shorter summer vacations. If students are behind grade level, it follows that they need more class time and extra teaching if they are to stand a chance of catching up. Through its Expanded Learning Time Initiative, Massachusetts is at the forefront of redesigning the school day with more time for learning and enrichment opportunities. Today, in Massachusetts, there are 26 schools serving more than 13,500 children implementing an expanded learning schedule. The early evaluations of these efforts show positive impact on teaching and learning.[22]

More time for learning may be an essential ingredient. The more general premise, however, is that low-income students require a more intensive education experience than that of many middle-class students. They need more time in class, better-trained teachers, and a rigorous curriculum to enable them to achieve at the same levels as middle-class children.

Of course, better than helping students catch up is preventing them from falling behind in the first place. Educators believe that 3rd grade is a critical marker in a child's education. By this grade, the signs of which children will struggle and be at risk of dropping out are clear. In 3rd

[19] Our description of Cambridge's integration plan comes from Richard Kahlenberg, "*Rescuing Brown v. Board of Education*: Profiles of Twelve School Districts Pursuing Socioeconomic School Integration," The Century Foundation, June 2007, pp. 28-34.

[20] For more on Metco, see Joshua Angrist and Kevin Lang, "Does School Integration Generate Peer Effects? Evidence from Boston's Metco Program," The American Economic Review, Vo. 94, No. 5 (Dec. 2004), pp. 1613-1634.

[21] Paul Tough, "What It Takes to Make a Student," *New York Times Sunday Magazine*, November 26, 2006, pp. 44.

[22] See "Redesigning Today's Schools to Build a Stronger Tomorrow: The Massachusetts Expanded Learning Time Initiative, 2007-2008 Annual Report," Massachusetts 2020.

grade, students transition from "learning to read" to "reading to learn."[23] After 3rd grade, students rely on literacy skills across all content areas. Other research confirms that by the end of 3rd grade, children must also have the math foundation skills for future success.[24] Early identification of at-risk students and aggressive intervention plans must be stepped up, realizing that in some schools the majority of students will need additional support. A focus on consistent assessment of student in early grades and intervention plans should be a priority.

Closer to home, there has also been a recent and influential study that compares the performance of students at Boston's charter, pilot, and traditional schools.[25] This research finds consistently positive effects for the city's charter schools on student achievement in all MCAS subjects at both the middle and high school levels. Currently, the state places several limits on the number and location of charter schools. Nationally, the Secretary of Education is targeting federal stimulus money toward states that embrace education reform, including removing the cap on charter schools. If Massachusetts raises or eliminates the cap on charter schools, this change could lead to new charter schools in a dozen communities, such as Boston, Holyoke, and Fall River, that are currently at the limit. In addition, the state should consider allowing effective charter schools serving high-poverty students to operate additional schools and thus allow for greater efficiencies and economies of scale. At the same time, the state should also be more aggressive about closing charter schools that are not working.

WE SHOULD REWARD TEACHERS WHO ARE EFFECTIVE IN INCREASING STUDENT ACHIEVEMENT

A robust system of vocational-technical schools with ties to job opportunities is important as another avenue of choice. The vocational-technical schools in Massachusetts have realized the importance of their students acquiring strong academic skills in addition to technical skills. A recent study finds that they have a better-than-average graduation and MCAS pass rate than similarly situated students. Moreover, almost all of the state's vocational and technical schools have waiting lists.[26] There are ways in which the Commonwealth could better leverage the resources of the voc-tech schools. Voc-tech schools could help increase the number of graduates in high-demand fields. The ability of voc-tech schools to offer technical associate degrees and certificates should be explored. In the meantime, the state should expand effective vocational-technical schools as one promising route to academic success.

Finally, there is a growing body of research that confirms what we all know to be true from our own experiences: Teachers make a huge difference in the quality of a student's education. Thomas Kane, professor of education and economics at the Harvard Graduate School of Education, and his colleagues have studied this issue extensively, quantifying the impact, or value-added, of teachers.[27] The research finds large differences between teachers' effectiveness but also that that teacher certification, a traditional crite-

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[23] See WBUR's Project Drop-out series at www.projectdropout.org.

[24] Brett V. Brown *et al.*, "Pre-Kindergarten to 3rd Grade (PK-3) School-Based Resources and Third Grade Outcomes.," *Cross Currents*, Issue 5, August 2007.

[25] Thomas Kane *et al., Informing the Debate: Comparing Boston's Charter, Pilot, and Traditional Schools*, prepared for the Boston Foundation, January 2009.

[26] Alison L. Fraser, "Vocational-Technical Education in Massachusetts," A Pioneer Institute White Paper, No. 42, October 2008.

[27] Robert Gordon *et al.*, " Identifying Effective Teachers Using Performance on the Job," The Brookings Institution, The Hamilton Project, Discussion Paper 2006-01, April 2006.

rion of measuring teacher quality, is not an indicator of effectiveness. Perhaps, more important, this research shows how within the first two or three years of teaching, a teacher's effectiveness is clear and measurable. After that period, effective teachers actually get better, and the weaker teachers fall further behind. Similarly, a recent evaluation by Mathematica Policy Research finds that teachers with alternative certification are as effective as teachers with traditional certification.[28]

These findings should spur a rethinking of the teacher hiring, training, and tenure process. Lower barriers to hiring coupled with more rigorous evaluation of teacher impact will lead to a more effective teacher corps, which, in turn, is critical for student achievement. As part of state policy, we should reward teachers who are effective in increasing student achievement and support a differentiated pay structure to draw the most effective teachers into the schools where they are needed the most. Quite simply, we need to find ways to place the most effective teachers in high-poverty schools.

Even with all of these reforms, there are still tough questions to be asked about the limits of schools to influence student achievement. No school, principal, or teacher can substitute for a child's parents and their responsibilities – to read to their children, engage with their children's schools, and attend parent/teacher conferences. There might be new ways to engage communities more systematically, making them partners in learning. Leaders across the state from the governor and mayors to business, community, and religious leaders should use the power of the bully pulpit to reinforce the message about the importance of education and the need for responsible parenting. But overall, education begins at home, and unless we find ways to bring parents and communities into the process, the impact of education reform will be limited.

The accomplishments of the Massachusetts Education Reform Act are clear, but the remaining challenges are large and demand new thinking. Since the time that Massachusetts enacted education reform, there is a growing body of work documenting success at educating low-income students to achieve high levels of success. The bottom line is that these schools use dramatically different approaches than those of the typical public school. If we are to meet today's challenges, we must be willing to support such efforts, even if they are controversial. The future of our state and our families depends on our ability to meet these challenges.

RECOMMENDATIONS:

- Reward teachers who are shown to be more effective in increasing student achievement
- Create incentives for policies that promote socioeconomic integration
- Create policies that place the most effective teachers in high-poverty schools
- Strengthen and expand policies to consistently assess students in early grades and provide intervention
- Promote policies that encourage longer school days for high poverty schools and create a targeted initiative around an expanded school year
- Raise the state cap on charter schools and consider allowing effective charter schools to operate additional schools
- Expand the capacity of effective vocational-technical schools
- Encourage cost savings measures, such as moving municipalities into the Group Insurance Commission (GIC)

[28] Jill Constantine *et al.*, "An Evaluation of Teachers Trained Through Different Routes to Certification," Institute of Education Sciences, U.S. Department of Education, NCEE 2009-4043, February 2009. Available at: http://www.mathematica-mpr.com/publications/pdfs/education/teacherstrained09.pdf

1. INTRODUCTION

In 1993, the Massachusetts Education Reform Act (MERA) sparked an unprecedented era of reform of K-12 education in the state. Since the passage of this landmark legislation, the state has more than doubled its local aid to schools and held local entities accountable by creating standards and assessments upon which the progress of all students is measured. These standards and assessments have become national models of rigor and quality.

The set of strategies embodied in the state's education reform have become models for other states contemplating ambitious and dramatic school reforms. Both the modifications of the system of school finance and the changes in policies and practice have been offered up as models. Since more than ten years have passed since MERA, the time is ripe and sufficient information available for a comprehensive analysis of the impact of educational reform in Massachusetts. Put simply, has the money from educational reform made a difference and, if so, where?

The reforms have been viewed as a model for other reform efforts because the legislation set new high standards for student performance accompanied by the financial investment needed to equalize resources across school districts. Further, MERA mandated the creation of a set of accountability measures which made it possible to track student progress towards those standards and which gave educators the data to guide and measure their own improvement efforts. New in this effort was the expectation that it would be possible for all students to achieve these standards because of the massive financial restructuring that would enable schools across the state to offer their students the opportunity to meet standards that were explicitly linked to the ambitious curriculum frameworks that were developed as a result of MERA. Because providing all students with the opportunity to learn was at the core of MERA, the state's new formula for making more equal the availability of financial resources between rich and poor towns, and the sheer size of the overall investment, was the reform's cornerstone.

Observers have argued that the performance of Massachusetts students on standardized tests indicates that MERA has been successful. Much mentioned is the fact that the percentage of 10th graders passing on their first try of the tests administered as part of the Massachusetts Comprehensive Assessment System (MCAS) has increased from 47 percent for the class of 2000 to 87 percent for the class of 2009. The improved performance of Massachusetts students on tests that are administered nationally is also frequently mentioned as an indication of the success of MERA. For example, 4th and 8th graders in Massachusetts have, since 2005, had the highest mean score in the nation on the National Assessment of Education Progress (NAEP) tests. And the recent increases in the mean SAT scores of Massachusetts high school graduates (Schworm, 2008) continues a period of relatively strong performances on this test by Massachusetts' students.

The performance of Massachusetts students relative to their peers elsewhere in the nation could well indicate that the commitment to elementary and secondary education resulting from MERA has translated into gains in Massachusetts relative to the rest of the nation. Given the nature of available data on student performance, in this study we will not, however, be able to determine if any such relative gains are attributable to MERA. But, as will hopefully be made clear by the discussion that follows, improving the performance of students in Massachusetts relative to those in the rest of the nation was probably not the primary goal of the reform. The most apparent goal of MERA was to create an elementary and secondary education system in which all districts had adequate funding such that a student's chances for success were independent of where she lived. In this study, we will evaluate the extent to which MERA has succeeded in accomplishing this goal.

Because additional financial investment was a central element of the reform effort, the first question we must answer in this research is how the distribution across districts of per pupil spending has changed. We will also analyze which districts have received the most financial investment from the state and how those districts have spent the money they received.

We will then turn to the distribution of student outcomes before and after MERA. Prior to education reform, there was statewide testing as part of the Massachusetts Educational Assessment Program (MEAP). After the legislation, the state developed a set of curriculum frameworks and linked the new testing program, the MCAS, to those frameworks. While the tests that are part of these different programs are not directly comparable, the available information on relative performance of school districts before and after education reform permits us to determine which districts have improved, relatively speaking, and which ones have not. We will also present information on the financial and demographic characteristics of the districts that have succeeded the best in raising student achievement, focusing particularly on the extent to which relative performance has improved in districts which received additional financial resources.

We find that the finance reforms that were implemented after MERA resulted in more equal education spending in Massachusetts. Before the reforms, districts serving larger shares of at-risk students tended to have lower levels of current spending per pupil; now these districts tend to have above average spending. The extent of equalization has, however, declined in the recent years. The growth in inequality was largest in the years in which the state fiscal condition was weakest and state aid was stagnant.

We also find that, when we do not account for trends in performance, relative performance in districts that had relatively low spending prior to MERA was, at best, unchanged after MERA. But we find evidence that, in the absence of MERA, the relative performance of the high spending districts was trending upwards compared to the low spending districts. When we account for these trends, we find that the relative performance of the previously low-spending districts generally improved in comparison to student performance in their higher spending counterparts. In other words, we find some evidence that, for those districts MERA was intended to help, the reforms served to negate the effects of trends that would have resulted in declining relative performance. Thus, even though we find no evidence of closing of performance gaps, the reforms appear to have helped the districts at which they were targeted. This result should be viewed with caution since these trends are based on only a few data points. Hence, we are left with a range of plausible impacts of MERA from having no impact (without trends) to having a fairly large positive impact (with trends) on student performance.

When we attempt to determine if districts that exhibited exceptional performance gains post-MERA share certain characteristics, we find few common attributes among the top performers. One commonality is that exceptional performers had slower growth in the percentage of limited English proficient (LEP) students. Such a result would be expected if the aid formula failed to compensate adequately for the cost of serving LEP students.

In the next section of this paper, we provide some background on the education reforms. Then, after briefly reviewing the relevant literature, we describe the data we use. We follow this description of our data with a description of the changes in the distribution of education spending brought about by MERA. We then turn to the empirical models we use to examine the impact of MERA on the distribution of student performance. We close the paper by summarizing the implications of our results.

2. EDUCATION REFORM IN MASSACHUSETTS: BACKGROUND

With its 1993 decision in *McDuffy v. Robertson*, the Supreme Judicial Court in Massachusetts provided the impetus for major reforms in the manner in which K-12 education was delivered. For, while there had been attempts to reform finances and delivery in the decade prior to the *McDuffy* decision, only after the decision did legislation that instituted substantive reforms become law.

The Massachusetts Education Reform Act (MERA), which was signed into law within days of the *McDuffy* decision, increased the extent to which schools controlled the delivery of education and implemented several important programmatic reforms. But the central element of MERA was the creation of Chapter 70, which codified a new system of school financing. Prior to MERA, the system of financing was nominally a foundation system. Foundation aid was determined not by any calculation of the need and capacity of each community, however, but by state policy makers determining an aid budget given available state resources. The result was aid amounts that moved with the business cycle, and inequality in spending that also moved with the cycle.

Chapter 70 established a foundation system under which, in theory, each district's need determined minimum spending in that district. Need for a representative district was input-based (Downes and Stiefel, 2007),[1] with adjustments made for variation in such cost determinants as the number of low income students served and the fraction of students with limited English proficiency. The result was an increase in total aid, with much of the increase in aid going to districts that had previously been low spending.

As with any foundation system, aid for any locality was the difference between that locality's foundation amount and the amount that locality was expected to contribute from local revenues. Each locality's expected contribution was based on the fiscal capacity of the locality as determined under the legislation. Capacity was calculated by combining information on each community's property wealth and income to generate a quantity known as adjusted equalized property value (AEQV).[2] While the manner in which the formula for AEQV combined information on property wealth and income was ad hoc, measuring capacity in this manner had the effect of targeting aid to communities with lower property wealth and lower mean income (Ardon and Costrell, 2001).

THE CENTRAL ELEMENT OF MERA WAS THE CREATION OF CHAPTER 70, WHICH CODIFIED A NEW SYSTEM OF SCHOOL FINANCING

Over time the financing system deviated from a textbook foundation system for several reasons. First, while in theory each community's expected contribution should have moved in concert with that community's fiscal capacity, in practice expected contribution increased according to the municipal revenue growth factor. The municipal revenue growth factor gives the most recent annual percentage change in each community's local revenues (such as the annual increase in the levy limit established by the state's property tax limitation measure Proposition 2½) that should be available for schools. Because each community's revenue growth, and thus its growth factor, depended on the extent to

1 Moscovitch (1992) details the process used to determine the input levels required to provide an adequate education.

2 Adjusted equalized property value was found by first calculating equalized property value and then multiplying by an adjustment factor that depended on how the community's income compared to the state average. A community with average income equal to the state average would have an adjustment factor of 1.

which that community's property tax revenues were permitted to grow under Proposition 2½, the expected contribution in many communities grew more slowly than capacity growth would have dictated.[3]

Second, after being set initially in 1993, the foundation level of spending in each district was never truly updated. Instead, the foundation amount was inflated upward using the price index for state and local government services. Thus, even if foundation amounts in 1993 had been correct, in the sense that they reflected the cost of providing each student with the education needed to meet state standards, over time the foundation amounts would have deviated from the costs of providing an adequate education.

These departures of the financing system from a textbook foundation system, along with other aspects of the system that resulted in students and taxpayers in similar communities being treated differently,[4] resulted in major modifications that took effect in the 2007 fiscal year (Berger and McLynch, 2006). The modifications established a method for systematically updating each community's target local contribution on an annual basis. As a result, in any year a community's target local contribution would be a sum of fixed percentages of that community's aggregate property values and aggregate personal income. Formal adjustment mechanisms were established to enable communities with large differences between actual and target local contributions to transition to having actual contributions in line with target contributions.

THE NEW FINANCING SYSTEM WAS DESIGNED TO INCREASE STATE AID TO LOW-WEALTH AND LOW-INCOME COMMUNITES

While the changes that took effect in fiscal year 2007 were designed primarily to reduce inequities, two important changes may have served to accentuate inequities. Under Chapter 70, all communities received aid, even those with capacity in excess of the capacity needed to fund foundation spending locally. After the new formula is phased in, the maximum share of foundation spending funded locally would be reduced to 82.5 percent.[5] As a result, even in the wealthiest communities, state aid funded at least 17.5 percent of foundation spending.

The modification that took effect in fiscal year 2007 also assured that communities with growing foundation spending would experience growth in state aid, even if the gap between a community's foundation spending and its target local contribution was unchanged or declining. This growth aid assured that districts with above average growth in property values and income would receive increases in aid. Since property values in Massachusetts have tended to grow more rapidly in higher-income communities and in communities in which measured student performance was higher (Case and Mayer, 1995), this change, along with the reduction in the maximum local share, may have served to reduce the extent to which cross-locality inequities in spending were reduced by the financing system.

While finance reforms were at the core of MERA, some of the programmatic reforms that were part of the act have had long-term effects on education in Massachusetts. Most important among these other reforms were the creation of curriculum frameworks that established learning expectations; the implementation of a rig-

[3] For each community, the municipal revenue growth factor was not allowed to exceed the growth in state aid.

[4] For example, actual contributions of many communities differed from formula contributions, and no mechanism existed to bring into alignment actual and target contributions.

[5] The original legislation established no cap on the locally-funded share of foundation spending.

orous system of accountability that applied to students, schools, and districts; and the creation of an assessment system, the Massachusetts Comprehensive Assessment System (MCAS), designed to evaluate progress towards meeting the learning expectations (Reville, 2007). Prior to MCAS, students took tests that were part of the Massachusetts Educational Assessment Program (MEAP). But the MEAP tests were neither high stakes nor linked to any learning expectations.

The combination of school finance reforms and substantive accountability in MERA was the result of a political compromise (Reville, 2007), not an explicit linking of accountability and changes in the financing system. Thus, while the expectation was that the finance reforms would make it possible for all communities to provide the type of education that was envisioned by the creators of the curriculum frameworks, the calculation of the foundation amounts did not involve any determination of the cost in each community of meeting the standards. The new financing system was designed to increase spending in low spending communities, to increase state aid to low wealth and low income communities, and to produce a less disperse distribution of spending. The system may have resulted in an increase in spending in communities with low pre-reform performance, but that outcome was not an explicit goal of the reform.

The absence of any explicit link between the finance reforms and the accountability system has been the norm. Only very recent reforms, such as the reform in Maryland in 2002 (Maryland Budget and Tax Policy Institute, 2004), have accounted for the state's academic standards in determining the resources that need to flow to each school district. As a result, the experience in other states with finance reforms and with accountability can help us to form expectations about the likely effects of the reforms in Massachusetts. As a result, it is to these experiences that we now turn.

3. WHAT ARE THE EFFECTS OF EDUCATION REFORM? A BRIEF REVIEW OF THE LITERATURE

In evaluating the effects of the education reforms in Massachusetts, we are adding to a growing body of literature that documents the impact of such reforms on the distributions, and sometimes the levels, of spending on public education and of student performance. The existence of a number of studies that parallel this one does not, however, eliminate the need for systematically documenting the impact of reforms in Massachusetts. As Downes (2004) notes, no two states have modified their finance systems in the same way. Similarly, the literature on the impact of accountability (e.g., Carnoy and Loeb, 2003; Braun, 2004) has documented the variation across states in the stringency of accountability efforts. As a result, each analysis of an individual state's reforms can, in combination with other like analyses, help policy makers trying to learn from past experience in order to best structure school finance or accountability reforms.

Nevertheless, previous analyses of the effects of finance and accountability reforms provide context for this evaluation of the effects of the reforms in Massachusetts. The reasonableness of any results that we estimate can be judged by relating these results to the estimated impacts of reforms in other states. In addition, previous analyses can guide us in choosing the methods we use for estimating the impacts of reforms.

3.1 The National Picture: Effects on Spending

Starting with the decisions of the California Supreme Court in the *Serrano v. Priest* case, the earliest court rulings on the constitutionality of state school finance systems focused on the cross-district equity of education spending. Even more recent decisions like *McDuffy* that have focused on whether the finance system makes it possible for all districts to provide an adequate education have been described by researchers (e.g., Briffault, 2006; Reich, 2006) as effectively being equity decisions. Thus, quantifying the equity implications is a natural starting point for evaluating any finance reform.

Much of the research on the impact of court-ordered finance reforms is nicely summarized in Corcoran and Evans' (2007) recent review of the literature. Uniformly, analyses of court-ordered finance reforms find that these reforms result in more equal spending. The literature has not, however, reached consensus on whether this greater equality is attributable to raising up the spending of districts at the bottom of the spending distribution or of leveling down the spending of districts at the top of the spending distribution. Corcoran and Evans note that research that has quantified the effect of finance reforms on mean per pupil spending in a state, such as Silva and Sonstelie (1995), Manwaring and Sheffrin (1997), and Downes and Shah (2006), has established that there is significant cross-state variation in the impact of court-ordered finance reforms on mean spending. That cross-state variation depends on characteristics of the state's population that affect the political landscape of the state.

National-level studies that have used district-level (as opposed to state-level) data, such as Corcoran and Evans (2007), Hoxby (2001), Evans, Murray, and Schwab (1997), and Murray, Evans, and Schwab (1998) have tended to confirm the conclusions drawn from state-specific analyses. Reforms that followed court mandates have equalized per pupil spending, though reforms that followed court decisions based on adequacy grounds have resulted in less equalization (Corcoran and Evans, 2007). The district-level data used in these studies has made possible relatively nuanced examinations of the leveling-up/leveling-down question. Analyses, like those of

Corcoran and Evans (2007), Evans, Murray, and Schwab (1997), and Murray, Evans, and Schwab (1998), that treat court-mandated reforms as discrete, exogenous events have generally concluded that equalization happened through leveling-up, with spending increasing everywhere in the spending distribution. On the other hand, analyses that attempt to account for the political nature of spending decisions, like Hoxby (2001), tend to echo the conclusion of cross-state variability reached in some of the studies that used state-level data. In particular, Hoxby argues that the impact of a reform on spending in a district depends critically on the impact of that reform on the district's tax price. In the Massachusetts case, where the finance reform did not dramatically increase tax prices in high wealth and high income communities, it seems plausible that equalization results from the leveling-up of low spending districts. Because the data we use are for Massachusetts only, we will not be able to shed further light on this proposition.

3.2 The National Picture: Impact on Student Performance

The earliest attempt to document the impact of school finance reforms on student performance was Downes (1992), who showed that the extensive school finance reforms in California in the late 1970s generated greater equality across school districts in per pupil spending but not greater equality in measured student performance. The problem with using the California case as a benchmark is that it has proven to be the exception, not the rule. First, the limits imposed on local control over spending have not been duplicated in any other state. Even in Michigan and Vermont, the states in which the most extensive post-*Serrano* reforms have been implemented, some degree of local control over taxes and spending is permitted. Further, the population of students served by California schools changed more dramatically than the population of students in any other state in the nation. From 1986 to 1997, the percent of the California public school student population identified as minority increased from 46.3% to 61.2%. Nationally, the percent minority grew far more slowly, from 29.6% to 36.5%.[6] As Downes (1992) notes, these demographic changes make it difficult to quantify the impact of the finance reforms in California on the cross-district inequality in student achievement.

In response to the realization that lessons from California may not be generalizable and in an effort to examine the impact of finance reforms on mean student performance in reform states, a number of researchers attempted to use national-level data to determine how the level and distribution of student performance in a state was affected by a finance reform. These studies have varied in how they measured student performance, how they classified the nature of finance reforms, and how they characterized the distribution of student performance. Further, because the national-level nature of these analyses made cross-state comparisons possible, these studies tended to focus much of their attention on the impact of reforms on mean performance. These studies have not, however, produced a consistent vision of the impact of finance reforms on student performance. Several national-level studies indicate that relative performance may have declined in states in which finance reforms have been implemented. For example, Husted and Kenny (2000) suggest that equalization may detrimentally affect student achievement. Using data on 34 states from 1976-77 to 1992-93, they

[6] Generating comparable numbers for earlier years is difficult. Nevertheless, the best available data support the conclusion that these sharp differences in trends in the minority share pre-date the *Serrano*-inspired reforms. For example, calculations based on published information for California indicate the percent minority in 1977-78 was approximately 36.6%. Nationally, estimates based on the October 1977 Current Population Survey indicate the percent minority was 23.9%.

find that the mean SAT score is higher for those states with greater intra-state spending variation. However, the period for which they have test score information, 1987-88 to 1992-93, postdates the imposition of the first wave of finance reforms. Thus, the data do not permit direct examination of the effects of policy changes. In addition, because they use state-level data, Husted and Kenny cannot examine the degree to which equalization affects cross-district variation in test scores.[7]

Hoxby (2001), in contrast to Husted and Kenny, finds weak evidence that finance reforms may result in relative improvement in student outcomes. In particular, two of the specifications Hoxby presents indicate that dropout rates decline in districts in which foundation aid relative to income increases. Other specifications, however, indicate that there is no relationship between school spending and dropout rates. Thus, while it seems possible that finance reforms could improve the distribution of student outcomes, since it is likely that the increases in foundation aid relative to income would be largest in those districts with relatively high dropout rates prior to equalization, these results do not unequivocally imply that equalization could positively affect both the level and the distribution of student performance.

Card and Payne (2002), who explore the effects of school finance equalizations on the within-state distributions of SAT scores, offer a more sanguine picture of the effects of such finance reforms. They characterize a school finance policy as more equalizing the more negative is the within-state relationship between state aid to a school district and school district income. They find that the SAT scores of students with poorly-educated parents (their proxy for low income) increase in states that, under their definition, become more equalized. Data limitations, however, make it impossible for Card and Payne to examine the effects of policy changes on students residing in school districts in which the changes had the greatest impact.

Downes and Figlio (2000) attempt to determine how the tax limits and finance reforms of the late 1970s and early 1980s affected the distribution of student performance in states in which limits were imposed and how student performance has changed in these states relative to student performance in states in which no limits or no finance reforms were imposed. The core data used in the analysis were drawn from two national data sets, the National Longitudinal Study of the High School Class of 1972 (NLS-72) and the 1992 (senior year) wave of the NELS. The NELS data were collected sufficiently far from the passage of many of the earliest finance reforms[8] to permit quantification of the long-run effects of these reforms by analyzing changes in the distributions of student performance between the NLS-72 cross-section and the NELS cross-section.

Downes and Figlio find that finance reforms in response to court-decisions, like the reforms in Massachusetts, result in small and frequently insignificant increases in the mean level of student performance on standardized tests of reading and mathematics. Further, they note that there is some indication that the post-reform distribution of scores in mathematics may be less equal. This latter result highlights one of the central points of the paper; any evaluation of finance reforms must control for the initial circumstances of affected districts. The simple reality is that finance reforms are likely to have

7 Husted and Kenny do find evidence consistent with the conclusion that, in states in which school finance reforms occurred, these reforms had no impact on the standard deviation of SAT scores. Since, however, the standard deviation of test scores could be unchanged even if cross-district inequality in performance had declined, this evidence fails to establish that finance reforms do not reduce cross-district performance inequality.

8 A number of researchers have grouped finance reforms into waves. The first and second waves, in which the equity of the financing system was challenged, were both completed by the mid-1980s (Briffault, 2006).

differential effects in initially high spending and initially low spending districts.

The fundamental reason for the absence of clear predictions of the impact of finance reforms has been mentioned by a number of authors (e.g., Corcoran and Evans, 2007; Downes and Shah, 2006; Hoxby, 2001; Evans, Murray, and Schwab, 1997), all of whom have emphasized the tremendous diversity of school finance reforms. In a national-level study, any attempt to classify finance reforms will be imperfect. So, even though there is general consensus that the key elements of a finance reform are the effects of the reform on local discretion, the effects of the reform on local incentives, and the change in state-level responsibilities in the aftermath of reform (Hoxby, 2001; Courant and Loeb, 1997), different authors take different approaches to account for the heterogeneity of the reforms. The result is variation in predictions generated by studies that are asking the same fundamental question.

For that reason, a number of authors have chosen to analyze carefully the impact of reforms in individual states. Analyses of individual states also allow for examination of the effects of reforms in those districts likely to benefit most from the changes in the financing system. Recent examples of this style of work include evaluations of the reforms in Kentucky by Clark (2003) and Flanagan and Murray (2004), in Michigan by Roy (2003) and Papke (2005), in Kansas by Deke (2003) and Duncombe and Johnston (2004), and in Vermont by Downes (2004). While the contexts and the methods of analysis vary, most of these studies document relatively small reductions in variation in student performance in the aftermath of finance reforms. The strongest estimated effects are for Michigan, where both Roy and Papke document relative improvement of students in initially low-spending and low-performing districts, particularly in mathematics.

Strikingly, the results of the state-specific analyses of finance reforms do not appear to depend on the method used for quantifying the impact of the reforms. A number of authors (e.g., Papke, Deke, Flanagan and Murray) use an education production function-style analysis that relates spending to performance, other authors (Duncombe and Johnston, Downes) use an event analysis that compares performance before and after the reform for different types of districts, and still other authors (Clark, Roy) use both methods. The estimated effects of the reforms appear to depend far more on the context than the method, a conclusion that is particularly strongly supported by the Clark and Roy results.

3.3 The Impact of MERA: Early Analyses

Two analyses of the effects of the Massachusetts reforms are the most direct antecedents of the work in this paper. In the first of these analyses, Thomas Dee and Jeffrey Levine (2004) analyzed data on education spending drawn from the National Center for Education Statistics' Common Core of Data for school districts in Massachusetts, Connecticut, and Maine in fiscal years 1990, 1992, 1994, 1995, and 1996. By combining data from Massachusetts with data from Connecticut and Maine, they hoped to be able to quantify the impact of MERA not just on the distribution of spending but also on the level of spending. Dee and Levine find that, after the finance reforms, spending by school districts in Massachusetts did increase more rapidly than did spending by districts in Connecticut and Maine. Further, the increases were largest for districts with spending in the bottom two thirds of the pre-reform distribution of education spending. As a result, the finance reforms did reduce inequality in spending. And the low spending districts appear to have been allocating the additional dollars primarily to instructional expenditures, expenditures on student support services, and capital expenditures.

The second analysis, by Jonathan Guryan (2003), attempts to provide direct estimates of the impact of additional spending on student performance on the MEAP. To do this, Guryan takes advantage of the nonlinearities in overburden aid that was provided to school districts to ease the transition to the new financing system. Like Dee and Levine, Guryan finds that districts tended to allocate the new dollars towards instruction, particularly teachers. And these new resources appear to have mattered. The preponderance of Guryan's estimates indicate that increases in spending translated into significant increases in student performance.

Guryan's results provide a more positive picture of the effects of MERA than do those of the Beacon Hill Institute (2002). In that study, the Beacon Hill Institute found that increases in teacher salaries and reductions in the student-teacher ratio were associated with lower 2001 MCAS scores. Flaws in the analysis, including the failure to account for district-specific effects and for the potential endogeneity of schooling inputs, make these results a less relevant benchmark than are the results of Guryan.[9] Nevertheless, the contradictory nature of the results of these two studies makes further analysis of the effects of MERA imperative.

In addition, a drawback of the work of Dee and Levine and of Guryan is that these papers offer a picture of the short-term effects of MERA. The additional data currently available will enable us to generate estimates of the long-term effects. Further, Guryan is not able to indicate whether the added resources that flowed to districts after MERA translated into better performance on the MCAS, the test that was linked to the new curriculum standards. Again, our data enable us to determine if, in fact, the infusion of funds enabled districts to increase the extent to which students were learning the material encompassed in the state's curriculum frameworks.

3.4 Impact of Accountability: A Brief Review

Because MERA combined finance reforms with substantive changes in the accountability of schools and districts, any estimates of the impact of MERA necessarily conflate the effects of the finance reforms and the changes in accountability. For that reason, isolating the impact of the finance reforms resulting from MERA is not feasible. As a result, the models described below are designed to provide estimates of the overall impact of MERA.

Nevertheless, we can use results from other studies that have estimated effects of accountability to gauge the extent to which the changes in accountability that followed MERA alone could have contributed to the changes in student performance that we observe. Figlio and Ladd (2007) discuss the challenges facing researchers attempting to estimate the impact of accountability and summarize the results of attempts to quantify this impact. They note that the results of Carnoy and Loeb (2002) in particular indicate that an ambitious accountability system of the kind put in place after MERA could result in significant improvements in student performance, particularly in mathematics. However, even the largest estimates of the performance gains attributable to accountability indicate that these gains are relatively small. Further, none of the existing estimates of the effects of accountability controls for other finance-related and non-finance-related school reforms in a comprehensive way. As a result, the impact of accountability alone is likely to be small. For that reason, our expectation is that any post-MERA performance changes that we find will be attributable primarily to the finance reforms, rather than to the changes in accountability.

[9] The Beacon Hill Institute analysis also utilizes an ordered-logit methodology, which is inappropriate for the grouped data used to produce the results.

4. DATA AND INITIAL ANALYSIS

The data used for this analysis come from two sources; the Massachusetts Department of Education (MADOE) and the U.S. Department of Education (USDOE). Test score data were obtained from the MADOE. School characteristics (including fiscal data) were obtained from the MADOE and the USDOE. The test data are based on two separate tests. Starting in 1988, the Massachusetts Educational Assessment Program (MEAP) was administered every other year until 1996. Mathematics and reading exams were given statewide to 4th, 8th, and 12th grade students in 1988, 1990 and 1992 and to 4th, 8th, and 10th grade students in 1994 and 1996. Scaled scores on the MEAP test took on numerical values between 1000 and 1600. The statewide average for each academic area was set at 1300 in 1988 for grade 4 and 8, and in 1994 for grade 10. District-level means for the scaled scores are given for all years. Starting in 1992, MEAP results were also reported according to the proficiency levels of students in each district. Based on their scores, students were placed into one of four "proficiency levels." Level 4 was the highest, and students who did work at this level showed an exemplary grasp of knowledge, thinking, reasoning and communicating abilities. Level 3 described students who were beginning to think critically, solve problems, reason and communicate effectively. Level 2 described students who had a firm grasp of factual knowledge. Level 1 students were beginning to grasp factual knowledge. Students who did not meet the standard for level one were placed in the Below Level 1 category. School- and district-level results indicate what percentage of students performed at each of these five levels.

One of the components of the Massachusetts Education Reform Act of 1993 (MERA) was the institution of a new statewide test in 1998; the Massachusetts Comprehensive Assessment System (MCAS). Differences in the MCAS included:

1. Reporting is at the student level as well as at the school and district level.
2. The MCAS is given every year whereas the MEAP was given every other year.

Table 1:

MCAS Schedule: 1998-2006

	GRADE																	
	MATH							ENGLISH LANGUAGE ARTS							SCIENCE			
Year	3	4	5	6	7	8	10	3	4	5	6	7	8	10	4	5	8	10
1998		X				X	X		X				X	X	X		X	X
1999		X				X	X		X				X	X	X		X	X
2000		X				X	X		X				X	X	X		X	X
2001		X		X		X	X	X	X			X	X	X				
2002		X		X		X	X	X	X			X		X				
2003		X		X		X	X	X	X			X		X		X	X	
2004		X		X		X	X	X	X			X		X		X	X	
2005		X		X		X	X	X	X			X		X		X	X	
2006	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X	

3. The MEAP mostly consisted of multiple choice questions, whereas the MCAS "calls for a much more comprehensive approach including portfolio evaluations, performance tasks, and other more authentic assessment techniques." (http://www.doe.mass.edu/edreform/1st_Imp/GOAL1.html)
4. MCAS is given to all students whereas the MEAP was not given to certain students with special needs or limited English proficiency.
5. Starting with the class of 2003, students must pass the 10th grade mathematics and ELA tests in order the graduate.
6. The MCAS is given in grades 3-8 and 10.

Table 1 gives the exams that were administered in each grade (3-8 and 10) in 1998-2006. MCAS test score results are numerical values that are scaled between 200 and 280 (though, at this point, we are missing district- and school-level means for 1998-2001). MCAS results are also grouped into four levels: advanced, proficient, needs improvement, and warning/failing. Thus school- and district-level results indicate what percentage of students performed at each of these four levels.

ONE COMPONENT OF MERA WAS THE INSTITUTION OF A NEW STATEWIDE TEST CALLED THE MASSACHUSETTS COMPREHENSIVE ASSESSMENT SYSTEM (MCAS)

School and district characteristics (including fiscal information) were obtained from the USDOE's Common Core of Data (CCD). The CCD is a repository of school data across the U.S. that is collected annually by the National Center for Education Statistics (NCES). Typically the data are supplied by state education agency officials. Problems with merging the MEAP and CCD data arose because school codes changed in this time period. We provide details on our matching procedure in the Appendix.

Some problems with the comparability of the MEAP and MCAS test scores data exist. Recall that the MEAP results are grouped into five categories. The MCAS results are only presented for four categories (advanced, proficient, needs improvement, warning/failing). We focus on the percentage of students who are proficient. For the MCAS data, these are students scoring in the advanced or proficient categories. The comparable measure for the MEAP data is the top three of the five MEAP categories. We focus on district-level reading (verbal) and math test results for 4th and 8th grades since they are available for most years.[10]

Charter schools, vocational technical and agricultural schools are excluded from the analysis. We exclude the former both because we do not have spending numbers for these schools and because these schools were not in existence prior to MERA. We exclude vocational schools because they are subject to a different and more complicated funding scheme than regular schools.

Annual district-level means for 4th and 8th grade test scores are given in Table 2. There is a clear jump between 1996 and 1998 when we switch from MEAP to MCAS data. We deal with the seam effect by standardizing the data on an annual basis. We present the means for other variables in Table 3.

[10] For 8th grade reading, the MCAS were not given in 2002-2005, but 7th-grade scores are available for these years.

Table 2:

Annual District-Level Means for 4th and 8th Grade Student Performance Measures

PERFORMANCE MEASURE	1988	1990	1992	1994	1996	1998	1999
Grade 4 Math Mean (std dev)	1325.043 (115.4282)	1346.52 (77.6715)	1356.151 (114.4461)	1357.471 (73.8398)	1349.698 (105.5617)	236.2401 (6.783632)	232.35317 (3.721561)
Grade 4 Math Percent Proficient (std dev)	---	---	59.70 (13.87)	65.93 (13.07)	68.10 (12.71)	38.96 (16.05)	40.85 (15.56)
Grade 4 ELA Mean (std dev)	1324.458 (112.0858)	1347.492 (78.0196)	1355.33 (113.4235)	1378.812 (73.29463)	1375.428 (72.48987)	232.19 (4.058445)	243.36748 (3.520139)
Grade 4 ELA Percent Proficient (std dev)	----	----	62.69 (12.08)	64.69 (11.97)	66.52 (10.84)	21.80 (12.46)	24.00 (11.16)
Grade 8 Math Mean (std dev)	1332.368 (85.7367)	1346.312 (84.68553)	1368.858 (87.53319)	1312.997 (227.3209)	1351.318 (67.88917)	230.3286 (8.585685)	229.95969 (13.92566)
Grade 8 Math Percent Proficient (std dev)	----	----	57.65 (12.73)	57.63 (16.13)	63.36 (9.43)	37.26 (16.25)	33.72 (16.48)
Grade 8 ELA Mean (std dev)	1332.729 (84.35637)	1352.871 (85.6591)	1368.17 (90.45732)	1401.838 (124.8606)	1402.53 (70.2995)	239.4138 (4.860811)	248.55754 (13.458)
Grade 8 ELA Percent Proficient (std dev)	----	----	60.09 (10.59)	61.24 (15.54)	71.94 (9.31)	62.11 (14.79)	63.00 (15.45)

PERFORMANCE MEASURE	2000	2001	2002	2003	2004	2005	2006
Grade 4 Math Mean (std dev)	232.59626 (3.908189)	233.71327 (3.81919)	238.5104 (5.958356)	238.2266 (6.279659)	239.9229 (5.817207)	239.5976 (5.991937)	239.0426 (5.647738)
Grade 4 Math Percent Proficient (std dev)	45.51 (15.40)	38.84 (15.69)	44.54 (15.17)	44.55 (14.47)	45.93 (15.06)	43.84 (15.61)	43.33 (14.58)
Grade 4 ELA Mean (std dev)	247.45202 (3.950552)	250.53073 (3.661312)	241.6579 (5.165738)	242.0602 (6.261268)	242.0781 (5.088079)	240.7798 (5.10528)	240.9198 (5.219544)
Grade 4 ELA Percent Proficient (std dev)	22.69 (12.14)	56.01 (15.82)	59.48 (15.17)	60.55 (14.94)	60.21 (14.40)	53.92 (15.12)	53.83 (15.16)
Grade 8 Math Mean (std dev)	229.3716 (14.32237)	229.77733 (14.50067)	234.7432 (7.405797)	235.0199 (8.651856)	236.4663 (7.14539)	236.5135 (7.189041)	236.7237 (6.611955)
Grade 8 Math Percent Proficient (std dev)	39.53 (16.30)	39.61 (17.03)	39.07 (16.86)	42.28 (17.08)	44.14 (16.61)	44.08 (16.80)	44.89 (15.92)
Grade 8 ELA Mean (std dev)	248.27706 (13.43582)	251.44543 (13.23878)	244.319 (5.182398)	244.1214 (6.327727)	244.8619 (4.920036)	245.1635 (5.002006)	247.3064 (4.989651)
Grade 8 ELA Percent Proficient (std dev)	69.12 (14.85)	73.35 (13.90)	70.28 (14.81)	71.36 (14.56)	74.06 (13.52)	72.32 (14.02)	79.71 (11.76)

Table 3:

Summary Statistics - Expenditure, Revenue, and District Characteristics by Year

VARIABLE	OBSERVATIONS	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
1990					
Current per pupil spending	314	6918.365	1576.101	3987.694	15114.46
Total per pupil spending	314	7895.992	1932.631	4537.052	19965.62
Share of revenues from local sources	314	60.64119	21.28959	10.7	95.8
Share of revenues from state sources	314	35.31309	19.07803	3.2	80.2
Share of revenues from federal sources	314	4.045615	3.545506	0	47
Percent low income					
Percent LEP					
Percent Special Educ.	317	16.0386	2.950613	7.303011	28.493
Percent African-American					
Percent Hispanic					
Students (membership)	317	2566.35	4219.389	118	59597
1992					
Current per pupil spending	332	7053.612	1613.361	4056.281	15137.88
Total per pupil spending	332	7673.732	1860.238	4400.659	30834.13
Share of revenues from local sources	332	63.09599	19.85856	19.1	97.5
Share of revenues from state sources	332	31.96584	17.29005	2	74.2
Share of revenues from federal sources	332	4.94536	4.247448	0	48
Percent low income	329	22.31858	18.60659	0	66.6
Percent LEP	330	5.079863	7.771841	0	36.1
Percent Special Educ.	332	15.79154	2.966672	4.052781	30.33708
Percent African-American					
Percent Hispanic					
Students (membership)	332	2522.904	4227.107	40	60922
1994					
Current per pupil spending	317	7380.042	1350.584	4464.202	15281.94
Total per pupil spending	317	8182.481	1513.582	5554.048	15768.6
Share of revenues from local sources	317	60.50453	20.24133	11.9	94.2
Share of revenues from state sources	317	34.51305	17.90402	5.4	75.4
Share of revenues from federal sources	317	4.98205	3.590146	0	27.8
Percent low income	297	24.50729	19.71848	0.5	72.2
Percent LEP	181	6.263729	8.399784	0	36.4
Percent Special Educ.	317	17.17591	3.074996	8.529411	33.13953
Percent African-American					
Percent Hispanic					
Students (membership)	317	2737.883	4460.45	126	63738

VARIABLE	OBSERVATIONS	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
1996					
Current per pupil spending	329	7611.141	1424.275	4436.821	15684.94
Total per pupil spending	329	8775.227	1911.736	6035.929	23016.95
Share of revenues from local sources	329	53.80578	22.23736	3.567322	90.38128
Share of revenues from state sources	329	42.12822	21.03674	7.97227	87.98121
Share of revenues from federal sources	329	4.065994	2.220327	0	34.39359
Percent low income	329	25.32833	22.01712	0	82.7
Percent LEP	329	4.991584	8.057029	0	39.7
Percent Special Educ.	329	16.94323	2.969956	9.213483	33.68984
Percent African-American					
Percent Hispanic					
Students (membership)	329	2770.432	4454.383	64	63293
1998					
Current per pupil spending	329	8172.256	1520.422	4956.402	16063.45
Total per pupil spending	329	9119.292	1890.462	5674.257	23951.12
Share of revenues from local sources	329	53.76512	22.91298	3.316267	91.32112
Share of revenues from state sources	329	41.53703	21.25479	8.293153	87.47957
Share of revenues from federal sources	329	4.697853	2.278723	0	11.26685
Percent low income	329	25.19666	22.37433	0	72.6
Percent LEP	329	4.895501	7.470383	0	30.7
Percent Special Educ.	329	16.99849	3.396776	8.163265	49.12281
Percent African-American					
Percent Hispanic					
Students (membership)	329	2861.267	4543.183	46	63762
1999					
Current per pupil spending	327	8414.286	1553.488	4786.151	17126.71
Total per pupil spending	327	9357.862	1969.54	5788.486	20042.1
Share of revenues from local sources	327	52.50652	22.46227	2.947178	90.57172
Share of revenues from state sources	327	42.70053	20.83872	9.327984	87.42201
Share of revenues from federal sources	327	4.792955	2.272489	0	10.941
Percent low income	322	25.54441	23.45942	0.1	75.1
Percent LEP	181	5.850572	7.505519	0	28.5
Percent Special Educ.	327	17.49227	3.70973	8.8	34.8718
Percent African-American	313	8.587256	13.46205	0.1	49
Percent Hispanic	310	9.977366	15.01482	0	79.9
Students (membership)	327	2928.63	4578.19	52	63043

VARIABLE	OBSERVATIONS	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
2000					
Current per pupil spending	329	8649.5	1593.39	5609.881	15981.65
Total per pupil spending	329	9760.142	1912.496	6300.943	23301.63
Share of revenues from local sources	329	53.424	21.44426	3.009526	90.042
Share of revenues from state sources	329	41.62991	19.69932	9.957173	87.9929
Share of revenues from federal sources	329	4.946096	2.384913	0	11.62117
Percent low income	329	25.14922	23.76464	0.1	82.8
Percent LEP	329	4.724096	6.869371	0	26.1
Percent Special Educ.	329	16.47601	3.567906	0	43.13726
Percent African-American	329	8.523538	13.43962	0	48.8
Percent Hispanic	329	10.13456	15327062	0	81.1
Students (membership)	329	2914.605	4566.011	51	62950
2001					
Current per pupil spending	328	9077.115	1766.902	5993.097	20234.49
Total per pupil spending	328	10524.09	2404.787	6603.661	28700.67
Share of revenues from local sources	328	54.20738	19.82719	7.65694	94.01818
Share of revenues from state sources	328	41.23	18.35263	5.19984	84.24609
Share of revenues from federal sources	328	4.562614	2.513258	0	42.60184
Percent low income	328	24.99	24.16765	0	81.7
Percent LEP	328	4.694678	6.798338	0	27
Percent Special Educ.	328	16.18261	3.254108	0	31.25
Percent African-American	328	8.554676	13.4431	0	48.4
Percent Hispanic	328	10.66148	15.56371	0	81.8
Students (membership)	328	2944.912	4590.983	48	63024
2002					
Current per pupil spending	329	9598.205	1930.9	6167.6	18289.91
Total per pupil spending	329	11250.62	3137.661	6777.325	40866.41
Share of revenues from local sources	329	51.7058	21.798	2.677146	94.68267
Share of revenues from state sources	329	429796	19.88012	4.683016	88.49025
Share of revenues from federal sources	329	5.314602	2.583083	0	13.75439
Percent low income	329	25.15136	24.642	0	80.3
Percent LEP	329	4.879914	6.798279	0	25.2
Percent Special Educ.	329	15.2631	3.085294	0	27.02703
Percent African-American	329	8.436931	13.31859	0	47.6
Percent Hispanic	329	10.70381	15.82116	0	82.8
Students (membership)	329	2914.957	4521.53	8	62141

VARIABLE	OBSERVATIONS	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
2003					
Current per pupil spending	327	9581.18	1918.491	6049.125	19697.59
Total per pupil spending	327	10617.17	2542.524	6567.441	43580.47
Share of revenues from local sources	327	52.74293	20.0113	5.669617	89.24641
Share of revenues from state sources	327	41.3044	17.88915	10.33023	81.72887
Share of revenues from federal sources	327	5.952667	2.967636	0	13.71814
Percent low income	327	26.07328	25.16744	0	80
Percent LEP	327	5.425533	7.427485	0	26.7
Percent Special Educ.	327	15.14035	3.134379	1.508722	24.943
Percent African-American	327	8.540784	13.25432	0	47.2
Percent Hispanic	327	11.12626	16.28501	0	83.9
Students (membership)	327	2954.404	4528.339	50	61552
2004					
Current per pupil spending	329	9672.326	2040.674	6047.358	32770.84
Total per pupil spending	329	10830.53	2447.39	6393.249	55491.96
Share of revenues from local sources	329	53.75242	20.70749	6.006046	90.78947
Share of revenues from state sources	329	40.02523	18.295	8.911483	79.43114
Share of revenues from federal sources	329	6.222356	3.310752	0	16.95264
Percent low income	329	26.93433	25.79454	0	82.7
Percent LEP	329	5.175062	6.717427	0	23.5
Percent Special Educ.	329	15.58432	3.000772	3.571429	50
Percent African-American	326	8.578576	13.08804	0	46.4
Percent Hispanic	326	11.43	16.6071	0	84.8
Students (membership)	329	2925.495	4427.836	2	60150

VARIABLE	OBSERVATIONS	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
2005					
Current per pupil spending	329	9626.197	2063.412	6365.349	34905.3
Total per pupil spending	329	10843.04	2553.33	6813.524	55437.84
Share of revenues from local sources	329	52.43537	20.04047	11.69831	91.02871
Share of revenues from state sources	329	41.78965	18.16878	8.672246	79.654
Share of revenues from federal sources	329	5.774984	3.034769	0	13.5258
Percent low income	329	27.36938	26.08648	0	84.6
Percent LEP	329	5.240896	6.732948	0	27.8
Percent Special Educ.	329	16.49242	3.005058	2.816901	50
Percent African-American	326	8.539967	12.91172	0	47.9
Percent Hispanic	326	11.69832	16.87208	0	85.4
Students (membership)	329	2903.419	4298.855	2	57742
2006					
Current per pupil spending	329	9726.645	2142.773	6500.774	43234.4
Total per pupil spending	329	10935.84	2768.239	7204.512	143725.2
Share of revenues from local sources	329	51.53888	19.93007	9.34686	88.86982
Share of revenues from state sources	329	43.19755	18.26188	9.5422	83.09069
Share of revenues from federal sources	329	5.26357	2.92372	0	13.55184
Percent low income	329	27.82175	25.92614	0	84
Percent LEP	329	5.476321	6.985758	0	27.4
Percent Special Educ.	329	15.29564	2.91871	0	27.11864
Percent African-American					
Percent Hispanic					
Students (membership)	329	2887.389	4244.931	2	57349

5. THE EVOLUTION OF EDUCATION SPENDING IN MASSACHUSETTS

We begin by examining whether the extent of inequality in education spending in Massachusetts has changed in the aftermath of the enactment of MERA in 1993. We document the trends in inequality in both current and total expenditures per pupil. Next, we consider the extent to which any recent increases in inequality can be attributed to growth in the importance of local revenue sources. We close the section by looking at possible sources of variation in spending among districts in Massachusetts.

Table 4 briefly defines the inequality measures we consider in this paper. The first four of these measures are referred to as horizontal equity measures because they quantify the degree to which the finance system treats students who are similar to one another similarly (Downes and Steifel, 2007). Each of the horizontal equity measures is univariate because the measures are constructed using only a measure of spending.

The remaining two measures defined in Table 4, the simple and conditional wealth elasticity, are referred to as vertical equity measures because they indicate the extent to which the financing system treats differently students who reside in school districts with differing abilities to generate local revenue (Downes and Steifel, 2007). Because these measures are constructed by characterizing the relationship between spending and one or more attribute of a district and its students, these vertical equity measures are bivariate or multivariate.

The results presented in Table 5 clearly indicate that inequality declined throughout the 1990s for each of the spending measures and for each type of school district. Inequality increased

Table 4:

Definition of Inequality Measures

INEQUALITY MEASURE	DEFINITION/EXPLANATION
Gini Coefficient	A number between 0 and 1, with a Gini of 0 indicating perfect equality (each district has the same spending) and a Gini of 1 indicating perfect inequality (only one district has non-zero spending)
Coefficient of Variation	The ratio of the standard deviation and the mean across districts of per pupil operating expenditures. This is a unit-less measure and, therefore, can be used to compare the variation in variables of different magnitudes.
Standard Deviation of the Logs	Measure of the extent of variation in the natural log of the spending measure. Taking the logarithm of a series of data mutes the extreme values, so this measure is less affected by extreme values.
McLoone Index	Ratio of the actual sum of spending of districts with per-pupil spending below the state median to the sum of spending of those districts if their per-pupil spending was equal to the median of per pupil spending in the state. (Times 100 to convert the ratio into a percentage.)
Simple Wealth Elasticity	Gives the percentage change in the spending measure when the assessed value per student increases by one percent when no other characteristics of the districts, such as local tax effort, are held constant.
Conditional Wealth Elasticity	Gives the percentage change in the spending measure when assessed value per student increases by one percent and when observable determinants of that district's tax effort and its cost of providing schooling were unchanged.

Table 5:

Inequality Measures: 1989-90 to 2005-06

INEQUALITY MEASURE	1989 - 1990	1991 - 1992	1993 - 1994	1995 - 1996	1997 - 1998	1998 - 1999
CURRENT EXPENDITURES PER PUPIL						
Gini Coefficient	0.1227	0.1228	0.0946	0.1001	0.1011	0.1013
Coeff. of Variation	0.2237	0.2227	0.1751	0.1839	0.1842	0.1840
Std. Dev. of Logs	0.2096	0.2108	0.1648	0.1725	0.1733	0.1729
McLoone Index	88.9478	87.9349	91.4136	91.9537	92.3392	92.8931
Simple Wealth Elasticity	0.2006	0.2014	0.1297	0.0940	0.0619	0.0578
Cond. Wealth Elasticity[2]	---	0.1571	0.1208	0.1202	0.1011	0.1003
TOTAL EXPENDITURES PER PUPIL						
Gini Coefficient	0.1321	0.1236	0.0966	0.1132	0.1111	0.1108
Coeff. of Variation	0.2424	0.2306	0.1774	0.2130	0.2049	0.2093
Std. Dev. of Logs	0.2258	0.2128	0.1676	0.1937	0.1895	0.1897
McLoone Index	84.8395	86.0274	88.6031	90.3374	90.8316	92.5839
Simple Wealth Elasticity	0.2354	0.2148	0.1319	0.1185	0.0572	0.0514
Cond. Wealth Elasticity[2]	---	0.1811	0.1334	0.1500	0.0755	0.0879

Table 6:

Correlations between spending, revenue shares, and student characteristics: Various years

	CURRENT PER PUPIL SPENDING	FEDERAL SHARE	STATE SHARE	PERCENT LOW INCOME	PERCENT LEP
1991-92					
Current per pupil spending	1.0000				
Federal share	-0.1514	1.0000			
State share	-0.4855	0.5306	1.0000		
Percent low income	0.0342	0.7841	0.5788	1.0000	
Percent LEP	0.2394	0.6477	0.3134	0.8408	1.0000
1998-99					
Current per pupil spending	1.0000				
Federal share	0.3428	1.0000			
State share	-0.0949	0.6877	1.0000		
Percent low income	0.5672	0.8701	0.5845	1.0000	
Percent LEP	0.6380	0.6808	0.3960	0.8747	1.0000
2005-06					
Current per pupil spending	1.0000				
Federal share	0.3807	1.0000			
State share	-0.1397	0.5166	1.0000		
Percent low income	0.5476	0.9008	0.5103	1.0000	
Percent LEP	0.5563	0.7287	0.3601	0.8604	1.0000

1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003 - 2004	2004 - 2005	2005 - 2006
0.1005	0.1065	0.1099	0.1076	0.1125	0.1138	0.1165
0.1831	0.1935	0.2005	0.2002	0.2106	0.2140	0.2200
0.1719	0.1812	0.1870	0.1839	0.1923	0.1944	0.1990
92.2465	92.0714	91.3360	91.6452	91.4964	90.6936	90.0663
0.0587	0.0609	0.0731	0.0759	0.0835	0.0900	0.0919
0.0989	0.1078	0.1052	0.0996	0.1106	0.1183	0.1247
0.1070	0.1227	0.1332	0.1160	0.1194	0.1192	0.1222
0.1922	0.2264	0.2702	0.2205	0.2242	0.2212	0.2290
0.1830	0.2098	0.2282	0.1984	0.2042	0.2035	0.2084
91.8377	91.1523	88.2492	91.1148	89.5344	90.1553	88.4008
0.0505	0.0489	0.0705	0.0942	0.1030	0.0997	0.0981
0.0881	0.0743	0.0759	0.1087	0.1196	0.1259	0.1308

Notes 1. Each spending measure was weighted by enrollment (average number belonging) in the calculation of the inequality measures. See Murray, Evans, and Schwab (1998) for further discussion of the need for weighting by enrollment.
2. In addition to the log of equalized value per pupil, the regressions used to calculate the conditional wealth elasticity included the log of enrollment, the log of per capita income in 1990, the percent low income, the percent limited English proficient, and the percent identified as special education.

slightly in the early years of the current decade for two reasons. First, inequality rose as a result of declining state aid during the state fiscal crisis at the beginning of the decade. While the declines in state aid were larger in Massachusetts than in most other states (Reschovsky, 2004), spending inequality grew in most states in this period. Second, horizontal equity measures may have increased due to an increased share of spending from federal sources. The reforms that resulted from MERA had resulted in some districts that served large shares of low income students shifting from being below-average spending to being above-average spending districts. The growth in revenue from the federal government targeted districts serving low-income and minority student populations, further increasing the spending of some districts with above-average spending. As we indicate below, this inflow of money to districts serving large shares of low-income students can, therefore, help explain why the trends in this decade in horizontal and vertical measures of equity are not the same.

5.1 Trends in Inequality in Massachusetts

We examined trends in inequality for current and total spending per student, where the Fall enrollment (membership) as reported in the CCD was used as the measure of the number of students per district. Table 4 provides brief definitions of several frequently used measures of the extent of inequality in education provision. Except for the McLoone Index, a larger value of one of these inequality measures signals greater inequality.

Table 5 presents the within-state trends in inequality for the two different spending measures for all school districts in Massachusetts that are coterminous with municipal boundaries, except for vocational districts. The results in Table 5 show that, for each of the spending mea-

THE IMPACT OF MERA ON INEQUALITY IN SPENDING

- The finance reforms triggered by MERA have reduced spending inequality relative to pre-MERA levels.
- The main beneficiaries of the reduction in inequality have been districts with larger shares of students with limited English proficiency or with eligibility for free or subsidized school lunches. These districts have gone from having below to above average levels of spending.
- Reductions in real state aid in the early part of this decade resulted in increases in spending inequality, though the extent of inequality still remains below its pre-MERA level.

sures, inequality declined from 1989-90 (before MERA) to 1993-94 (after MERA). For each of the spending measures, the horizontal equity measures of inequality changed little after 1993-94, with many of the measures of inequality indicating inequality in spending was minimized in 1993-94.[11]

The vertical equity measures of inequality (the simple and conditional wealth elasticities) provide a similar picture of the evolution of inequality in spending in Massachusetts through the 1990s. The relationship between spending and property wealth weakened in the first few years after MERA, reaching a minimum sometime in the late 1990s. The wealth elasticities increased during the fiscal crisis in the early part of this decade, indicating, as do the horizontal equity measures, that inequality increased notably in the current decade. These increases in inequality are, however, less apparent for the conditional wealth elasticities.[12]

Costrell (2005) hints at an explanation for the differences in the trends in the horizontal and vertical equity measures. The finance reforms that resulted from MERA resulted in districts which previously had low spending moving up the spending distribution. Since these districts also tended to have larger shares of students with limited English proficiency or with eligibility for free or subsidized school lunches, as is apparent from Table 6, these districts also received larger than average shares of their funding from the federal government. As a result, recent increases in federal funding have improved the relative position of these districts even further, making spending look less equal when equality is gauged by any of measures of equity that are constructed using only information on spending. At the same time, these additional funds flowing to districts with low pre-reform spending have further weakened the relationship between spending and property wealth.

The bottom line, then, is that, even though the reductions in real state aid in the early part of this decade did result in increases in spending inequality, the finance reforms triggered by MERA have resulted in reductions in spending inequality relative to pre-MERA levels. The main beneficiaries of this reduction in inequality have been districts with larger shares of students with limited English proficiency or with eligibility for free or subsidized school lunches. As the correlations in Table 6 indicate, these districts have gone from having below to above average levels of spending.

11 We have also computed these inequality measures for regional districts and for the combined set of local and regional school districts. The patterns evident in Table 5 also are evident for the regional districts and for the set of all non-vocational districts.

12 We computed all of the wealth elasticities using per capita income in 1990 instead of property wealth per student. The simple and conditional wealth elasticities calculated in this way declined throughout the 1990s and continued to decline in the early part of the current decade. Thus, when property wealth is replaced by income, there is no evidence of increases in inequality.

5.2 Trends in Sources of Revenue, Current Expenditures, and Expenditures on Special Education

The inequality measures summarized in Table 5 provide only a partial picture of the fiscal effects of MERA. By looking at the evolution of components of the revenue and expenditures of school districts, we provide more detail on the impact of MERA on schoolchildren and taxpayers in Massachusetts.

For the local school districts that are the basis for Table 5, Figures 1 to 13 summarize trends in local revenue and state aid for districts classified by their status in fiscal year 1992, the last pre-MERA year.[13] For example, in Figure 1, districts are divided into quartiles based on current expenditures per pupil in 1992.

Figures 1 and 2 show that per pupil contributions from parent governments, the principal source of local revenue, declined in each quartile in the period immediately after MERA. By fiscal year 2001, however, per pupil contributions from parent governments had returned to or exceeded their pre-MERA levels. This is true whether districts are divided into quartiles on the basis of pre-MERA spending (Figure 1) or on the basis of increases from 1992 to 1996 in real state aid per pupil (Figure 2). And from Figure 1, we can see that, in districts with the highest spending in 1992, real per pupil contributions from parent governments were over $2500 higher in fiscal year 2006 than they had been in fiscal year 1992.

The implication of Figures 1 and 2 is that, while a portion of the initial increases in state aid were used to provide property tax relief (McIntyre, 2003), on a per pupil basis these reductions in property taxes have not been sustained. Figures 3

Figure 1:

Trends in per pupil local revenues (by quartile of spending in 1992)

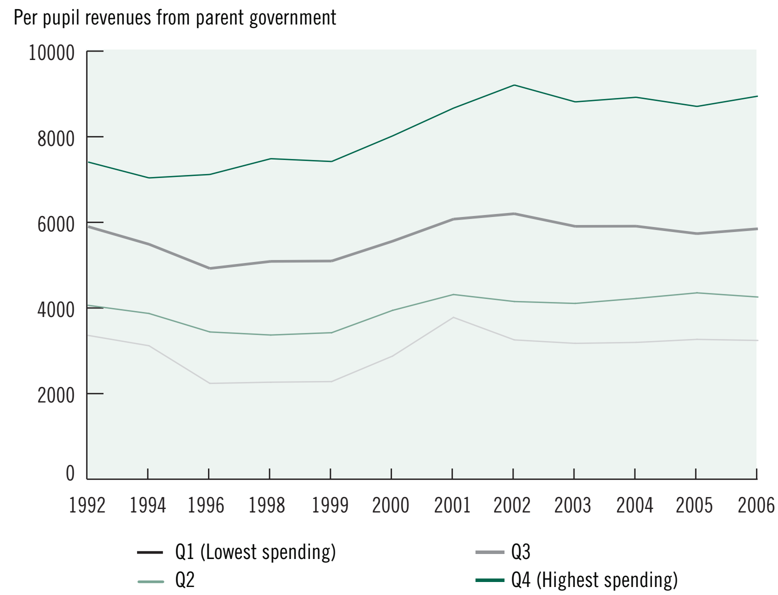
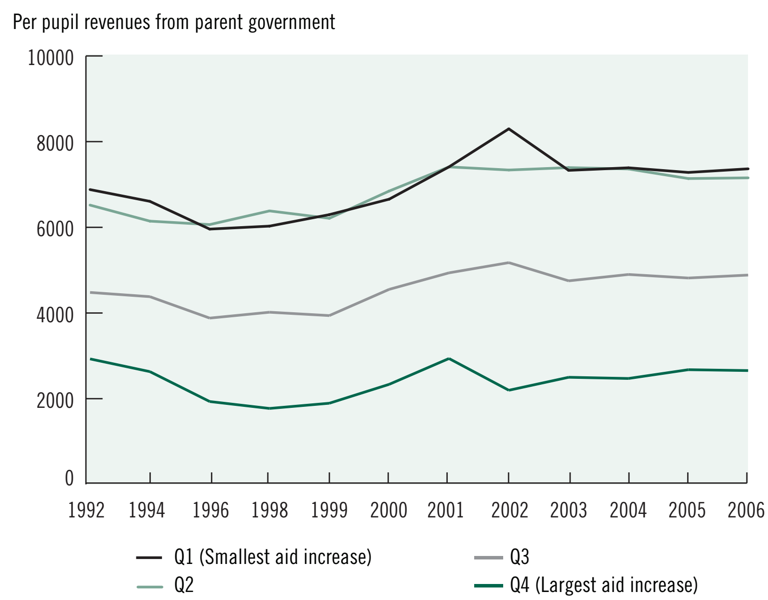


Figure 2:

Trends in per pupil local revenues (by quartile of spending in 1992)



[13] Again, if these figures are generated for the full set of local and regional districts, the same patterns emerge as are evident in Figures 1 to 13.

Figure 3:

Trends in total state aid per pupil (by quartile of 1992 spending)

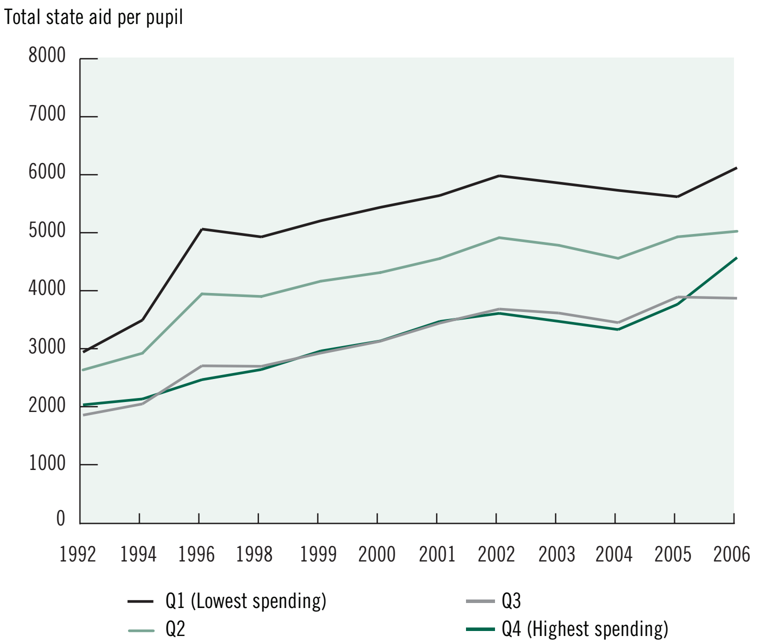
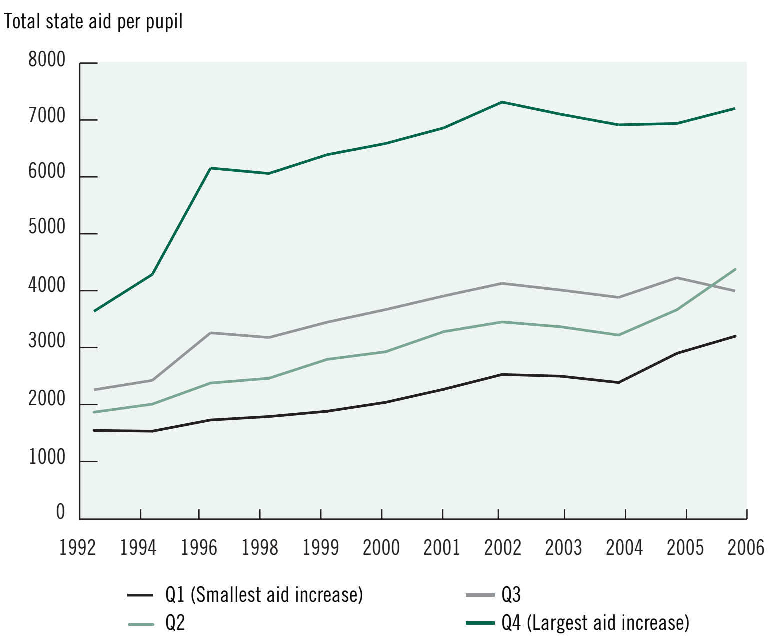


Figure 4:

Trends in total state aid per pupil (by quartile of change in state aid)



and 4 provide some indication why locally-generated revenues have risen in recent years; real state aid per pupil declined from 2002 to 2004. In fact, Figures 5 and 6 show that the aid distributed according to the foundation aid formula continued to decline in the most recent years for which the CCD data are available. Property tax revenues were used to keep real spending per pupil stable in most districts.[14]

Figures 7 and 8 present the trends in current expenditures per pupil. When districts are divided into quartiles on the basis of spending in 1992, readily apparent is the convergence in spending among districts in the bottom three quartiles in 1992. The gap between the bottom and top quartiles has, however, remained almost constant in real terms. The small amount of gap closing that occurred before 2001 has dissipated somewhat in recent years.

What Figure 7 only partially reveals is the importance of state aid in generating convergence in spending. Figure 8 makes clear the pivotal role of aid. The quartile of districts with the largest real increase in state aid between 1992 and 1996 moved from having the lowest spending, on average, in 1992 to having the second highest spending, on average. The differences in spending between this quartile and the two quartiles with the smallest aid increases had, by 1998, been substantially reduced. And these differences have not grown in the decade since.

The trends in per pupil instructional spending[15,16] are the same as the trends in current expenditures per pupil. Thus, like Dee and Levine (2004), we find that districts that received the largest increases in state aid after MERA used many of those additional dollars to increase spending on classroom services. Using additional aid to

[14] Non-traditional revenues also helped districts avoid reductions in real spending per pupil. For example, miscellaneous revenues, which include private contributions, grew substantially, on average, in each quartile when districts are divided into quartiles on the basis of either spending in 1992 or on the basis of growth in state aid. And this growth was relatively larger in districts with the smallest growth in state aid, post-MERA. Nevertheless, even in fiscal year 2006, these non-traditional revenues were but a small portion of total revenues even in districts with the smallest growth in state id post-MERA.

increase classroom services was not unique to school districts in Massachusetts; Resch (2008) found that two thirds of Abbott parity aid in New Jersey was used to increase current expenditures, with these increases targeted to instructional expenditures and support services. And in Massachusetts we see no evidence of relative decline in instructional spending after fiscal year 1996, the last in Dee and Levine's analysis.

Several analyses of the fiscal condition of school districts in Massachusetts have noted that the growth of special education costs have constrained the ability of districts to provide other services (e.g., Berman, Davis, Koufman-Frederick, Urion, 2001; Office of Strategic Planning, Research, and Evaluation, 2008). Figure 9, which presents trends in expenditures per special education student served in district, shows, starting before MERA, the growth that occurred in the largest component of special education expenditures.[17] The growth in special education spending is evident for each quartile. Figure 10, which gives special education expenditures as a share of total expenditures,[18] provides an alternative view of this growth starting in 1998, the first year in which data on this share are available. In addition to confirming that the growth evident in Figure 9 is apparent no matter how special education expenditures are measured, Figure 10 provides evidence that the burden imposed by special education mandates may have increased relatively in districts with the largest growth in state aid after MERA. In fiscal year 1998, on average the share of expenditures on special education was lower in the quartile of districts with the largest aid growth post-MERA relative to districts in the next two aid

Figure 5:

Trends in per pupil formula aid (by quartile of spending in 1992)

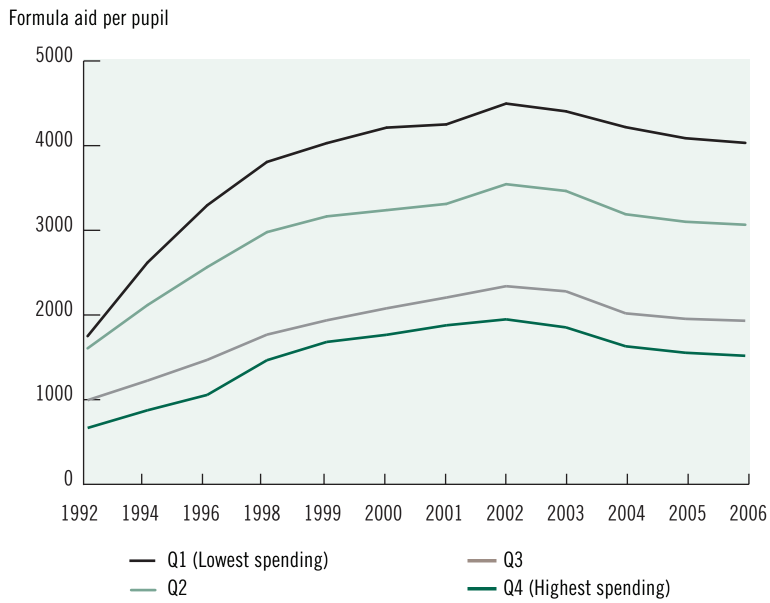
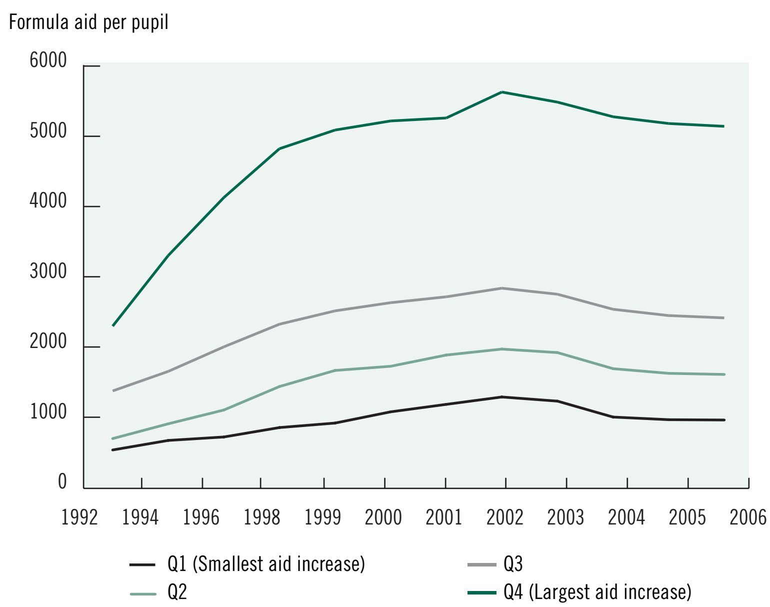


Figure 6:

Trends in per pupil formula aid (by quartile of change in state aid)



15 In the CCD, instructional spending is any current operating expenditure for activities dealing with the interaction of teachers and students. Instructional expenditures do not include current expenditures for pupil support, instructional staff support, administration, operation and maintenance of the physical plant, transportation, or other support services.

16 Beginning in fiscal year 2005, MADOE changed how spending was reported. Starting with this fiscal year, spending was reported in eleven functional categories and in 63 sub-functions. Shifting to this method of reporting made it possible for districts to provide more refined measures of instructional spending. This change is the explanation for the apparent decline in in the CCD data in instructional spending in fiscal year 2005, even as current expenditures were increasing. As a result, while in any single year cross-district comparisons of instructional spending are valid, comparisons of instructional spending before and after fiscal year 2005 are not.

Figure 7:

Trends in real spending per pupil (by quartiles of 1992 spending)

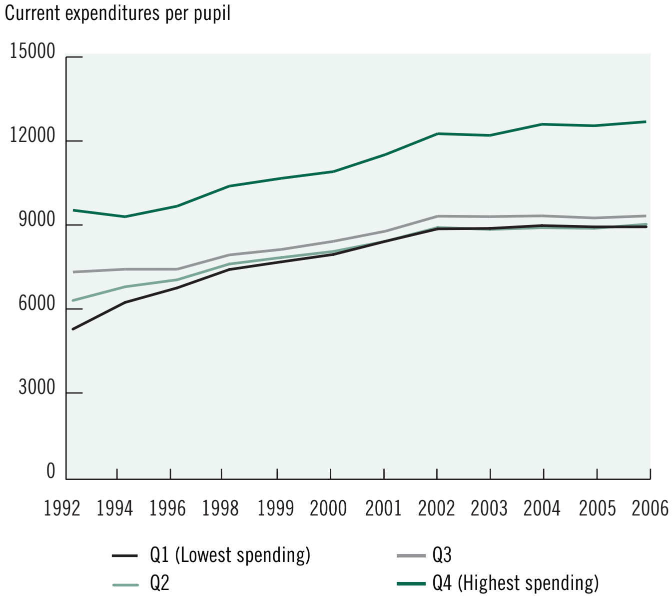


Figure 8:

Trends in real spending per pupil (by quartile of change in state aid)

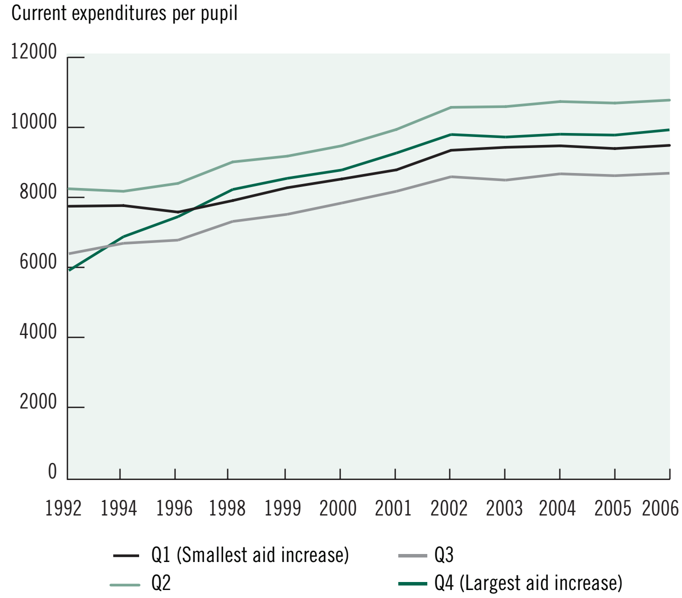


Figure 9:

Trends in special education expenditures per pupil served (by quartile of change in state aid)

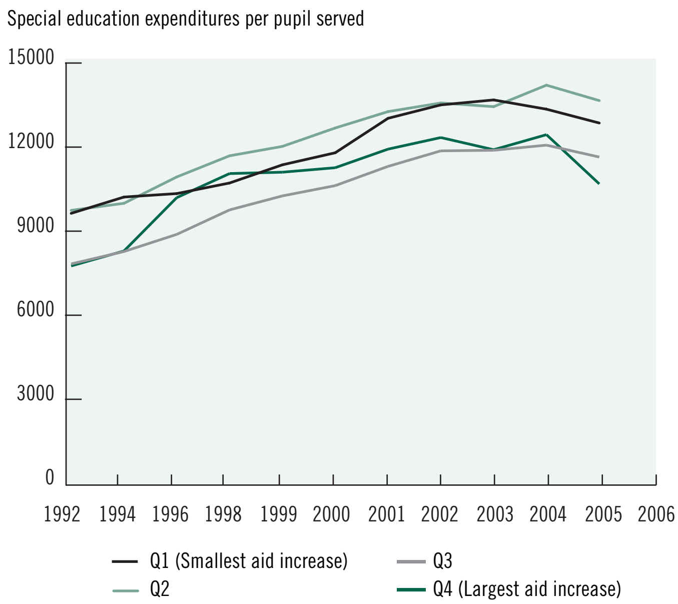
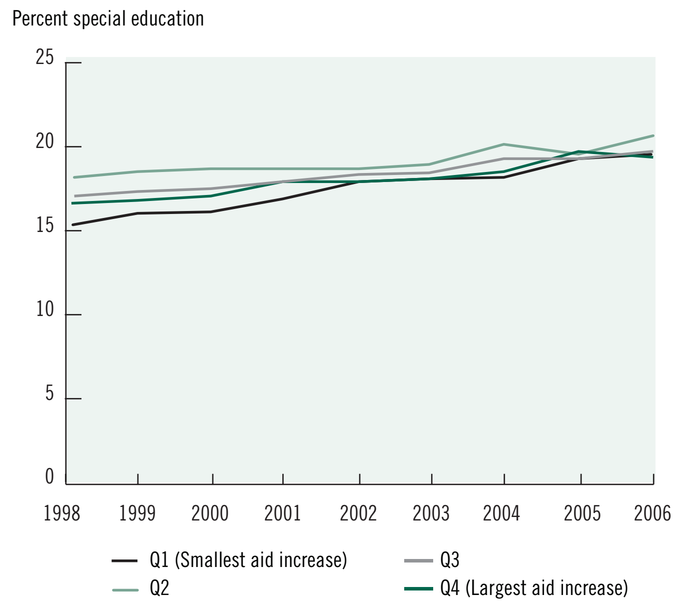


Figure 10:

Trends in percent of expenditures on special education (by quartile of change in state aid)



growth quartiles. By 2006, the special education shares in these three quartiles were essentially the same, on average.

The slight relative growth in districts with low spending pre-MERA in the share of expenditures on special education indicates that some of the additional dollars that flowed to these districts post-MERA were used to serve students designated as needing special education services. But the costs facing those districts that benefited the most fiscally from MERA may have grown more rapidly in areas other than special education. Figure 11 presents the trends in the percent of students identified as low income by quartile of change in state aid. While, on average, the percent low income grew in each of the quartiles, there was particularly dramatic relative growth in the quartile with the largest growth in state aid. Since numerous studies have established a link between costs and the percent of students identified as low income (Duncombe and Yinger, 2007a), relative growth in the percent low income most certainly translated into relative growth in costs. And while the aid formula was designed to provide more resources to districts with growing shares of students identified as low income, the absence of an explicit link between each district's foundation level and the academic standards established under MERA means that the adjustment in the formula for percent low income may well have been inadequate in the early post-MERA years (Duncombe and Yinger, 2007a). Growth in the percent low income would have served to accentuate this inadequacy.

As we noted above, the finance reforms that resulted from MERA were not explicitly designed to target additional dollars to districts with the lowest student performance pre-MERA.[19] Nev-

Figure 11:

Trends in percent low income (by quartile of change in state aid)

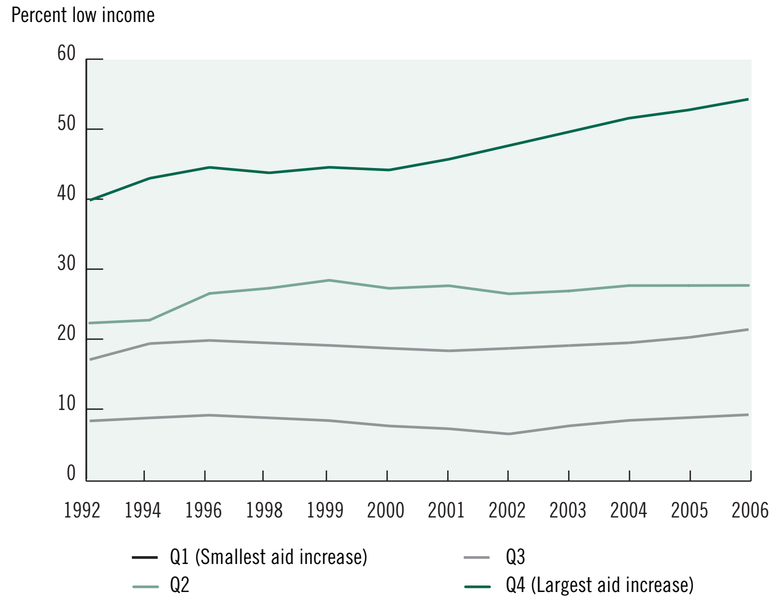
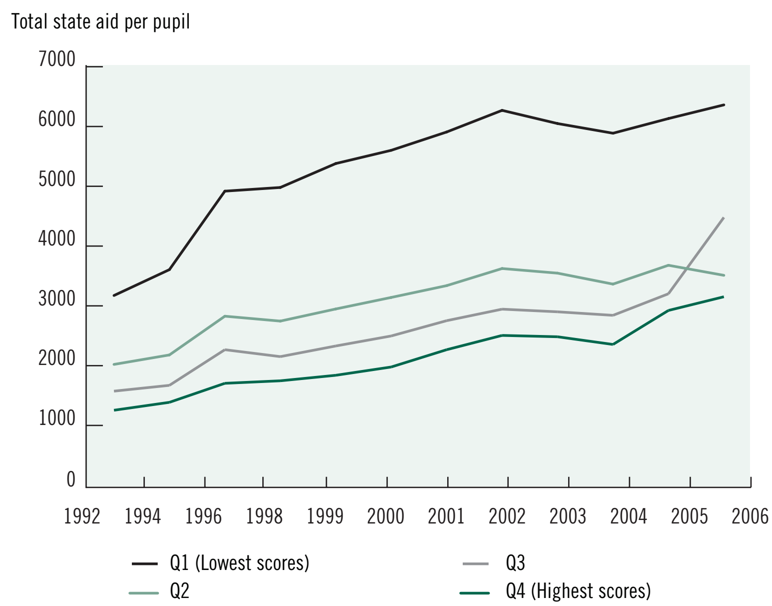


Figure 12:

Trends in total state aid per pupil (by quartile of 1992 8th grade math score)



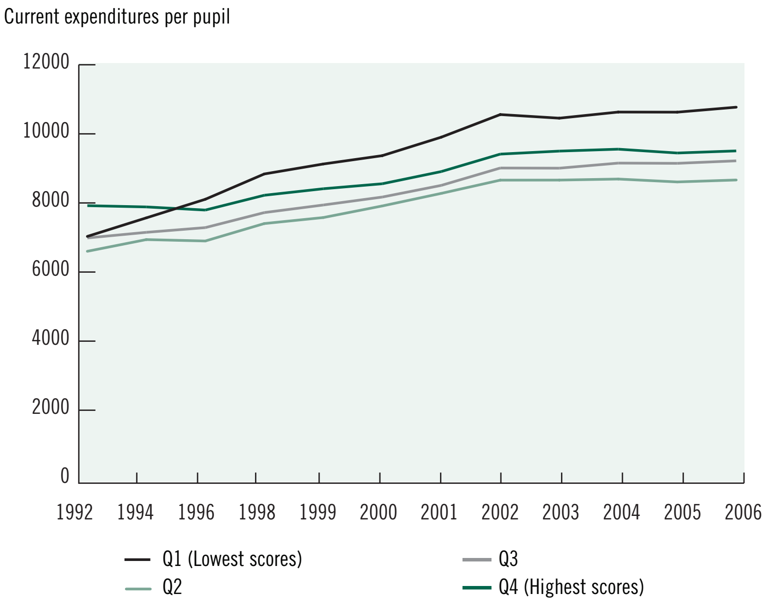
17 In-district expenditures include expenditures in both special education and regular education settings.

18 Special education expenditures include both expenditures on students served in district and tuition paid for students served out of district.

19 In Massachusetts, as in other states, there were districts, like Boston and Cambridge, which had relatively high spending and relatively low performance prior to MERA.

Figure 13:

Trends in real spending per pupil (by quartile of 1992 8th grade math score)



ertheless, as is apparent from Figure 12, state aid grew most rapidly in the quartile of districts with the lowest mean scores on the eighth grade MEAP test in 1992. This influx of aid translated into more rapid growth in spending in districts with scores in the bottom quartile in 1992. By fiscal year 1996, both current expenditures per pupil (Figure 13) and instructional expenditures per pupil were, on average, higher in the quartile of districts with the lowest mean scores on the eighth grade MEAP test in 1992 than in any of the other quartiles. Thus, after MERA districts with low pre-MERA test scores did have relative increases in spending. Whether those increases in spending were sufficient to overcome the growing costs facing these districts and, as a result, to translate into reductions in cross-district variation in student performance is the subject of the next several sections of this paper.

POST-MERA TRENDS IN REVENUES, TOTAL SPENDING, AND SPECIAL EDUCATION SPENDING

- While a portion of the initial increases in state aid after MERA were used to provide property tax relief, these reductions in property taxes have not been sustained. In response to declines in real state aid per pupil from 2002 to 2004, most districts increased the use of property tax revenues so as to keep real spending per pupil stable.
- Current expenditures per pupil have become substantially more equal among those districts in the bottom three quartiles of pre-MERA spending, The spending gap between those districts and the districts in the top quartile of pre-MERA spending has remained essentially unchanged.
- Districts that received the largest increases in state aid after MERA used many of those additional dollars to increase spending on classroom services.
- Special education expenditures, both on a per pupil basis and as a share of total expenditures, have grown for districts in each quartile of the distribution of post-MERA aid increases. This growth was somewhat larger in districts with the largest growth in state aid after MERA.
- Factors that influence the cost of educating students, such as the percent low income, grew most rapidly in districts with the largest growth in state aid after MERA.
- State aid and current expenditures per pupil grew most rapidly in those districts with the lowest mean test scores pre-MERA.

6. THE FRAMEWORK FOR EVALUATING THE IMPACT OF MERA ON STUDENT PERFORMANCE

In this section, we develop the framework for evaluating the impact of MERA on student test scores. We present an intuitive discussion and we leave the more analytical analysis to the appendix. We carry out this analysis at the district level because state aid is allocated at the district level so this is where we expect to see the impact of MERA.

One purpose of MERA was to equalize resources across school districts. We will evaluate if this redistribution of spending led to an improvement of student performance in low-spending compared to high-spending districts. Hence, we need to first designate districts as low- and high-spending based on their outlays prior to MERA. To do so, we identify districts in the upper quartile and lower quartile of the spending distribution in 1992.[20] We denote these two groups as Low-Spend_92 and High-Spend_92. This offers a clear delineation between the low spending and high spending schools.

The simplest means for determining the initial, short-term, impact of MERA is the difference-in-difference approach. This method compares the relative performances of Low-Spend_92 and High-Spend_92 in 1992 and 1994, the closest years before and after reform. The result is a measure of difference in the average change in achievement between 1992 and 1994 for the Low-Spend_92 and High-Spend_92 districts. If the reform was effective in raising achievement of the less advantaged districts then we expect that this difference will be positive.

We carry out this approach separately for math and verbal test scores for grades 4 and 8. These results are for MEAP scores only since the MCAS was first given in 1998. Note that because we classify districts as low and high spending based on spending in 1992 which is pre-MERA, we do not have the endogeneity problem that Guryan was faced with since he used current spending to measure the impact of reform.

For numerous reasons, the impact of MERA is likely to differ in the short-run and the long-run. First, the full impact of reform will not occur until after 1994. In particular, by 1998, 4th graders in the Low-Spend_92 districts will have experienced the cumulative effects of four full years of increased spending and eight full years by the time they are in 8th grade in 2002. Second, it may take the Low-Spend_92 districts a number of years to best use the increased resources they received due to MERA. Third, two of the components of MERA were the establishment of rigorous system of accountability and the creation of an assessment system, the MCAS starting in 1998. The full impact of these components of MERA on student performance would not be felt until the current decade.

WE EVALUATE WHETHER THE NEW SPENDING LED TO AN IMPROVEMENT OF STUDENT PERFORMANCE

Thus we extend the framework for estimating the short-run impact of MERA to be able to estimate the long-term impacts of MERA. That is, we estimate the difference in the average change in achievement for the Low-Spend_92 and High-Spend_92 districts between 1992 and each of the post-MERA years for which we have test scores (1994, 1996, 1998-2006). A number of factors that affect achievement have changed over this 1994-2006 period, including the percent of low-income, special education, LEP,

[20] We also carry out the same analysis using the actual spending values in 1992 instead of this quartile analysis and this does not change the basic results.

black, and Hispanic students. In order to isolate the impact of MERA on student performance, we account for these characteristics when comparing the test scores in the Low-Spend_92 and High-Spend_92 districts. To complete the analysis we will also compare the performance of Low-Spend_92 and the districts in the middle two quartiles of the 1992 spending distribution (denoted Mid-Spend_92).

Finally, it is likely that there are unobserved (and time invariant) characteristics of districts that affect student performance and that are correlated with their initial position in the 1992 spending distribution. These factors include the students' backgrounds (e.g. family characteristics such as whether both parents are present and their education and income levels), teacher and administrator quality and the quality of the facilities. Not controlling for these factors can bias the estimates of the impact of MERA. Because we observe the same districts over time, we are able to augment our framework to control for these unobserved district characteristics (called district fixed effects).

7. RESULTS – THE IMPACT OF MERA ON STUDENT PERFORMANCE

We first estimate the short-run impact of MERA for districts that reported MEAP scores in 1992 and 1994. There are 220 such districts for 4th grade scores and 208 for 8th grade scores. We compare the performance of districts in the bottom and top quartiles of the 1992 spending distribution (denoted "Low-Spend_92" and "High-Spend_92") for the 4th and 8th grade math and verbal tests. (The full set of results is presented in Appendix 3.) Note that in order to be able to compare the performance of districts across years and especially across the MEAP and MCAS tests, we standardize the test scores for each year. This means that estimates of the impact of MERA are measured in standard deviations of test scores. This also implies that we are measuring relative rather than absolute changes in performance.[21]

The mean performance on the four MEAP tests (4th and 8th grade math and verbal) in 1992 for the districts in Low-Spend_92 is in the range of 0.23 to 0.66 standard deviations below the performance of the districts in High-Spend_92.[22] This difference could be due to the differential in spending across the two groups, but it could also be caused by other systematic differences in district characteristics such as the demographic makeup of the students including their family backgrounds. Regardless, this result makes it clear that the low spending schools that are targeted by MERA also tend to be low performing schools.

The short-run impact of MERA is measured as the difference in the change in the mean achievement between 1992 and 1994 for Low-Spend_92 and High-Spend_92. For the 4th and 8th grade math tests and for the 8th verbal test, the short-run impact of MERA is marginally positive and not significant. For the 4th grade verbal test, this impact is negative, very small, and not significant. Overall, there is little difference in the change in performance on all four tests between 1992 and 1994 for Low-Spend_92 and High-Spend_92. From this, we conclude that there is no evidence that MERA had a positive short-run impact on the relative performance of the low-spending districts.

WE ARE MEASURING RELATIVE CHANGES IN PERFORMANCE

Next we examine the long-term effects of MERA by including additional years in the analysis. We control for changes in other determinants of test score performance; the percent of black and Hispanic students, the number of enrolled students in the district, the natural log of per-

21 One might be concerned that basing this analysis on the results from two tests (MEAP in 1988 -1996 and MCAS in 1998-2006) might be problematic particularly since accountability was only in place for the MCAS exams. Hence the MEAP results may be a worse measure of school quality since districts had less incentive to perform well on the tests. Thus any changes in relative performance when moving from the MEAP to the MCAS might be picking up the move to an accountability system as well as the redistribution of spending. We acknowledge that our results are picking up impacts due to both these factors so this is not troublesome from our perspective. Further, if one believes that the onset of accountability had a significant impact on relative performance then the correlation between relative performance in 1996 and 1998 should be appreciably lower than other times when the tests are the same across years. This correlation is 0.73 and 0.76 for the 4th grade math and verbal tests. The mean of the correlations for the other years is 0.84 and 0.81. Thus while, the correlation in lower across 1996 and 1998 for both tests, this does not seem like a huge difference. This correlation is 0.86 and 0.79 for the 8th grade math and verbal tests. The mean of the correlations for the other years is 0.81 and 0.77. So for the 8th grade tests, the correlations across 1996 and 1998 are higher than other years. Overall, these results do not lead us to be too concerned that the change in tests has a significant impact on the results.

22 The mean test scores are weighted by student enrollment to account for the differences in district size. Means are also weighted for all subsequent performance comparisons. Note that the Boston and Cambridge school districts are in High_Spend_92 but are relatively low performing and, because they are so large, the weighted results show a much smaller differential in performance in 1992 than the unweighted results; the districts in Low-Spend_92 performed in the range of one-half to almost one full standard deviation below the districts in High-Spend_92.

Table 7:

MERA Impacts: 1994-2006

	MATH – 4G	VERB – 4G	MATH – 8G	VERB – 8G
YEAR	LOW-SPEND_92 COMPARED TO MID-SPEND_92			
1994	-0.020	-0.065	0.107	0.01
1996	0.075	0.102	0.097	0.009
1998	0.049	0.029	0.061	-0.047
1999	-0.054	-0.060	0.107	0.051
2000	-0.021	0.009	0.135	0.134
2001	-0.057	-0.049	0.055	0.099
2002	-0.05	-0.025	0.15	-0.105
2003	-0.03	-0.016	0.151	-0.004
2004	0.059	-0.024	0.132	-0.035
2005	0.109	0.054	0.169	-0.052
2006	0.085	0.037	0.108	0.116
	LOW-SPEND_92 COMPARED TO HIGH-SPEND_92			
1994	0.106	-0.067	0.457**	0.414*
1996	0.117	-0.022	0.201	0.122
1998	-0.149	-0.406	-0.033	-0.084
1999	-0.326	-0.405	-0.195	-0.221
2000	-0.257	-0.358	-0.100	-0.092
2001	-0.341	-0.386	-0.148	-0.052
2002	-0.352	-0.357	-0.064	-0.211
2003	-0.281	-0.322	0.049	-0.003
2004	-0.342	-0.424	-0.08	-0.202
2005	-0.297	-0.414	-0.093	-0.196
2006	-0.345	-0.287	-0.045	-0.010

** p<0.01, * p<0.05

Table 8:

MERA Impacts: 1994-2006 District Fixed Effects Included

	MATH – 4G	VERB – 4G	MATH – 8G	VERB – 8G
YEAR	LOW-SPEND_92 COMPARED TO MID-SPEND_92			
1994	-0.122	-0.162	0.012	-0.064
1996	-0.074	-0.039	-0.010	-0.078
1998	-0.058	-0.077	-0.039	-0.140
1999	-0.154	-0.166	0.010	-0.039
2000	-0.164	-0.137	-0.042	-0.028
2001	-0.148	-0.145	-0.058	-0.003
2002	-0.092	-0.070	0.051	-0.200
2003	-0.046	-0.037	0.113	-0.044
2004	0.007	-0.085	0.013	-0.151
2005	0.062	0.000	0.084	-0.132
2006	0.038	-0.016	0.013	0.016
	LOW-SPEND_92 COMPARED TO HIGH-SPEND_92			
1994	-0.089	-0.238*	0.146	0.147
1996	0.074	-0.059	0.065	-0.006
1998	-0.070	-0.332**	-0.066	-0.130
1999	-0.212	-0.307**	-0.195	-0.231
2000	-0.113	-0.232*	-0.101	-0.107
2001	-0.199	-0.264*	-0.148	-0.062
2002	-0.157	-0.190	-0.076	-0.238*
2003	-0.088	-0.168	0.021	-0.051
2004	-0.199	-0.327**	-0.141	-0.271*
2005	-0.104	-0.279*	-0.095	-0.206
2006	-0.192	-0.178	-0.066	-0.042

** p<0.01, * p<0.05

pupil spending, and the percent of low income, limited English proficiency (LEP), and special education students.[23] This allows us to isolate the impact of MERA versus these other determinants of performance. We also compare the performance of Low-Spend_92 to the districts in the middle two spending quartiles (denoted "Mid-Spend_92").

Results are presented in Table 7 for the 4th and 8th grade math and verbal tests. Each row of the table is the difference in the change in mean performance between Low-Spend_92 and either Mid-Spend_92 or High-Spend_92 for a given year (i.e., the row labeled 2000 corresponds to the change in performance between 1992 and 2000). The lowest spending districts do not appear to do comparably better than the middle spending districts in 4th grade as is evident by the mix of (insignificant) positive and negative values in columns (1) and (2) in the top-half of Table 7. The same is true for the 8th grade verbal test. There is some evidence that Low-Spend_92

[23] Of these district characteristics, per-pupil spending has a consistently positive and significant impact on performance whereas the percent of low income students has a significantly negative impact on performance. These results are included in the full set of results in Appendix 3.

did better post-MERA than did Mid-Spend_92 in 8th grade math. Still, none of the terms is significant at the 5% level in the upper-half of column (3) in Table 7.

When comparing Low-Spend_92 to High-Spend_92, there are large negative but insignificant long-run impacts for the 4th grade math and verbal tests. Despite large positive and significant impacts in 1994, there are consistently negative but insignificant long-run impacts for the 8th grade math and verbal tests. These effects are generally smaller in magnitude than those for the 4th grade tests.

THE IMPACT OF MERA ON STUDENT PERFORMANCE

- The initial analysis shows that, if anything, MERA had a negative long-run impact on the relative performance of the low-spending districts.
- We find evidence that, in the absence of MERA, the relative performance of the high-spending districts was trending upwards relative to the low-spending districts.
- When we allow for district-level trends, the low-spending districts show large positive and increasing impacts in post-MERA performance compared to the higher-spending districts on the 4th grade math and verbal tests and positive long-run impacts on the 8th grade verbal test.

Next we estimate the long-term impact of MERA controlling for unobserved district-level characteristics that affect student performance (we include district fixed effects). The results are provided in Table 8. Generally, there is no dramatic change compared to the results without district fixed effects. The addition of district fixed effects results in impacts of MERA on the performance Low-Spend_92 compared to Mid-Spend_92 that are generally more negative than the estimates without the district fixed effects (Table 7). Still, none of the individual effects are statistically significant and are generally not economically significant. The impacts of MERA on the performance of Low-Spend_92 compared to High-Spend_92 are slightly more negative for the 8th grade math and verbal tests and slightly less negative for the 4th grade math and verbal tests compared to the results without the district fixed effects. Further, a number of the negative impacts in the comparison of Low-Spend_92 to High-Spend_92 are now statistically (as well as economically) significant. From looking at the results in Table 8, one gets the general impression that, if anything, MERA had a negative long-run impact on the relative performance of the low-spending districts compared to the high-spending districts.[24]

Recall that Guryan finds a short-term positive impact of MERA on student performance in 4th and 8th grade. While we get positive short-run impacts if we do not weight the district means by student enrollments, these impacts become smaller and negative for the 4th grade math and verbal tests when we correctly weight the district mean test scores and include district fixed effects. Further, even when we do not weight the observations, our results show that this initial positive impact was not sustained in the long-run, and, in fact, we find that the low-spending schools did relatively worse (compared to their performance in 1992) than did the high-spending schools.

One concern with this analysis is that, in the absence of MERA, the relative performance of Mid-Spend_92 and High-Spend_92 may have been trending upwards relative to Low-Spend_92. Hence, our results might be picking up these trends rather than the impact of MERA.

[24] It might be the case that the controls included in the regressions (the percent of black and Hispanic, low income, LEP, and special education students, enrolled students, and per-pupil spending) are themselves affected by MERA. If this is the case, then the total impact of MERA may be better measured without including the controls in the regression. When we exclude the controls from the model that includes district fixed effects the results show little change. This indicates that the indirect effect of MERA on student performance, through its impact on the demographic make-up of the districts, is small.

Figure 14:

Means for bottom, top, and middle two quartiles grade 4 math with linear trends

Figure 15:

Means for bottom, top, and middle two quartiles grade 4 verbal with linear trends

Figure 16:

Means for bottom, top, and middle two quartiles grade 8 math with linear trends

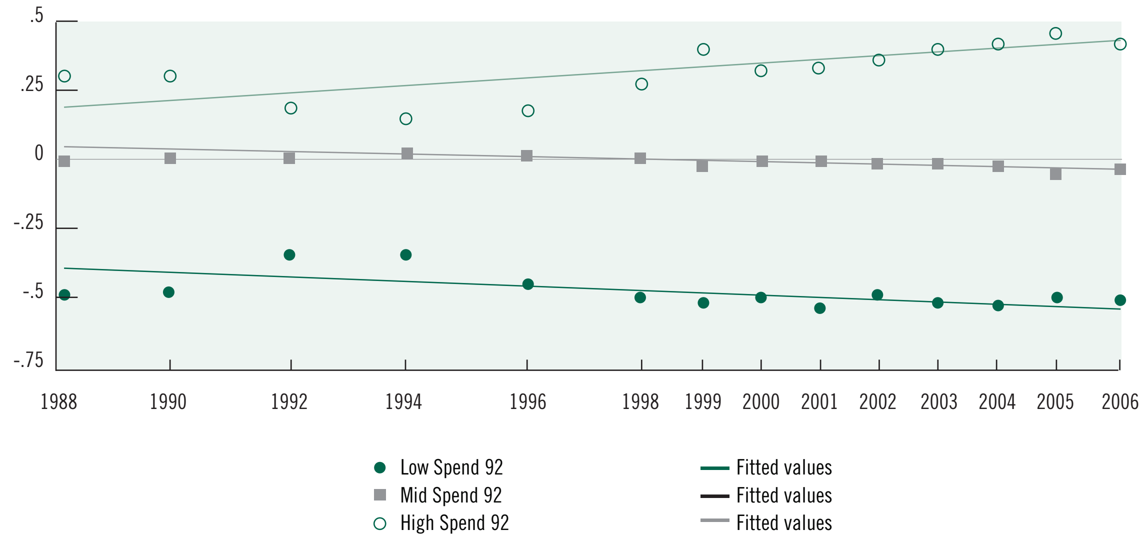
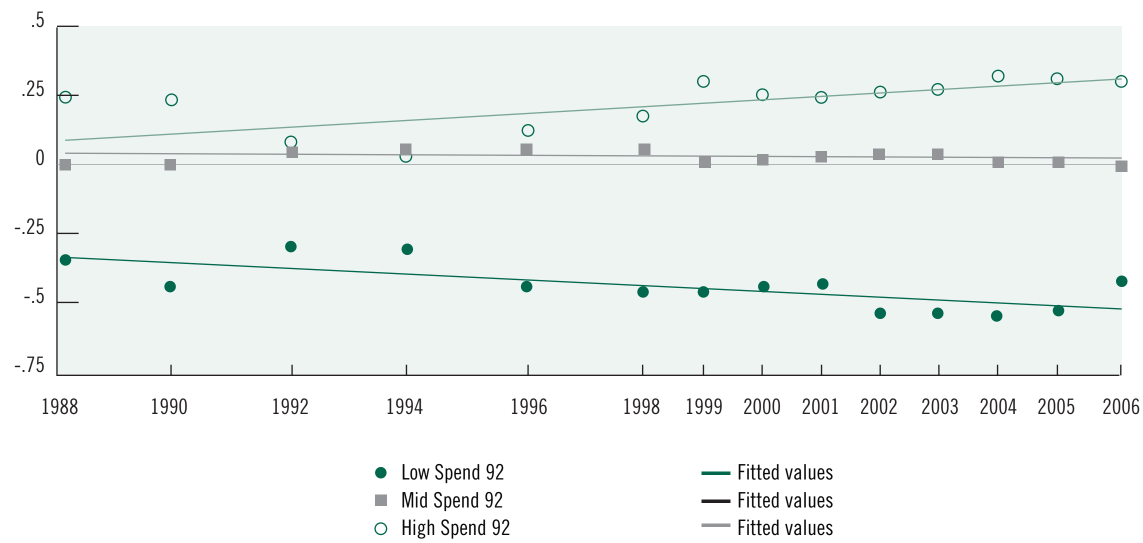


Figure 17:

Means for bottom, top, and middle two quartiles grade 8 verbal with linear trends



Figures 14-17 plot the mean performances of districts in these three groups from 1988 to 2006 for the 4th and 8th grade math and verbal tests. That is, each data point is the average of the districts' mean performances on one of these four tests in a given year in each of the three spending groups. Again, we weight these means by student enrollment. There appears to be a decline over time in the relative performance of Low-Spend_92 and Mid-Spend_92 on the 4th grade math and verbal exams. On the other hand, there is a dramatic increase over time in the relative performance of High-Spend_92 on both 4th grade exams. In 8th grade, the relative perfor-

Table 9:

MERA Impacts: 1994-2006 District Fixed Effects and Linear Trends Included

	MATH – 4G	VERB – 4G	MATH – 8G	VERB – 8G
YEAR	LOW-SPEND_92 COMPARED TO MID-SPEND_92			
1994	0.108	0.205	-0.039	0.073
1996	0.266	0.512*	-0.097	0.126
1998	0.386	0.654*	-0.164	0.144
1999	0.350	0.657	-0.138	0.278
2000	0.389	0.782	-0.201	0.334
2001	0.470	0.873*	-0.221	0.417
2002	0.579	1.032*	-0.140	0.247
2003	0.676	1.147*	-0.095	0.445
2004	0.783	1.191*	-0.213	0.366
2005	0.892	1.361*	-0.163	0.426
2006	0.918	1.425*	-0.251	0.600
	LOW-SPEND_92 COMPARED TO HIGH-SPEND_92			
1994	0.108	0.136	0.102	0.199
1996	0.376	0.505	-0.018	0.086
1998	0.323	0.405	-0.184	0.007
1999	0.256	0.547	-0.325	-0.056
2000	0.377	0.694	-0.248	0.084
2001	0.361	0.778	-0.292	0.173
2002	0.466	0.942	-0.251	-0.004
2003	0.580	1.056	-0.164	0.214
2004	0.533	0.994	-0.337	0.010
2005	0.695	1.143	-0.299	0.115
2006	0.675	1.345	-0.291	0.289

** p<0.01, * p<0.05

mances of Low_Spend_92 and Mid-Spend_92 decline slightly over time in math. On the verbal exam, there is a negative trend in relative performance in Low-Spend_92 and no change in Mid_Spend_92. Again, High-Spend_92 exhibits a positive trend in relative performance on both the math and verbal tests, though this rise is not as sharp as in 4th grade.

It is important to control for these trends when estimating the impact of MERA.[25] Thus, we augment the analysis to include individual district linear trends. The results are presented in Table 9. This has a marked effect on the estimated impact of MERA on the relative performance of Low-Spend_92. The low-spending districts now show positive increases in post-MERA performance compared to Mid-Spend_92 and High-Spend_92 on all but the 8th grade math exams. All four 4th grade cases show evidence of increasing impacts over time. This is consistent with the result that MERA had a cumulative positive impact on student performance in the low-spending districts. By 2006, these districts exhibited increases in performance relative to that of the middle- and high-spending districts of 0.7 to 1.4 standard deviations. These are all very large impacts in an economic sense. Further, compared to High-Spend_92, the impacts are jointly significant at the 1% level for the 4th grade verbal test. The results for the 8th grade verbal test are less pronounced but still positive. While the results for 8th grade math show a relatively negative performance post-MERA for Low-Spend_92, they are generally less in magnitude than is the case for the other three tests. While these results that account for linear trends provide some support for the positive impact of MERA on student performance in the low-spending districts, these impacts should be viewed with caution and are likely an upper bound on the impact of MERA since the linear trends are based on only a few data points, and the impacts themselves are generally not individually significant at the five percent level.

[25] One might be concerned that the estimated trends are influenced by observations post MERA, which themselves can be affected by MERA. But when we allow the trend to differ in the pre- and post-MERA periods, the slopes are nearly identical and are not statistically different at the 1% level in any case.

8. DIGGING DEEPER – WHAT TYPES OF DISTRICTS AND SCHOOLS BENEFITED MOST FROM MERA?

Which districts and schools appeared to benefit the most from MERA? To begin to answer this question, we can determine which districts and schools did best relative to their performance prior to MERA. To do so, we first consider the factors that are correlated with the average post-MERA change in performance for each district on the 4th grade math tests (4th grade verbal gives similar results and 8th grade math is covered below). We limit the analysis to the 216 districts with non-missing test scores for 1988 through 2006 for 4th grade math. We choose to focus on the districts in the top 25% of this performance distribution as the ones that performed the best post-MERA. We denote this group "Top25". If MERA had a positive impact on the relative standing of Low-Spend_92 then one would expect that lower spending districts would be represented disproportionately in Top25. Of these top performing districts, 14/49 (28.6%), 33/125(26.4%) and 7/42 (16.7%) are from Low_Spend_92, Mid-Spend_92, and High-Spend_92, respectively. The slight over-representation of districts in the bottom two spending groups in Top25 is positive but weak evidence in support of a positive impact of MERA on the performance of the low-spending districts.

For Low-Spend_92, we compare the characteristics of the Top25 districts with the other districts that did not show a significant improvement in post-MERA performance (denoted "Next75"). The overall means for the characteristics are also given. This can give us some idea of the types of districts that appear to respond best to MERA. We use the district characteristics in 1992 and 2006 and changes between these dates. We include the total number of students, the percent of black, Hispanic, low income, LEP, and special education students, per-pupil expenditures, and test performance.[26] The results are given in Panel A of Table 10. Columns labeled "Top 25" and "Next 75" include the means of characteristics for districts in the Top25 and Next75 groups. The columns labeled "p-value" give the p-value for the t-test of equal population means for these two groups. Again, these results are weighted by student enrollment.[27]

As expected, the change in the mean 4th grade test score between 1992 and 2006 is significantly greater in Top25 districts as compared to Next75 districts. Other than this, there are only two significant differences in the characteristics of districts in Top25 and Next75. First, the Top25 districts had greater growth in student enrollment between 1992 and 2006 than those in Next75. Second, the Top25 districts experienced a 2.55 decline in the percentage of LEP students between 1992 and 2006 whereas Next75 showed a 2.41 percentage point increase in LEP students during this time period.

We then run a set of regressions where the dependent variable is 1 if the district is in the top 25% of post-MERA performing districts (Top25) and 0 otherwise. This allows for partial correlations between performance and district characteristics (that is, conditional on the other characteristics). We run three sets of regressions using as explanatory variables the characteristics in

26 We also carry out the same comparisons for Mid-Spend_92 and High_Spend_92. Further, we also include characteristics from the 1990 and 2000 Decennial Censuses and changes between these dates to provide some additional information on students' backgrounds. To save space, these results are only included in the full set of results in Tables A5-A10 in Appendix 3.

27 In particular, we weight the 1992 values of the characteristics using enrollment in 1992, the 2006 values using enrollment in 2006 and the changes in these values using the average of the enrollments in 1992 and 2006.

Table 10:

Comparison of Mean Characteristics of Top and Other post-MERA Performers: Low-Spending Districts

	1992 DISTRICT CHARACTERISTICS			2006 DISTRICT CHARACTERISTICS			CHANGE IN DISTRICT CHARACTERISTICS		
NAME	TOP 25	NEXT 75	P-VALUE	TOP 25	NEXT 75	P-VALUE	TOP 25	NEXT 75	P-VALUE
PANEL A: DISTRICTS: 4TH GRADE MATH TEST									
Total Enrollment (thousands)	12.06*	12.28*	0.83	3.08	3.00	0.95	1.83*	0.58*	0.05
Per-pupil expenditures (thousands)	4.13	4.36	0.09	10.92	11.76	0.40	12.06*	12.28*	0.06
Percent black	1.61	8.27	0.19	1.71	7.95	0.16	12.06	12.28	0.96
Percent Hispanic	22.64	12.75	0.56	26.33	19.69	0.74	0.18	-0.12	0.67
Percent low income	28.43	27.78	0.96	32.96	36.61	0.84	5.48	7.40	0.62
Percent SPED	14.60	14.14	0.62	14.29	16.34	0.12	6.27	9.72	0.55
Percent LEP	10.25	3.96	0.41	7.04	6.28	0.88	-0.26	2.27	0.20
Test Score	-1.18	-0.83	0.59	-0.69	-0.76	0.90	0.42	0.03	0.01
Number	14	35		14	35		14	35	
PANEL B: DISTRICTS: 8TH GRADE MATH TEST									
Total Enrollment (thousands)	3.29	3.85	0.75	3.98	4.01	0.99	2.13	0.20	0.00
Per-pupil expenditures (thousands)	1.47	10.58	0.14	1.78	10.13	0.13	11.73*	12.80*	0.65
Percent black	22.54	15.46	0.68	26.66	24.47	0.91	0.39*	-0.50*	0.28
Percent Hispanic	29.38	31.43	0.88	32.61	43.51	0.58	5.69	9.00	0.43
Percent low income	14.41	13.98	0.68	14.37	17.01	0.07	4.73	12.28	0.25
Percent SPED	10.19	4.91	0.49	7.53	7.29	0.96	0.07	3.02	0.17
Percent LEP	4.20	4.39	0.21	10.87	12.21	0.20	-2.04	2.31	0.15
Test Score	-1.19	-0.99	0.72	-0.79	-1.25	0.47	0.35	-0.26	0.00
Number	11	19	11		11	19		11	19
PANEL C: SCHOOLS: 4TH GRADE MATH TEST									
Total Enrollment (thousands)	63.14	76.58	0.06	63.74	76.93	0.09	0.57*	0.33*	0.70
Per-pupil expenditures (thousands)	4.41	4.46	0.55	9.92	10.37	0.10	9.15*	9.65*	0.35
Percent black	5.72	7.24	0.44	5.17	9.43	0.63	0.30	2.41	0.07
Percent Hispanic	13.94	10.67	0.53	19.50	16.62	0.75	7.11	6.51	0.77
Percent low income	33.35	29.87	0.55	35.99	38.27	0.66	6.63	10.20	0.16
Percent SPED	14.35	14.72	0.49	14.76	15.05	0.94	0.29	0.32	0.98
Percent LEP	5.67	4.24	0.44	5.76	5.88	0.10	0.24	1.73	0.06
Test Score	-0.51	-0.29	0.26	0.05	-0.41	0.01	0.44	-0.14	0.00
Number	35	105		35	105		35	105	

* - Annual Percent Change

1992, 2006, and changes between these dates. The results are given in Panel A of Table 11. One result that is consistent with the simple comparison of means (Table 10) is that the change in the percent of LEP students is negatively correlated with being in Top25.

Next, we carry out this analysis for 8th grade math. There are 192 districts that have scores for 1988 through 2006. Of the top performing districts, 11/30 (36.7%), 24/111 (21.6%) and 13/51 (25.5%) are from Low_Spend_92, Mid-Spend_92, and High-Spend_92, respectively. The higher

Table 11:

Dependent Variable is 1 if in Top 25% of Post-MERA Performers: Low-Spending Districts

	1992 DISTRICT CHARACTERISTICS	2006 DISTRICT CHARACTERISTICS	CHANGE IN DISTRICT CHARACTERISTIC
PANEL A: DISTRICTS: 4TH GRADE MATH TEST			
Total Enrollment	-0.026 (0.035)	-0.025 (0.031)	0.076 (0.048)
Percent Black	0.036 (0.025)	0.009 (0.023)	0.053 (0.058)
Percent Hispanic	-0.021 (0.023)	0.007 (0.013)	0.023 (0.018)
Per-Pupil Expenditures	0.049 (0.267)	-0.100 (0.089)	-0.022 (0.024)
Percent Low Income	-0.030 (0.018)	-0.001 (0.016)	-0.003 (0.021)
Percent SPED	0.016 (0.032)	-0.042 (0.032)	-0.005 (0.029)
Percent LEP	0.091* (0.039)	-0.025 (0.021)	-0.062** (0.009)
R-squared	0.52	0.48	0.40
Observations	49	49	49
PANEL B: DISTRICTS: 8TH GRADE MATH TEST			
Total Enrollment	0.055 (0.070)	0.027 (0.040)	0.342** (0.118)
Percent Black	-0.051 (0.064)	0.008 (0.044)	0.171 (0.088)
Percent Hispanic	-0.017 (0.024)	0.059 (0.038)	0.018 (0.028)
Per-Pupil Expenditures	-0.315 (0.330)	0.068 (0.193)	-0.021 (0.028)
Percent Low Income	0.020 (0.032)	-0.084 (0.060)	-0.042 (0.021)
Percent SPED	-0.022 (0.049)	-0.019 (0.048)	0.070* (0.033)
Percent LEP	0.019 (0.042)	0.020 (0.039)	-0.065** (0.014)
R-squared	0.55	0.54	0.71
Observations	30	30	30
PANEL C: SCHOOLS: 4TH GRADE MATH TEST			
Total Enrollment	-0.002** (0.001)	-0.003** (0.001)	0.001 (0.013)
Percent Black	-0.007 (0.004)	-0.004 (0.003)	0.000 (0.004)
Percent Hispanic	0.001 (0.004)	0.003 (0.004)	0.005 (0.005)
Per-Pupil Expenditures	-0.050 (0.145)	-0.106** (0.035)	-0.032 (0.017)
Percent Low Income	0.002 (0.002)	0.001 (0.003)	-0.002 (0.002)
Percent SPED	-0.013 (0.017)	-0.020 (0.017)	0.008 (0.013)
Percent LEP	-0.001 (0.009)	0.003 (0.011)	-0.024* (0.011)
R-squared	0.06	0.13	0.06
Observations	140	140	140

Standard errors in parentheses

** $p<0.01$, * $p<0.05$

percentage of low-spending schools in Top25 compared to Mid-Spend_92 and High-Spend_92 provides stronger evidence (compared to the 4th grade results) of a positive impact of MERA on the performance of low-spending districts.

The results from the comparison of the characteristics of Top25 with those of Next75 for the districts in Low-Spend_92 are given in Panel B of Table 10. Generally, again, there are few significant differences in the characteristics between Top 25 and Next75. Those districts in Top25 had

WHAT TYPES OF DISTRICTS AND SCHOOLS BENEFITED MOST FROM MERA?

- Based on post-MERA performance, districts were divided into those in the top 25% (Top25) and the next 75% (Next75)
- the Top25 districts and schools experienced a smaller change in the percentage of LEP students between 1992 and 2006 compared to those in Next75.
- The Top25 districts had greater growth in student enrollment between 1992 and 2006 than those in Next75.
- The Top25 schools (based on 4th grade math performance) had smaller enrollments in 1992 and 2006 than those in Next75.

a significantly higher percentage increase in the total number of students, and relatively lower changes in the percentage of low income, sped, and LEP students than those districts in Next75 (though these latter three differences are not statistically significant).

We then run a set of regressions where the dependent variable is 1 if the district is in Top25 and 0 otherwise. The results are given in Panel B of Table 11. Consistent with the simple comparison of means, the percent change in enrollment and the change in the percentage of LEP students are significantly positively and negatively correlated with Top25, respectively.

We also carry out the same analysis at the school level. That is, we determine which schools did best relative to their performance prior to MERA. The analysis is limited to the 643 schools with non-missing test scores for 1988 through 2006 for 4th grade math. We do not carry out this school-level analysis for 8th grade since approximately 80% of districts have only one school that includes 8th grade and hence the school-level analysis will be vey similar to the district-level analysis performed above. Again, we focus on the schools in the top 25% of this performance distribution as the ones that performed the best post-MERA; the Top25. Of the top performing schools on the 4th grade math test, 35/140 (25.0%), 77/337(22.8%) and 49/166 (29.5%) are from Low_Spend_92, Mid-Spend_92, and High-Spend_92, respectively. So, as is the case at the district level, there are not a disproportionate number of low-spending schools in Top25 (for 4th grade math).

Next, we compare the characteristics of the Top25 schools with the Next75 schools. Data availability allows us to measure enrollments at the grade level, the percent of black, Hispanic, and low income students at the school level, and the percent of special education and LEP students and per-pupil spending at the district level. The results are given in Panel C of Table 10. The means are weighted by 4th grade student enrollment.

First, note that the mean 4th grade test score in 1992 is lower for schools in Top25 as compared to Next75 whereas this mean is greater for schools in Top25 as compared to Next75 in 2006 (and, of course, the change in the mean test score between 1992 and 2006 is significantly greater for Top25 compared to Next75). Second, schools in Top25 had smaller 4th grade enrollments in both 1992 and 2006 than those in Next 75 and experienced lower changes in the percent of black and LEP students. The regression analysis (Panel C of Table 11) supports the differences in enrollments in 1992 and 2006 and the change in the percent of LEP students.

9. CONCLUDING REMARKS

The Massachusetts Education Reform Act (MERA), which became law in 1993, ushered in a period of radical change in the state's public education system, much like the Kentucky Education Reform Act (KERA) on which MERA was modeled. However, while a number of analysts have analyzed the long-term effects of KERA, no systematic analyses of the long-term effects of MERA exist. This paper seeks to fill this gap by providing the first attempt to evaluate the long-term effects of MERA on the distributions of education spending and student performance.

Our results indicate that, while some of the short-term effects of MERA appear to have been sustained, other short-term effects are not apparent in the long run. As Dee and Levine (2004) found, we find that, in the short run, MERA did equalize education spending, increasing relative spending in districts serving disproportionate shares of disadvantaged students. In the long run, however, the extent of equalization declined, particularly in those years where state fiscal circumstances resulted in little growth, or even declines, in state aid.

We also find that, while a portion of the initial increases in state aid after MERA were used to provide property tax relief, these reductions in property taxes have not been sustained. In response to declines in real state aid per pupil from 2002 to 2004, most districts increased the use of property tax revenues so as to keep real spending per pupil stable. Further, while current expenditures per pupil have become substantially more equal among those districts in the bottom three quartiles of pre-MERA spending, the spending gap between those districts and the districts in the top quartile of pre-MERA spending has remained essentially unchanged. Districts that received the largest increases in state aid after MERA used many of those additional dollars to increase spending on classroom services. Special education expenditures, both on a per pupil basis and as a share of total expenditures, have grown for districts in each quartile of the distribution of post-MERA aid increases. This growth was somewhat larger in districts with the largest growth in state aid after MERA. Factors that influence the cost of educating students, such as the percent low income, grew most rapidly in districts with the largest growth in state aid after MERA.State aid and current expenditures per pupil grew most rapidly in those districts with the lowest mean test scores pre-MERA.

CAREFULLY DEVELOP STRATEGIES TO ENCOURAGE DISTRICTS TO CONSOLIDATE

When we turn to the analysis of the impact of MERA on the distribution of student performance, our data do not make it possible to evaluate the impact of the reforms on absolute performance. That said, our results are consistent with the observation, made in the report of the Commonwealth Readiness Project, that "[f]ifteen years after landmark education reform legislation, we can claim unmatched accomplishments in demonstrating that high expectations and high standards can work for students" (Executive Office of Education, 2008, p. 4).[28] What our data do allow us to do is see how the performance of districts with low spending prior to MERA changed relative to the performance of students in higher spending districts. And we find some

[28] To support this assertion, the report notes that Massachusetts' 4th and 8th graders have been first or tied for first on all four examinations of NAEP since 2005 and that the percentage of 10th graders passing the MCAS on their first try had increased in each year since 2001 (Executive Office of Education, 2008).

evidence that, in the long term, there was an improvement in the relative performance of districts which were low spending prior to MERA .

This result only comes after controlling for individual district trends in performance. In particular, in the absence of MERA, we find that high-spending districts exhibited significant positive trends in relative performance. If we do not

THE EXISTING FORMULA DOES NOT ACCOUNT FULLY FOR THE COST OF EDUCATING LEP STUDENTS

take these trends into consideration, it appears that, if anything, MERA had a negative impact on the performance of the low-spending districts. Hence, in some cases, the impact of MERA was to mitigate this otherwise widening gap in the performance of the low-spending districts relative to the performance in the middle- and high-spending districts.

We also attempted to determine the particular characteristics of districts and schools whose post-MERA performance showed the greatest improvement relative to their pre-MERA results. For the low-spending districts, there is some evidence that the better performing districts saw greater growth in enrollments between 1992 and 2006 (particularly for 8th grade) and lower changes in the percentage of LEP (significant) and low income students (negative but not significant). At the school level, the better performers among the low-spending districts had lower enrollments in 1992 and 2006 and smaller increases in the percentage of low income students.

Recommendations/Observations

- Necessity of stable revenue streams – Our results establish that inequality increased when state revenues declined. Stable revenue streams make it possible for the state to maintain the financial commitment to provide sufficient state aid to avoid increases in inequality.

- Evaluate the formula that determines each district's foundation spending – While the reforms may have been effective, gaps in student performance remain. While our results do not permit us to identify the sources of these gaps, the fact that districts with more rapid growth in the fraction of students who are LEP were less likely to be top performers is noteworthy. Such a result is consistent with the possibility that the existing formula, constructed as it was before the establishment of current standards, does not fully account for the cost of serving LEP students and for other costs that districts face in meeting the standards. Determining if the formula needs to be modified to account for these costs could be a first step towards closing the persistent performance gaps.

- Proceed with caution to encourage districts to consolidate – A large literature, summarized nicely by Duncombe and Yinger (2007b), supports the Readiness Project recommendation to "[i]ncrease the size while reducing the number of the Commonwealth's current school districts to streamline administration and management structures" (Executive Office of Education, 2008, p. 26). While our results shed little direct light on the benefits of encouraging consolidation of districts, the more rapid enrollment growth of top performing districts is consistent with districts being able to take advantage of the benefits of scale. Our results also highlight an important caution concerning consolidation. Numerous analysts (see Rural Trust, 2008) have argued that the gains from consolidation are achieved through reducing administrative costs. Merging schools can reduce or eliminate the gains from consolidation (Chan, Leach, and Payne, 2008). We find (in Table 11) that larger schools were less likely to be top performers. Thus, if policies to encourage consolidation are pursued, we would argue for structuring these policies so that they promote district, but not school, consolidation.

- Use the Massachusetts' reforms as a model for other states – The combination of finance and accountability reforms has generated more benefits for previously low spending districts than have any of the finance reforms described above.

- Pursue structural reforms and have in place mechanisms to evaluate those reforms – This study indicates that finance and accountability reforms are unlikely to be enough to close gaps completely. Contemplating the type of reforms suggested in the Commonwealth Readiness Project report (Executive Office of Education, 2008) is a logical first step. In addition, the lessons from case study analyses such as the Donahue Institute's "Gaining Traction" (Donahue Institute, 2007) should be used to help guide policy makers to institute the types of structural changes that will create environments that make high performance possible. But our work indicates the need to evaluate carefully and to be ready to pursue new strategies if needed.

APPENDIX 1

Matching Procedure for Merging the MEAP and CDD Data

The first step in compiling our dataset was to merge the Massachusetts Educational Assessment Program (MEAP) data with the USDOE's Common Core of Data (CCD) data. The primary method of matching was by school number. This includes a three digit district code and a three digit school code. Using this school code, 88% of MEAP observations were successfully merged with the CCD data. The large number of failed merges is due the fact that many school codes were changed and these changes were recorded in separate years in the MEAP and CCD data sets. The following matching process was carried out in order to reduce the number of failed matches:

1. MEAP observations were dropped if the data contained missing scores or zeros for all subjects in all grades.
2. School names were matched whenever possible.
3. Some ambiguities were resolved with the available data by determining whether a school was an elementary, middle, or high school. MEAP mean reading scores for grades 4, 8, and 10 indicated the school types for the MEAP observations. Similarly, grade-level populations for the CCD data suggested the school type in the target data.
4. Since missing matches were most infrequent in 1996 and increased going back in time, the manual matching began with 1994. For each failed match in a given year, the new school code was used in previous years. While this often fixed unmatched observations in previous years, in some cases it created a new unmatched observation. In years where a new unmatched observation was generated, the old school code was reapplied.

This approach reduced the number of unmerged observations to around 2.5% of the total. After this, the MEAP-CCD matches were done manually based on known school name changes that occurred during the span of years covered by the study. Additionally, some schools were reassigned to their district in cases where their district number incorrectly reflected their district membership.

Six remaining unmatched cases were new schools created in a particular year that were not registered in the CCD data set but were present in the MEAP data set. For nine cases, no suitable match existed in the CCD database. For these limited cases, enrollment data was applied, in order of preference, from the nearest available year of the same cohort of students, the nearest available year from the same grade, or district averages. After this there were no unmatched schools. The MCAS data were then merged with the MEAP/CCD data based on school and district codes. There was no problem with compatibility using these variables.

APPENDIX 2

The Analytical Framework for Evaluating the Impact of MERA on Student Performance

In this appendix, we develop the analytical framework for evaluating the impact of MERA on student test scores. We carry out this analysis at the district level because state aid is allocated at the district level so this is where we expect to see the impact of MERA. One purpose of MERA was to equalize resources across school districts. We will evaluate if this redistribution of spending led to an improvement of student performance in low-spending compared to high-spending districts. Hence, we need to first designate districts as low- and high-spending based on their outlays prior to MERA. To do so, we identify districts in the upper quartile and lower quartile of the spending distribution in 1992. We denote these two groups as Low-Spend_92 and High-Spend_92. This offers a clear delineation between the low spending and high spending schools.

The first model that we present is a simple difference-in-difference model. This method compares the relative performances of Low-Spend_92 and High-Spend_92 in 1992 and 1994, the closest years before and after reform. This is equivalent to the following model that is limited to districts in Low-Spend_92 and High_Spend_92

(A1)

$$A_{dt}=\beta_0+\beta_1 Y94_t+\beta_2 SP\_Q1_d+\beta_3 SP\_Q1_d \bullet Y94_t+\varepsilon_{dt}$$

where

A_{dt} = the standardized achievement in district d in year t.

Y94 = 1 if year is 1994 and 0 if year is 1992

SP_Q1 = 1 if spending in 1992 in bottom quartile, 0 if in top quartile.

Note that the dependent variable is standardized to have a mean of zero and a standard deviation of one in each year. The variable $Y94_t$ is included to account for the difference in mean test scores between 1992 and 1994 (note that not all districts are included in the regression so the mean of A_{dt} is not necessarily zero in either year). The variable SP_Q1_d captures the average difference in achievement between the districts in Low-Spend_92 and High_Spend_92. The key variable is the interaction term; $SP\_Q1_d \bullet Y94_t$. The associated coefficient, β_3, measures the average change in the achievement distribution between 1992 and 1994 for districts in Low-Spend_92 compared to those in High-Spend_92. If the reform was effective in raising achievement of the less advantaged districts then we expect that β_3 will be positive. The results for equation (A1) are given in Table A1 in Appendix 3.

This equation is estimated separately for math and verbal tests in grades 4 and 8. These results are for MEAP scores only since the MCAS was first given in 1998. Note that because we classify districts as low and high spending based on spending in 1992 which is pre-MERA, we do not have the endogeneity problem that Guryan (2003) was faced with since he used current spending to measure the impact of reform.

Next we include additional post-reform years. This will allow us to measure the effect of MERA over time. One might believe that the full impact of reform will not occur until after 1994. In particular, by 1998, 4th graders in the pre-MERA low-spending districts will have experienced the cumulative effects of four full years of increased spending and eight full years by the time they are in 8th grade in 2002. We also include additional covariates to control for other district characteristics that can affect student achievement. These include the percent black and Hispanic students, the total number of students enrolled in the district, the natural log of current per pupil spending, and the percent of low income, LEP, and special education students. We also include the middle two quartiles of districts to aid in identifying the impacts of these characteristics. This group is denoted "Mid-Spend_92." We will thus include regressors to capture separate impacts of the reform on Low-Spend_92 compared to Mid-Spend_92 and High-Spend_92. The model that allows us to evaluate the long-term impacts of MERA is

(A2)

$$A_{dt}=\beta_0+\beta_1 Y_t+\beta_2 X_{dt}+\beta_3 SP\_Q23_d+\beta_4 SP\_Q4_d+\beta_3 SP\_Q23_d \bullet Y_t+\beta_6 SP\_Q4_d \bullet Y_t+\varepsilon_{dt}$$

t = 1988, 1990, 1992, 1994, 1996, 1998 - 2006

where

Y_t = 1 if year = t and 0 otherwise

X_{dt} = additional covariates

SP_Q23 = -1 if spending in 1992 in the second or third quartile, 0 otherwise

SP_Q4 = -1 if spending in 1992 in top quartile, 0 otherwise

Note that Y_t is a vector of time dummies. In this case, the key variables are included in the vectors $SP\_Q23_d \bullet Y_t$ and $SP\_Q4_d \bullet Y_t$. The coefficients for these variables will provide measures of the impact of the reform on Low-Spend_92 as compared to Mid-Spend_92 and High-Spend_92 over time. If the impact of the reform evolved over time then we expect the elements of β_3 and β_4 to vary over time. In particular, if we expect the impact to not be fully felt for a number of years, then the impact in 1996 will be greater than that in 1994. Note that the variables SP_Q23_d and SP_Q4_d are equal to -1 (as opposed to 1) for districts in Mid-Spend_92 and High-Spend_92. This means that the coefficients are interpreted as the difference between the performance for Low-Spend_92 as compared to Mid-Spend_92 and High-Spend_92 (as opposed to the reverse). The results for equation (A2) are given in Table A2 in Appendix 3.

It is likely that there are unobserved (and time invariant) characteristics of districts that are correlated with the initial position in the 1992 spending distribution that can bias the estimates of the reform impact. We will eliminate this bias by adding district fixed effects, u_d, to the model

(A3)

$$A_{dt}=\beta_0+\beta_1 Y_t+\beta_2 X_{dt}+\beta_3 SP\_Q1_d \bullet Y_t+\beta_4 SP\_Q4_d \bullet Y_t+u_d+\varepsilon_{dt}$$

t = 1988, 1990, 1992, 1994, 1996, 1998 - 2006

Note that $SP\_Q23_d \bullet Y_t$ and $SP\_Q4_d \bullet Y_t$ are excluded because they are constant across time within the district so they are captured in the district-level fixed effects. The key parameters are β_3 and β_4 which measure the relative performance of Low-Spend_92 compared to Mid-Spend_92 and High-Spend_92. The results for equation (A3) are given in Table A3 in Appendix 3.

As discussed in Section 7, there is strong evidence that, in the absence of MERA, the performance of students in high-spending districts would have significantly improved relative to students in the low-spending districts. It is important to control for these trends when estimating the impact of MERA. Thus, we augment the above model (equation A3) to include individual district linear trends

(A4)

$$A_{dt}=\beta_0+\beta_1 Y_t+\beta_2 X_{dt}+\beta_3 SP\_Q1_d \bullet Y_t+\beta_4 SP\_Q4_d \bullet Y_t+u_d+u_d \bullet t+\varepsilon_{dt}$$

t = 1988, 1990, 1992, 1994, 1996, 1998 - 2006

Again, the key parameters are β_3 and β_4 which measure the relative performance of Low-Spend_92 compared to Mid-Spend_92 and High-Spend_92. The results for equation (A4) are given in Table A4 in Appendix 3.

APPENDIX 3 — The Full Set of Regression Results

Table A1:

Difference-in-Difference Model

VARIABLE	MATH – 4G	VERB – 4G	MATH – 8G	VERB – 8G
Y94	-0.027 (0.047)	0.003 (0.113)	-0.115 (0.090)	-0.109 (0.104)
SP_Q1	-0.314 (0.734)	-0.234 (0.698)	-0.662 (0.580)	-0.496 (0.585)
SP_Q1*Y94	0.077 (0.107)	-0.007 (0.141)	0.077 (0.120)	0.048 (0.184)
Observations	220	220	208	208
Adj R-squared	-0.005	-0.007	0.042	0.019
Standard Error	1.450	1.451	1.279	1.294

Robust standard errors in parentheses

** $p<0.01$, * $p<0.05$

Notes: The dependent variable is the standardized district-level achievement
Y94 = 1 if year is 1994 and 0 if year is 1992
SP_Q1 = 1 if spending in 1992 in bottom quartile, 0 if in top quartile

Table A2:

Long-Run MERA Impacts: 1994 -2006

	MATH – 4G	VERB – 4G	MATH – 8G	VERB – 8G
YEAR	LOW-SPEND_92 COMPARED TO MID-SPEND_92			
1994	-0.020 (0.198)	-0.065 (0.183)	0.107 (0.142)	0.010 (0.132)
1996	0.075 (0.250)	0.102 (0.219)	0.097 (0.182)	0.009 (0.196)
1998	0.049 (0.185)	0.029 (0.180)	0.061 (0.197)	-0.047 (0.152)
1999	-0.054 (0.159)	-0.060 (0.170)	0.107 (0.190)	0.051 (0.162)
2000	-0.021 (0.192)	0.009 (0.217)	0.135 (0.191)	0.134 (0.184)
2001	-0.057 (0.196)	-0.049 (0.206)	0.055 (0.205)	0.099 (0.187)
2002	-0.050 (0.194)	-0.025 (0.216)	0.150 (0.223)	-0.105 (0.223)
2003	-0.030 (0.233)	-0.016 (0.262)	0.151 (0.269)	-0.004 (0.277)
2004	0.059 (0.251)	-0.024 (0.271)	0.132 (0.268)	-0.035 (0.272)
2005	0.109 (0.249)	0.054 (0.268)	0.169 (0.270)	-0.052 (0.272)
2006	0.085 (0.230)	0.037 (0.264)	0.108 (0.228)	0.116 (0.206)
YEAR	LOW-SPEND_92 COMPARED TO HIGH-SPEND_92			
1994	0.106 (0.235)	-0.067 (0.205)	0.457** (0.163)	0.414* (0.161)
1996	0.117 (0.289)	-0.022 (0.282)	0.201 (0.226)	0.122 (0.254)
1998	-0.149 (0.291)	-0.406 (0.285)	-0.033 (0.295)	-0.084 (0.208)
1999	-0.326 (0.290)	-0.405 (0.271)	-0.195 (0.336)	-0.221 (0.259)
2000	-0.257 (0.288)	-0.358 (0.317)	-0.100 (0.312)	-0.092 (0.287)
2001	-0.341 (0.318)	-0.386 (0.306)	-0.148 (0.340)	-0.052 (0.265)
2002	-0.352 (0.313)	-0.357 (0.334)	-0.064 (0.389)	-0.211 (0.321)
2003	-0.281 (0.403)	-0.322 (0.430)	0.049 (0.450)	-0.003 (0.423)
2004	-0.342 (0.420)	-0.424 (0.432)	-0.080 (0.432)	-0.202 (0.389)
2005	-0.297 (0.421)	-0.414 (0.397)	-0.093 (0.414)	-0.196 (0.377)
2006	-0.345 (0.458)	-0.287 (0.418)	-0.045 (0.381)	-0.010 (0.333)
SPENDING GROUP INDICATORS				
Middle 50 Percent	0.133 (0.157)	0.067 (0.156)	0.187 (0.166)	0.087 (0.157)
Top 25 Percent	0.305 (0.281)	0.170 (0.275)	0.557* (0.279)	0.439 (0.237)
DISTRICT CHARACTERISTICS				
Ln(per-pupil expenditures)	0.859** (0.302)	0.746** (0.283)	1.023** (0.254)	0.781** (0.223)
Enrollment	-0.009 (0.007)	-0.010 (0.007)	-0.004 (0.004)	-0.002 (0.005)
Percent Black	-0.013 (0.008)	-0.013 (0.009)	-0.011 (0.006)	-0.014* (0.006)
Percent Hispanic	-0.012 (0.007)	-0.014* (0.007)	-0.012* (0.005)	-0.016** (0.005)
Percent Low Income	-0.029** (0.005)	-0.031** (0.005)	-0.039** (0.005)	-0.040** (0.004)
Percent SPED	-0.023* (0.010)	-0.020 (0.011)	-0.030** (0.010)	-0.020* (0.010)
Percent LEP	0.001 (0.015)	0.004 (0.016)	0.029** (0.011)	0.029** (0.010)
Observations	3738	3738	3306	3307
Adjusted R-squared	0.670	0.711	0.710	0.754
Standard Error	0.688	0.662	0.624	0.606

Robust standard errors in parentheses
** p<0.01, * p<0.05

Table A3:

Long-Run MERA Impacts: 1994-2006, District Fixed Effects Included

	MATH – 4G	VERB – 4G	MATH – 8G	VERB – 8G
YEAR	LOW-SPEND_92 COMPARED TO MID-SPEND_92			
1994	-0.122 (0.117)	-0.162 (0.103)	0.012 (0.089)	-0.064 (0.140)
1996	-0.074 (0.155)	-0.039 (0.117)	-0.010 (0.097)	-0.078 (0.092)
1998	-0.058 (0.121)	-0.077 (0.097)	-0.039 (0.107)	-0.140 (0.096)
1999	-0.154 (0.124)	-0.166 (0.114)	0.010 (0.101)	-0.039 (0.105)
2000	-0.164 (0.110)	-0.137 (0.110)	-0.042 (0.105)	-0.028 (0.103)
2001	-0.148 (0.128)	-0.145 (0.113)	-0.058 (0.102)	-0.003 (0.114)
2002	-0.092 (0.127)	-0.070 (0.108)	0.051 (0.117)	-0.200 (0.116)
2003	-0.046 (0.107)	-0.037 (0.103)	0.113 0.112)	-0.044 (0.109)
2004	0.007 (0.116)	-0.085 (0.110)	0.013 (0.118)	-0.151 (0.114)
2005	0.062 (0.117)	0.000 (0.110)	0.084 (0.132)	-0.132 (0.114)
2006	0.038 (0.133)	-0.016 (0.114)	0.013 (0.121)	0.016 (0.118)
YEAR	LOW-SPEND_92 COMPARED TO HIGH-SPEND_92			
1994	-0.089 (0.133)	-0.238* (0.118)	0.146 (0.115)	0.147 (0.168)
1996	0.074 (0.143)	-0.059 (0.107)	0.065 (0.104)	-0.006 (0.100)
1998	-0.070 (0.131)	-0.332** (0.104)	-0.066 (0.117)	-0.130 (0.136)
1999	-0.212 (0.123)	-0.307** (0.104)	-0.195 (0.118)	-0.231 (0.119)
2000	-0.113 (0.102)	-0.232* (0.102)	-0.101 (0.108)	-0.107 (0.107)
2001	-0.199 (0.135)	-0.264* (0.115)	-0.148 (0.111)	-0.062 (0.127)
2002	-0.157 (0.132)	-0.190 (0.111)	-0.076 (0.146)	-0.238* (0.114)
2003	-0.088 (0.148)	-0.168 (0.141)	0.021 (0.171)	-0.051 (0.147)
2004	-0.199 (0.140)	-0.327** (0.114)	-0.141 (0.133)	-0.271* (0.110)
2005	-0.104 (0.145)	-0.279* (0.124)	-0.095 (0.136)	-0.206 (0.129)
2006	-0.192 (0.175)	-0.178 (0.129)	-0.066 (0.129)	-0.042 (0.135)
DISTRICT CHARACTERISTICS				
Ln(per-pupil expenditures)	-0.243 (0.143)	-0.324* (0.137)	-0.266* (0.104)	-0.289** (0.110)
Enrollment	-0.090** (0.028)	-0.059* (0.024)	-0.022 (0.017)	-0.024 (0.020)
Percent Black	-0.006 (0.009)	-0.006 (0.010)	-0.015** (0.004)	-0.021** (0.006)
Percent Hispanic	0.011 (0.010)	0.008 (0.009)	0.013* (0.006)	0.007 (0.007)
Percent Low Income	0.002 (0.003)	0.002 (0.003)	0.000 (0.002)	-0.004* (0.002)
Percent SPED	0.002 (0.007)	0.002 (0.005)	-0.009* (0.004)	-0.003 (0.005)
Percent LEP	-0.000 (0.009)	-0.001 (0.007)	-0.008 (0.005)	-0.007 (0.005)
Observations	3738	3738	3306	3307
Number of Districts	296	296	256	256
Adjusted R-squared	0.066	0.053	0.080	0.085
Standard Error	0.397	0.367	0.310	0.361

Robust standard errors in parentheses

** p<0.01, * p<0.05

Table A4:

Long-Run MERA Impacts: 1994-2006, District Fixed Effects Linear Trends Included

	MATH – 4G	VERB – 4G	MATH – 8G	VERB – 8G
YEAR	LOW-SPEND_92 COMPARED TO MID-SPEND_92			
1994	0.108 (0.133)	0.205 (0.150)	-0.039 (0.118)	0.073 (0.164)
1996	0.266 (0.210)	0.512* (0.241)	-0.097 (0.186)	0.126 (0.192)
1998	0.386 (0.275)	0.654* (0.316)	-0.164 (0.220)	0.144 (0.254)
1999	0.350 (0.310)	0.657 (0.369)	-0.138 (0.263)	0.278 (0.289)
2000	0.389 (0.351)	0.782 (0.425)	-0.201 (0.297)	0.334 (0.320)
2001	0.470 (0.362)	0.873* (0.438)	-0.221 (0.312)	0.417 (0.337)
2002	0.579 (0.389)	1.032* (0.484)	-0.140 (0.332)	0.247 (0.352)
2003	0.676 (0.452)	1.147* (0.533)	-0.095 (0.340)	0.445 (0.388)
2004	0.783 (0.480)	1.191* (0.574)	-0.213 (0.389)	0.366 (0.414)
2005	0.892 (0.508)	1.361* (0.594)	-0.163 (0.417)	0.426 (0.439)
2006	0.918 (0.502)	1.425* (0.606)	-0.251 (0.469)	0.600 (0.489)
YEAR	LOW-SPEND_92 COMPARED TO HIGH-SPEND_92			
1994	0.108 (0.157)	0.136 (0.197)	0.102 (0.151)	0.199 (0.196)
1996	0.376 (0.255)	0.505 (0.283)	-0.018 (0.223)	0.086 (0.263)
1998	0.323 (0.386)	0.405 (0.376)	-0.184 (0.277)	0.007 (0.345)
1999	0.256 (0.446)	0.547 (0.458)	-0.325 (0.339)	-0.056 (0.394)
2000	0.377 (0.511)	0.694 (0.511)	-0.248 (0.377)	0.084 (0.451)
2001	0.361 (0.543)	0.778 (0.532)	-0.292 (0.411)	0.173 (0.473)
2002	0.466 (0.589)	0.942 (0.583)	-0.251 (0.448)	-0.004 (0.522)
2003	0.580 (0.679)	1.056 (0.626)	-0.164 (0.484)	0.214 (0.612)
2004	0.533 (0.734)	0.994 (0.684)	-0.337 (0.522)	0.010 (0.618)
2005	0.695 (0.780)	1.143 (0.730)	-0.299 (0.545)	0.115 (0.645)
2006	0.675 (0.803)	1.345 (0.750)	-0.291 (0.607)	0.289 (0.706)
DISTRICT CHARACTERISTICS				
Ln(per-pupil expenditures)	-0.186 (0.206)	-0.405* (0.170)	-0.188 (0.141)	-0.299 (0.152)
Enrollment	-0.100* (0.041)	-0.072* (0.036)	-0.038 (0.019)	-0.045* (0.019)
Percent Black	-0.051 (0.027)	-0.045 (0.025)	-0.014 (0.018)	-0.039* (0.018)
Percent Hispanic	0.005 (0.013)	-0.009 (0.013)	-0.007 (0.008)	-0.012 (0.008)
Percent Low Income	0.002 (0.004)	-0.001 (0.003)	0.000 (0.002)	-0.001 (0.003)
Percent SPED	0.012 (0.008)	0.005 (0.006)	-0.007 (0.004)	-0.005 (0.005)
Percent LEP	-0.001 (0.012)	0.003 (0.009)	-0.008 (0.006)	-0.008 (0.006)
Observations	3738	3737	3306	3306
Number of Districts	296	296	256	256
Adjusted R-squared	0.263	0.284	0.283	0.241
Standard Error	0.353	0.319	0.274	0.329

Robust standard errors in parentheses

** $p<0.01$, * $p<0.05$

Table A5:

Comparison of Mean Characteristics of Top and Other post-MERA Performing Districts:4th Grade Math Test

	LOW-SPENDING DISTRICTS			MIDDLE-SPENDING DISTRICTS			HIGH-SPENDING DISTRICTS			ALL
NAME	TOP 25	NEXT 75	P-VALUE	TOP 25	NEXT 75	P-VALUE	TOP 25	NEXT 75	P-VALUE	MEAN
SCHOOL DISTRICT CHARACTERISTICS IN 1992										
Total students	2.52	2.78	0.83	3.51	3.29	0.72	3.74	4.46	0.85	3.39
Per-pupil expend	4.13	4.36	0.09	5.38	5.37	0.93	8.06	7.47	0.51	5.72
Pct black	1.61	8.27	0.19	2.32	5.07	0.02	14.51	21.55	0.57	8.74
Pct Hispanic	22.64	12.75	0.56	6.44	6.00	0.92	14.78	10.40	0.60	9.02
Pct low income	28.43	27.78	0.96	19.40	21.76	0.66	31.29	26.46	0.71	23.84
Pct sped	14.60	14.14	0.62	15.26	16.17	0.14	19.22	16.84	0.18	15.93
Pct lep	10.25	3.96	0.41	4.22	3.50	0.76	10.13	9.96	0.97	5.61
Test score	-1.18	-0.83	0.59	-0.54	-0.27	0.34	-1.00	-0.48	0.58	-0.50
SCHOOL DISTRICT CHARACTERISTICS IN 2006										
Total students	3.08	3.00	0.95	4.02	3.71	0.65	3.93	4.86	0.80	3.80
Per-pupil expend	10.92	11.76	0.40	11.37	11.80	0.33	16.28	15.45	0.76	12.59
Pct black	1.71	7.95	0.16	3.32	7.37	0.06	13.28	17.65	0.68	8.82
Pct Hispanic	26.33	19.69	0.74	9.21	10.99	0.67	25.12	15.42	0.47	14.02
Pct low income	32.96	36.61	0.84	21.73	29.69	0.22	39.13	31.84	0.69	30.22
Pct sped	14.29	16.34	0.12	14.87	14.86	0.99	16.35	16.53	0.92	15.42
Pct lep	7.04	6.28	0.88	4.08	5.40	0.48	10.40	8.08	0.58	6.11
Test score	-0.69	-0.76	0.90	0.01	-0.42	0.13	0.32	0.01	0.66	-0.29
(ANNUAL) PERCENT CHANGE IN SCHOOL DISTRICT CHARACTERISTICS (1992 TO 2006)										
Total students	1.83	0.58	0.05	1.22	1.33	0.79	1.38	1.56	0.79	1.26
Per-pupil expend	12.06	12.28	0.92	8.24	8.70	0.57	7.92	7.72	0.88	9.03
CHANGE IN SCHOOL DISTRICT CHARACTERISTICS (1992 TO 2006)										
Pct black	0.18	-0.12	0.67	1.25	2.55	0.28	1.79	-1.64	0.02	0.97
Pct Hispanic	5.48	7.40	0.62	3.87	5.28	0.32	8.56	6.46	0.64	5.70
Pct low income	6.27	9.72	0.55	4.77	9.13	0.04	9.60	8.92	0.89	8.34
Pct sped	-0.26	2.27	0.20	-0.22	-1.24	0.11	-2.00	-0.03	0.29	-0.34
Pct lep	-2.55	2.41	0.06	0.42	2.08	0.13	0.53	-0.93	0.54	0.94
Test score	0.42	0.03	0.01	0.43	-0.22	0.00	1.15	0.28	0.04	0.10
1990 CENSUS CHARACTERISTICS										
median income	36.52	35.82	0.86	41.96	39.70	0.42	36.60	45.52	0.16	40.84
Pct poverty	7.20	7.83	0.86	4.87	6.85	0.15	7.91	7.65	0.93	7.46
Pct high school	29.61	30.90	0.35	29.10	27.08	0.21	20.29	21.17	0.80	27.93
Pct college	19.63	21.96	0.46	27.46	29.77	0.47	46.64	44.40	0.76	27.98
2000 CENSUS CHARACTERISTICS										
median income	48.89	46.09	0.70	53.25	50.78	0.56	50.89	57.97	0.45	52.33
Pct poverty	9.84	11.60	0.72	7.86	9.19	0.45	11.30	11.29	1.00	9.14
Pct high school	30.50	32.54	0.09	29.28	29.57	0.82	19.54	21.28	0.62	27.43
Pct college	21.68	21.91	0.95	28.78	28.55	0.94	48.87	45.23	0.68	32.68
(ANNUAL) PERCENT CHANGE IN CENSUS CHARACTERISTICS (1990 TO 2000)										
median income	3.75	3.20	0.26	3.45	3.43	0.93	4.26	3.89	0.23	3.58
CHANGE IN CENSUS CHARACTERISTICS (1990 TO 2000)										
Pct poverty	3.58	4.39	0.64	5.28	3.84	0.07	3.00	3.37	0.67	4.09
Pct high school	0.33	0.29	0.91	-0.22	0.11	0.20	-1.24	-0.72	0.31	-0.16
Pct college	1.66	1.11	0.25	1.92	1.45	0.06	1.39	1.25	0.72	1.42
Number	14	35		33	92		7	35		216

Table A6:

Dependent Variable: 1 if in Top 25% of Post-MERA Performing Districts: 4th Grade Math

	LOW-SPENDING	MID-SPENDING	HIGH-SPENDING	ALL DISTRICTS
CHARACTERISTICS IN 1990 AND 1992				
Total students	-0.026 (0.035)	0.003 (0.018)	-0.029 (0.015)	-0.010 (0.007)
Pct black	0.036 (0.025)	-0.021* (0.010)	0.017 (0.022)	0.000 (0.008)
Pct Hispanic	-0.021 (0.023)	0.010 (0.018)	-0.008 (0.013)	0.000 (0.010)
Per-pupil exp	0.049 (0.267)	0.052 (0.127)	-0.076 (0.172)	0.136 (0.084)
Pct low income	-0.030 (0.018)	-0.004 (0.009)	0.025 (0.015)	-0.009 (0.007)
Pct sped	0.016 (0.032)	-0.032 (0.017)	0.010 (0.025)	-0.004 (0.014)
Pct lep	0.091* (0.039)	-0.004 (0.029)	-0.008 (0.049)	0.028 (0.017)
Median income	0.011 (0.022)	0.009 (0.009)	-0.005 (0.009)	0.002 (0.006)
Pct hs grad	-0.081** (0.022)	-0.009 (0.019)	-0.003 (0.018)	-0.014 (0.016)
Pct coll grad	-0.064** (0.018)	-0.016 (0.012)	0.005 (0.015)	-0.015 (0.010)
Mid-Spend				-0.103 (0.109)
High-Spend				-0.345 (0.242)
R-squared	0.52	0.11	0.59	0.14
CHARACTERISTICS IN 2000 AND 2006				
Total students	-0.025 (0.031)	-0.001 (0.014)	-0.022** (0.006)	-0.003 (0.005)
Pct black	0.009 (0.023)	-0.001 (0.005)	-0.006 (0.018)	0.003 (0.004)
Pct Hispanic	0.007 (0.013)	0.008 (0.011)	-0.004 (0.008)	0.010 (0.006)
Per-pupil exp	-0.100 (0.089)	-0.021 (0.049)	-0.005 (0.029)	0.025 (0.034)
Pct low income	-0.001 (0.016)	-0.016* (0.007)	0.032* (0.012)	-0.016** (0.006)
Pct sped	-0.042 (0.032)	0.000 (0.020)	-0.041 (0.023)	-0.011 (0.015)
Pct lep	-0.025 (0.021)	0.016 (0.017)	-0.016 (0.019)	0.008 (0.011)
Median income	-0.005 (0.011)	-0.003 (0.007)	-0.003 (0.003)	-0.004 (0.003)
Pct hs grad	-0.115** (0.034)	-0.027 (0.026)	0.022 (0.033)	-0.028 (0.020)
Pct coll grad	-0.056* (0.025)	-0.020 (0.015)	0.024 (0.018)	-0.019 (0.011)
Mid-Spend				0.067 (0.092)
High-Spend				-0.023 (0.136)
R-squared	0.48	0.09	0.52	0.12
(PERCENT) CHANGES IN CHARACTERISTICS				
Total students	0.076 (0.048)	0.024 (0.029)	-0.013 (0.076)	0.021 (0.026)
Pct black	0.053 (0.058)	0.006 (0.013)	0.057 (0.028)	0.014 (0.010)
Pct Hispanic	0.023 (0.018)	0.002 (0.012)	0.019 (0.021)	0.012 (0.011)
Per-pupil exp	-0.022 (0.024)	0.004 (0.024)	-0.003 (0.062)	0.005 (0.018)
Pct low income	-0.003 (0.021)	-0.017 (0.013)	0.015 (0.016)	-0.014 (0.008)
Pct sped	-0.005 (0.029)	0.024 (0.013)	-0.044 (0.029)	0.004 (0.012)
Pct lep	-0.062** (0.009)	-0.009 (0.016)	0.009 (0.020)	-0.025* (0.010)
Median income	0.031 (0.127)	-0.125 (0.065)	0.084 (0.067)	-0.042 (0.044)
Pct hs grad	0.040 (0.115)	-0.036 (0.052)	-0.090 (0.070)	-0.020 (0.038)
Pct coll grad	0.001 (0.053)	0.085 (0.053)	-0.152 (0.097)	0.049 (0.033)
Mid-Spend				0.007 (0.104)
High-Spend				-0.116 (0.136)
R-squared	0.40	0.14	0.40	0.11
Observations	49	124	41	214

Standard errors in parentheses

** p<0.01, * p<0.05

Table A7:

Comparison of Mean Characteristics of Top and Other post-MERA Performing Districts: 8th Grade Math Test

	LOW-SPENDING DISTRICTS			MIDDLE-SPENDING DISTRICTS			HIGH-SPENDING DISTRICTS			ALL
NAME	TOP 25	NEXT 75	P-VALUE	TOP 25	NEXT 75	P-VALUE	TOP 25	NEXT 75	P-VALUE	MEAN
SCHOOL DISTRICT CHARACTERISTICS IN 1992										
Total students	3.29	3.85	0.75	2.98	3.54	0.45	2.74	4.00	0.65	3.52
Per-pupil expend	4.20	4.39	0.21	5.40	5.36	0.79	7.88	7.54	0.61	5.82
Pct black	1.47	10.58	0.14	3.34	4.43	0.59	11.28	22.01	0.37	9.13
Pct Hispanic	22.54	15.46	0.68	5.31	6.74	0.62	5.37	10.71	0.30	9.20
Pct low income	29.38	31.43	0.88	17.85	22.79	0.41	19.34	27.15	0.54	24.36
Pct sped	14.41	13.98	0.68	14.48	16.17	0.04	17.92	16.89	0.53	15.92
Pct lep	10.19	4.91	0.49	3.04	4.14	0.51	5.24	10.28	0.32	5.87
Test score	-1.19	-0.99	0.72	-0.63	-0.48	0.60	-0.13	-0.26	0.87	-0.52
SCHOOL DISTRICT CHARACTERISTICS IN 2006										
Total students	3.98	4.01	0.99	3.64	3.90	0.74	3.12	4.39	0.62	3.93
Per-pupil expend	10.87	12.21	0.20	11.17	11.88	0.14	15.14	15.54	0.85	12.76
Pct black	1.78	10.13	0.13	3.77	6.87	0.24	9.52	17.68	0.41	9.08
Pct Hispanic	26.66	24.47	0.91	12.51	10.66	0.73	8.45	15.56	0.32	14.16
Pct low income	32.61	43.51	0.58	24.63	29.70	0.60	20.08	32.42	0.45	30.76
Pct sped	14.37	17.01	0.07	14.75	14.86	0.86	16.46	16.55	0.95	15.50
Pct lep	7.53	7.29	0.96	5.53	5.29	0.94	4.91	8.12	0.35	6.25
Test score	-0.79	-1.25	0.47	-0.20	-0.56	0.24	0.46	0.06	0.53	-0.41
(ANNUAL) PERCENT CHANGE IN SCHOOL DISTRICT CHARACTERISTICS (1992 TO 2006)										
Total students	2.13	0.20	0.00	1.76	1.25	0.33	2.84	1.72	0.26	1.46
Per-pupil expend	11.73	12.80	0.65	7.87	8.84	0.26	7.11	7.72	0.62	8.96
CHANGE IN SCHOOL DISTRICT CHARACTERISTICS (1992 TO 2006)										
Pct black	0.39	-0.50	0.28	0.55	2.56	0.05	1.14	-1.82	0.04	0.85
Pct Hispanic	5.69	9.00	0.43	7.51	4.42	0.32	4.93	6.44	0.65	5.79
Pct low income	4.73	12.28	0.25	7.57	8.44	0.83	6.18	8.93	0.57	8.53
Pct sped	0.07	3.02	0.17	0.31	-1.24	0.03	-0.79	-0.01	0.57	-0.25
Pct lep	-2.04	2.31	0.15	2.64	1.43	0.50	1.14	-1.11	0.27	0.88
Test score	0.35	-0.26	0.00	0.37	-0.16	0.00	0.38	0.12	0.11	0.01
1990 CENSUS CHARACTERISTICS										
Median income	37.01	33.05	0.34	39.53	39.89	0.89	42.45	43.27	0.90	40.55
Pct poverty	7.36	9.24	0.66	5.73	6.03	0.82	6.32	8.72	0.41	7.67
Pct high school	31.22	31.31	0.94	29.27	28.28	0.52	20.25	20.87	0.84	27.79
Pct college	18.25	19.58	0.67	26.82	27.37	0.85	47.62	44.51	0.63	28.11
2000 CENSUS CHARACTERISTICS										
Median income	48.98	42.36	0.38	53.25	49.80	0.38	60.71	56.82	0.69	52.17
Pct poverty	10.03	13.52	0.51	7.84	9.33	0.42	8.30	11.29	0.45	9.32
Pct high school	31.32	32.82	0.23	30.29	29.91	0.81	19.22	21.19	0.52	27.32
Pct college	20.87	20.15	0.86	28.92	27.07	0.58	51.63	45.51	0.39	32.94
(ANNUAL) PERCENT CHANGE IN CENSUS CHARACTERISTICS (1990 TO 2000)										
Median income	3.69	3.10	0.28	3.53	3.38	0.54	4.48	3.95	0.04	3.62
CHANGE IN CENSUS CHARACTERISTICS (1990 TO 2000)										
Pct poverty	3.88	3.82	0.97	3.55	4.25	0.42	4.28	2.62	0.10	3.83
Pct high school	0.08	0.31	0.38	-0.08	0.15	0.24	-1.36	-0.66	0.12	-0.16
Pct college	1.97	1.03	0.11	1.73	1.55	0.50	1.71	1.31	0.09	1.45
Number	11	19		24	87		13	38		192

Table A8:

Dependent Variable: 1 if in Top 25% of Post-MERA Performing Districts: 8th Grade Math

	LOW-SPENDING	MID-SPENDING	HIGH-SPENDING	ALL DISTRICTS
CHARACTERISTICS IN 1990 AND 1992				
Total students	0.055 (0.070)	-0.010 (0.011)	-0.040** (0.012)	-0.015 (0.008)
Pct black	-0.051 (0.064)	-0.002 (0.010)	0.045* (0.019)	0.008 (0.009)
Pct Hispanic	-0.017 (0.024)	0.015 (0.008)	-0.030 (0.023)	-0.001 (0.009)
Per-pupil exp	-0.315 (0.330)	0.101 (0.118)	-0.136 (0.096)	0.096 (0.082)
Pct low income	0.020 (0.032)	-0.001 (0.012)	0.024 (0.012)	-0.003 (0.008)
Pct sped	-0.022 (0.049)	-0.039* (0.018)	0.004 (0.026)	-0.008 (0.014)
Pct lep	0.019 (0.042)	-0.024 (0.014)	-0.007 (0.037)	0.018 (0.015)
Median income	0.077** (0.023)	0.007 (0.012)	0.009 (0.010)	0.007 (0.007)
Pct hs grad	-0.050 (0.048)	-0.007 (0.013)	0.013 (0.035)	-0.003 (0.011)
Pct coll grad	-0.059* (0.023)	-0.013 (0.009)	0.002 (0.023)	-0.011 (0.007)
Mid-Spend				-0.210 (0.151)
High-Spend				-0.247 (0.270)
R-squared	0.55	0.10	0.42	0.11
CHARACTERISTICS IN 2000 AND 2006				
Total students	0.027 (0.040)	-0.010 (0.013)	-0.033** (0.008)	-0.008 (0.005)
Pct black	0.008 (0.044)	0.006 (0.005)	0.034 (0.020)	0.006 (0.006)
Pct Hispanic	0.059 (0.038)	0.016 (0.009)	-0.007 (0.018)	0.011* (0.005)
Per-pupil exp	0.068 (0.193)	-0.094 (0.050)	-0.057 (0.040)	-0.009 (0.035)
Pct low income	-0.084 (0.060)	-0.014 (0.008)	0.013 (0.012)	-0.012 (0.007)
Pct sped	-0.019 (0.048)	0.002 (0.019)	0.021 (0.027)	-0.005 (0.016)
Pct lep	0.020 (0.039)	0.021 (0.014)	-0.009 (0.020)	0.013 (0.012)
Median income	-0.032 (0.044)	-0.009 (0.007)	0.006 (0.005)	-0.001 (0.004)
Pct hs grad	0.046 (0.093)	-0.010 (0.014)	-0.030 (0.054)	-0.006 (0.013)
Pct coll grad	0.012 (0.069)	-0.002 (0.010)	-0.016 (0.026)	-0.007 (0.009)
Mid-Spend				-0.079 (0.123)
High-Spend				0.039 (0.170)
R-squared	0.54	0.14	0.31	0.11
(PERCENT) CHANGES IN CHARACTERISTICS				
Total students	0.342** (0.118)	0.030 (0.025)	0.033 (0.028)	0.026 (0.020)
Pct black	0.171 (0.088)	-0.006 (0.012)	0.067 (0.040)	0.013 (0.010)
Pct Hispanic	0.018 (0.028)	0.025* (0.010)	0.002 (0.024)	0.026* (0.011)
Per-pupil exp	-0.021 (0.028)	-0.034 (0.017)	0.009 (0.062)	-0.016 (0.017)
Pct low income	-0.042 (0.021)	-0.003 (0.010)	0.016 (0.013)	-0.010 (0.007)
Pct sped	0.070* (0.033)	0.029* (0.013)	-0.017 (0.024)	0.004 (0.012)
Pct lep	-0.065** (0.014)	0.008 (0.012)	-0.002 (0.018)	-0.006 (0.014)
Median income	-0.333* (0.141)	0.004 (0.068)	0.075 (0.046)	0.031 (0.044)
Pct hs grad	0.004 (0.088)	-0.029 (0.034)	-0.066 (0.060)	-0.027 (0.032)
Pct coll grad	-0.013 (0.066)	0.002 (0.036)	-0.080 (0.076)	0.029 (0.025)
Mid-Spend				-0.187 (0.123)
High-Spend				-0.252 (0.148)
R-squared	0.71	0.21	0.24	0.13
Observations	30	110	50	190

Standard errors in parentheses

** p<0.01, * p<0.05

Table A9:

Comparison of Mean Characteristics of Top and Other post-MERA Performing Schools: 4th Grade Math Test

	LOW-SPENDING DISTRICTS			MIDDLE-SPENDING DISTRICTS			HIGH-SPENDING DISTRICTS			ALL
NAME	TOP 25	NEXT 75	P-VALUE	TOP 25	NEXT 75	P-VALUE	TOP 25	NEXT 75	P-VALUE	MEAN
SCHOOL DISTRICT CHARACTERISTICS IN 1992										
Total students	63.14	76.58	0.06	62.99	67.34	0.24	62.22	60.15	0.61	66.40
Pct black	5.72	7.24	0.44	3.71	3.89	0.75	23.64	18.24	0.22	8.37
Pct Hispanic	13.94	10.67	0.53	9.14	5.64	0.28	11.94	10.68	0.70	8.70
Pct low income	33.35	29.87	0.55	27.18	22.56	0.24	41.28	27.53	0.01	27.18
Pct sped	14.35	14.72	0.49	16.28	15.83	0.25	17.16	17.19	0.95	15.91
Pct lep	5.67	4.24	0.44	5.04	3.34	0.32	12.19	8.84	0.05	5.36
Per-pupil expend	4.41	4.46	0.55	5.57	5.47	0.10	7.54	7.65	0.34	5.74
Test score	-0.51	-0.29	0.26	-0.26	0.22	0.00	-0.53	0.14	0.00	-0.04
SCHOOL DISTRICT CHARACTERISTICS IN 2006										
Total students	63.74	76.93	0.09	64.88	67.93	0.47	66.37	60.35	0.16	67.31
Pct black	5.17	9.43	0.04	4.64	4.65	0.99	17.52	15.61	0.60	8.32
Pct Hispanic	19.50	16.62	0.63	12.34	9.64	0.25	19.99	15.60	0.25	13.51
Pct low income	35.99	38.27	0.75	29.66	25.83	0.32	43.97	30.02	0.02	31.17
Pct sped	14.76	15.05	0.66	15.77	14.73	0.00	17.57	16.63	0.04	15.43
Pct lep	5.76	5.88	0.94	5.56	4.48	0.28	11.19	7.21	0.00	5.88
Per-pupil expend	9.92	10.37	0.10	10.71	10.41	0.07	13.77	13.52	0.49	11.17
Test score	0.05	-0.41	0.01	0.26	0.04	0.09	0.46	0.26	0.31	0.05
(ANNUAL) PERCENT CHANGE IN SCHOOL DISTRICT CHARACTERISTICS (1992 TO 2006)										
Total students	0.57	0.33	0.70	0.70	0.39	0.39	0.80	0.40	0.36	0.46
Per-pupil expend	9.15	9.65	0.35	6.76	6.58	0.60	5.93	5.66	0.21	7.11
CHANGE IN SCHOOL DISTRICT CHARACTERISTICS (1992 TO 2006)										
Pct black	0.30	2.41	0.07	0.82	1.08	0.57	-5.08	-0.29	0.01	0.58
Pct Hispanic	7.11	6.51	0.77	5.05	4.87	0.89	9.09	6.93	0.24	5.96
Pct low income	6.63	10.20	0.16	4.23	5.46	0.41	5.35	6.89	0.36	6.49
Pct sped	0.29	0.32	0.98	-0.38	-1.02	0.17	0.42	-0.21	0.17	-0.39
Pct lep	0.24	1.73	0.06	1.45	1.54	0.89	-0.45	-0.65	0.83	0.99
Test score	0.44	-0.14	0.00	0.44	-0.22	0.00	0.93	-0.05	0.00	0.01
Number	35	105		77	260		49	117		643

Table A10:

Dependent Variable: 1 if in Top 25% of Post-MERA Performing Schools: 4th Grade Math

	LOW-SPENDING	MID-SPENDING	HIGH-SPENDING	ALL DISTRICTS
CHARACTERISTICS IN 1990 AND 1992				
Total students	-0.002** (0.001)	-0.001 (0.001)	0.002 (0.002)	-0.001 (0.001)
Pct black	-0.007 (0.004)	-0.004 (0.004)	-0.006 (0.003)	-0.003 (0.002)
Pct Hispanic	0.001 (0.004)	0.002 (0.004)	-0.008* (0.003)	-0.003 (0.002)
Per-pupil exp	-0.050 (0.145)	0.126* (0.062)	-0.035 (0.053)	0.010 (0.036)
Pct low income	0.002 (0.002)	0.001 (0.002)	0.009* (0.004)	0.002 (0.001)
Pct sped	-0.013 (0.017)	0.006 (0.008)	-0.018 (0.018)	-0.000 (0.007)
Pct lep	-0.001 (0.009)	0.005 (0.007)	0.006 (0.014)	0.009 (0.005)
Mid-Spend				-0.019 (0.055)
High-Spend				0.025 (0.117)
R-squared	0.06	0.04	0.12	0.03
CHARACTERISTICS IN 2000 AND 2006				
Total students	-0.003** (0.001)	-0.001** (0.000)	0.002 (0.001)	-0.001* (0.000)
Pct black	-0.004 (0.003)	-0.006* (0.003)	-0.009** (0.003)	-0.003* (0.002)
Pct Hispanic	0.003 (0.004)	0.002 (0.003)	-0.008* (0.003)	-0.002 (0.002)
Per-pupil exp	-0.106** (0.035)	0.015 (0.028)	-0.017 (0.018)	-0.020 (0.013)
Pct low income	0.001 (0.003)	-0.001 (0.002)	0.005 (0.003)	0.001 (0.002)
Pct sped	-0.020 (0.017)	0.029** (0.011)	0.004 (0.021)	0.018* (0.008)
Pct lep	0.003 (0.011)	0.002 (0.005)	0.034* (0.013)	0.009* (0.004)
Mid-Spend				-0.004 (0.045)
High-Spend				0.122 (0.068)
R-squared	0.13	0.05	0.17	0.04
(PERCENT) CHANGES IN CHARACTERISTICS				
Total students	0.001 (0.013)	0.006 (0.007)	0.015 (0.017)	0.006 (0.006)
Pct black	0.000 (0.004)	-0.001 (0.005)	-0.018** (0.005)	-0.007* (0.003)
Pct Hispanic	0.005 (0.005)	0.002 (0.003)	-0.000 (0.005)	0.002 (0.002)
Per-pupil exp	-0.032 (0.017)	0.010 (0.018)	0.044 (0.036)	0.001 (0.012)
Pct low income	-0.002 (0.002)	-0.004 (0.003)	-0.002 (0.004)	-0.003 (0.002)
Pct sped	0.008 (0.013)	0.011 (0.008)	0.006 (0.013)	0.008 (0.006)
Pct lep	-0.024* (0.011)	0.000 (0.008)	0.007 (0.010)	-0.002 (0.005)
Mid-Spend				0.002 (0.057)
High-Spend				0.062 (0.071)
R-squared	0.06	0.01	0.11	0.03
Observations	140	337	166	643

Standard errors in parentheses
** p<0.01, * p<0.05

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