Does Money Matter in the Long Run? Effects of School Spending on Educational Attainment

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Online Appendix

1 Data Sources

All student microdata and education finance data used in this paper were provided by the Michigan Department of Education (MDE), Center for Educational Performance and Information (CEPI), Michigan Consortium for Educational Research (MCER), and Michigan Senate Fiscal Agency.

I assembled the microdata from individual test-taking records beginning in 1994 from Michigan's statewide assessment, the Michigan Educational Assessment Program (MEAP). These records included testing during grades four, five, seven, and eight. Test scores from grade eleven were from the Michigan High School Test (HST). Student-level enrollment and demographic information since 2003 are from Michigan's Single Record Student Database (SRSD). District-level school finance data beginning in 1993 are from the Michigan Bulletin 1014 files. School-level expenditure information are from Michigan's Historical Form B files. Both the microdata from 1994-2002 and the school-level expenditure data have never been used by academic researchers, likely because they were not known to exist. Finally, the foundation allowance and 1994 district revenue information are from the Michigan Senate Fiscal Agency.

The pre-Proposal A district-level enrollment, number of high school graduates, and expenditure information are from the National Center for Education Statistics (NCES) Common Core of Data (CCD). The total enrollment and number of high school graduates are from the Local Education Agency Universe Survey, available beginning in 1987, though Michigan only began reporting high school graduates in 1990. The current operating and total expenditure data are from the Local Education Agency Finance Survey (F-33), available in 1990 and 1992. I supplement these data with the Michigan Bulletin 1014 data files available in 1993 and 1994. No expenditure data are available in 1991.

In addition to the microdata and school finance information, I assembled a longitudinal, district-level dataset including several variables characterizing local school choice, demographic, and economic conditions. The school choice variables include: a) percent of students living in the district who attend a charter school; b) percent of students living in the district who use inter-district school choice to attend a traditional public school in another district; c) percent of students attending a traditional public school in the district who live in another district (i.e., gains from inter-district choice); d) number of charter schools located in the district; and e) number of charter schools located in the district and adjoining districts. The first three variables are constructed using information from CEPI's Public Student Headcount Data and CEPI's Nonresident Student Research Tool. The last two variables are constructed using charter school addresses and school district geographic boundaries.[1]

The district-level variables characterizing demographic and economic conditions are: a) population per square mile in the district (i.e., population density); b) fraction of 5–17 year olds living in poverty in the district; c) local median

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[1]Thank you to Brian Jacob, Tamara Wilder Linkow, and Francie Streich for providing the school choice variables.

household income (in 2012 dollars); d) fraction of students attending school in the district who are black; e) fraction of students attending school in the district that are eligible for free lunch; and f) local average unemployment rate. The fraction of a students in the district who are black and fraction eligible for free lunch come from the NCES CCD, available beginning in 1993. School district population and poverty counts are from the Census Small Area Income and Population Estimates (SAIPE), available since 1995. Median income information is also from SAIPE, but only available at the county level (there are 83 counties as opposed to the 518 districts in my sample). School district square mileage used to calculate population density is from CEPI.

Local unemployment rates were calculated using monthly city- and county-level unemployment rates from the Bureau of Labor Statistics (BLS). Average rates were calculated for a school year for August through July. If more than half of the students in a district attend school in a city for which the rate is available, then I used the student-weighted average rate across cities in the district. If fewer than half of students in the district attend school in a city with an available rate, then I used the county unemployment rate.

2 Replication of Papke (2008)

As a first step toward estimating the long-run effects of school spending in Michigan using student-level data, I replicate previous work examining the short-run effects on achievement using group-level (i.e., school- or district-level) data. I then examine the sensitivity of the estimates to concerns regarding omitted factors that were changing over this time period in Michigan and could have affected districts differentially by 1994 revenue. Finally, using my student-level data and several strategies to alleviate these concerns, I examine effects on student attrition, mobility, and achievement in later grades.

I begin my analysis of the effect of spending by replicating Papke's 2008 study of the effects of spending increases due to Proposal A on district-level fourth grade test proficiency rates.[2] Her main specification estimates the following equations using two-stage least squares (2SLS):

$$Y_{dy} = \beta_0 + \beta_1 ln\widehat{(Spend)}_{dy} + X_{dy} + \alpha_d + \gamma_y + \epsilon_{dy} \tag{1}$$

$$\ln(Spend)_{dy} = \delta_0 + \delta_1 Allow_{dy} + X_{dy} + \lambda_d + \pi_y + \mu_{dy} \tag{2}$$

where Y_{dy} is the fourth grade test pass rate of district d in year y, $Spend$ is average real spending in district d in years $y, y-1, y-2$, and $y-3$, X is a vector of district-level characteristics that includes enrollment and fraction free lunch, $Allow$ is the foundation allowance in district d and year y, λ and α are district fixed effects in the first and second stage, respectively, and π and γ are year fixed effects in the first and second stage, respectively. Following Papke (2008), I cluster the standard errors at the district level.

I insert the main results from that study in row 1 of Appendix Table 3 (these results are Papke's estimation of Equations 3 and 4). This is a level-log regression of the fraction passing the fourth grade test on logged spending. The interpretation of the coefficient is that a 10 percent increase in spending leads to a 3.7 percentage point increase in the fraction passing the fourth grade test (column 1, row 1). When I attempt to replicate this analysis, I estimate an effect of 4.0 percentage points (row 2).[3] The first stage coefficients (column 3)

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[2]Papke (2008) is a follow-up to Papke (2005). Both examine the effects of spending on fourth grade Michigan test scores, but I replicate the former because it uses more years of data (1995–2004) and a longer lag structure of spending.

[3]The 0.3 percentage point difference is likely due to a few minor differences between our data. First, our sample of districts is slightly different. Papke uses the 500 districts that have non-missing covariates in her data, while I have 518 districts with non-missing covariates. I do not know which specific districts are included in her analysis, so I cannot exactly replicate her sample. Second, Papke's data come largely from older data sources (e.g., "Michigan School Reports") that have since been deleted from the Michigan Department of Education website. The data may have been changed or corrected over the years, and may be slightly different than the sources from which I obtained my data. For spending, I used total current operating expenditures from the Bulletin 1014 Form. Similarly, instead of using

are also very similar across the two analyses.

The use of the allowance as an IV mitigates some key concerns with identification. However, there were a number of factors changing in Michigan over the sample period that could confound this estimation strategy. In order to examine whether this is the case, I run a handful of falsification checks in which I re-estimate Equations 3 and 4, replacing the achievement dependent variable with a district-level covariate. Ideally, the effect of spending on these characteristics would be zero or small, given that it is unlikely that an increase in school spending would cause large changes in district characteristics.

I find large and precisely estimated point estimates, suggesting that the specification is flawed. There are large negative "effects" of spending on the percentage of students living in the district attending a charter school. This suggests that districts experiencing the largest relative increases in the allowance are those experiencing the smallest relative increases in charter school attendance. This is consistent with increases in charter schools over the period occurring among the more urban, high-1994-revenue districts. Spending is positively related to district density, which is consistent with high-1994-revenue districts (such as Detroit) experiencing population declines during this period. Finally, the fraction of children in the district living in poverty, and the unemployment rate, are both precisely and negatively associated with spending, suggesting that the low-1994-revenue districts were gaining economically relative to the median district concurrent with the relative growth in their allowance.

To examine the sensitivity of the results to these omitted variables, I add them to the specification. I first include the demographic and economic char-

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district-level test proficiency rates, which have since become unavailable for those years, I used individual test scores aggregated to the district level, and so this could cause slight differences if the state used different scores in its aggregate reports.

acteristics listed in Appendix 1. Their inclusion reduces the point estimate from 3.97 to 3.14 percentage points. When I additionally include the school choice variables, the point estimate drops very slightly to 2.95 points. Finally, I include the demographic and economic characteristics in 1995 interacted with a quadratic time trend, to allow for differential trending of the outcome variable by districts with different baseline values of these covariates.[4] The point estimate is attenuated further to 2.18 percentage points (bottom row).[5]

The majority of the drop in the point estimate is from the inclusion of the economic and demographic variables and their trend interactions, suggesting that the changing economy during this period was an important omitted factor. This is consistent with the drop in the point estimate moving from column 2 to column 3 of Table 4. The difference here is that the inclusion of the school choice covariates did not increase the point estimate, as in Table 4.

As a next step, I use my student-level data to examine the effect of spending on seventh and eleventh grade test scores.[6] Because a substantial fraction of the sample leaves Michigan public schools prior to these grades, before presenting effects on test scores I examine whether the increases in allowance-induced spending are associated with student attrition and mobility. Appendix Table 4, row 1, column 1, presents estimates from Equations 1 and 2, showing that there is zero relation between the spending increases and the probability of a student attriting by grade seven. Adding district-level covariates, the interaction of the covariates with the quadratic cohort trend, and, as a robustness check, fourth grade test scores does little to affect the point estimate.

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[4]I do not interact the 1995 school choice variables because they were all zero during 1995.

[5]In the penultimate row, for the sake of completeness I report the coefficient from including a district-specific linear time trend. However, the district-specific trends completely absorb the first stage.

[6]I do not examine effects on fourth grade scores, because I do not observe students prior to grade four. When I estimate the effects of grade four spending on fourth grade scores, I find zero effect.

The probability of attriting by grade eleven, on the other hand, does have a statistically significant relationship with spending. A $1,000 increase in spending is associated with a 2.7 percentage point decrease in the probability of attriting by grade eleven using the preferred specification (column 3). This suggests some combination of additional spending reducing the probability that students either move out of state, switch to private school, or drop out of school, but unfortunately I cannot distinguish between these channels. There is a similar estimate for the probability that a student is not observed in grade eleven in his or her grade four district either due to attrition or moving to a different district. The association between spending increases and student attrition and mobility suggests another reason to suspect biased results from previous studies that examine the effects of lagged spending in a district on contemporaneous achievement in the district.

The bottom rows of Appendix Table 4 provide the estimated effects of spending on math achievement for the sample of students with non-missing math scores during grades seven and eleven. The results are sensitive to which controls are included; the preferred specifications show no effect on seventh grade scores and a small positive effect (sometimes marginally statistically significant) on eleventh grade scores.

Because some students have missing math scores but non-missing reading scores, I create a composite that averages math and reading scores. This produces a slightly larger sample and nearly identical results. In a further attempt to reduce attrition, I estimate effects on eleventh grade scores imputing missing scores with non-missing seventh grade scores – students' last observed test score. I conduct this analysis using both math and composite test scores. Again, the point estimates are similar, though the positive effect of spending on eleventh grade achievement mentioned above is attenuated and no longer

statistically significant. Overall there appears to be little to no effect of spending on middle or high school test scores, consistent with previous studies of Proposal A (Chaudhary, 2009; Roy, 2011).

References

CHAUDHARY, L. 2009. "Education Inputs, Student Performance and School Finance Reform in Michigan," *Economics of Education Review*, 28(1):90–98.

PAPKE, L. E. 2005. "The Effects of Spending on Test Pass Rates: Evidence from Michigan," *Journal of Public Economics*, 89:821–839.

———. 2008. "The Effects of Changes in Michigan's School Finance System," *Public Finance Review*, 36(4):456–474.

ROY, J. 2011. "Impact of School Finance Reform on Resource Equalization and Academic Performance: Evidence from Michigan," *Education Finance and Policy*, 6(2):137–167.

Appendix Table 1. Foundation Allowances, 1995-2010

	Minimum ($)	% at Minimum	Target ($)	% Below Target
1995	4,200	5.7	5,000	55.5
1996	4,506	5.7	5,153	51.1
1997	4,816	5.7	5,308	46.4
1998	5,124	5.7	5,462	36.1
1999	5,170	8.4	5,462	36.1
2000	5,700	55.7	5,700	0
2001	6,000	55.5	6,000	0
2002	6,300	55.5	6,300	0
2003	6,700	64.9	6,700	0
2004	6,700	64.9	6,700	0
2005	6,700	64.7	6,700	0
2006	6,875	64.7	6,875	0
2007	7,085	64.7	7,085	0
2008	7,204	62.6	7,204	0
2009	7,316	62.6	7,316	0
2010	7,316	62.4	7,316	0

Notes: Allowance is in nominal dollars per-pupil.

Appendix Table 2. District-Level First-Stage by Detailed Spending Category

Dependent Variable:	Absolute Effect	Mean (2012 $)	Fraction of Total Expenditure	P-Value: (col 1 / 0.739) = col 3
	(1)	(2)	(3)	(4)
Total Expenditure	0.739***	10,061	1.000	0.998
	(0.056)			
Total Instruction	0.358***	6,224	0.619	0.009
	(0.038)			
Basic Instruction	0.321***	4,728	0.470	0.343
	(0.028)			
K-12	0.313***	4,645	0.462	0.289
	(0.027)			
Preschool	0.006	60	0.006	0.779
	(0.007)			
Summer School	0.001	23	0.002	0.952
	(0.005)			
Added Needs	0.061**	1,378	0.137	0.141
	(0.027)			
Special Education	0.027*	779	0.077	0.072
	(0.017)			
Compensatory Education	0.007	409	0.041	0.101
	(0.014)			
Vocational Education	0.019	134	0.013	0.457
	(0.013)			
Other Needs	0.007	56	0.006	0.723
	(0.010)			
Adult Education	-0.024**	118	0.012	0.005
	(0.012)			
Total Non-Instruction	0.377***	3,830	0.381	0.003
	(0.032)			
Instructional Support	0.077***	959	0.095	0.784
	(0.025)			
Student Services	0.029	540	0.054	0.528
	(0.017)			
Instructional Staff	0.049***	418	0.042	0.215
	(0.014)			
Administration	0.091***	836	0.083	0.029
	(0.013)			
District Administration	0.027***	197	0.020	0.159
	(0.009)			
School Administration	0.064***	639	0.064	0.033
	(0.008)			
Business Office	0.043***	221	0.022	0.001
	(0.008)			
Other Support Services	0.014	188	0.019	0.984
	(0.012)			
Operations and Maintenance	0.131***	1,162	0.115	0.004
	(0.016)			
Transportation	0.021**	464	0.046	0.157
	(0.009)			

Notes: The sample is at the district-year level during 1995-2003. Each coefficient in column 1 is from a separate regression of the amount spent in the expenditure category on the foundation allowance, where both are in 2012 dollars (in levels). The p-values in column 4 are from a test of whether the column 1 coefficient divided by 0.739 equals the fraction of operating expenditure accounted for by that category (column 3). All regressions are student-weighted and contain district-year covariates and district and year fixed effects. Standard errors, in parentheses, are clustered at the district level. *** = significant at the 1% level, ** = 5% level, * = 10% level.

Appendix Table 3. Replication of Papke (2008) with Falsification and Sensitivity Checks

		Dep. Var.	First Stage	
		Mean	Coef.	F-Stat.
	(1)	(2)	(3)	(4)
Dep. Var. = Frac. Pass 4th Grade Math Test				
Papke (2008)	0.368***	NA	0.768	369
	(0.078)			
Replication	0.397***	0.678	0.758	419
	(0.090)			
Replication Specification, Dep. Var. =				
Percent of Students Living in District Attending Charter School	-9.536***	0.943	0.758	419
	(2.412)			
Population per Square Mile	63.788***	81.624	0.758	419
	(14.592)			
Fraction Black in School	-0.218***	0.055	0.758	419
	(0.036)			
Fraction of 5 - 17 Year Olds in Poverty	-0.063**	0.119	0.758	419
	(0.026)			
Unemployment Rate	-5.800***	5.746	0.758	419
	(1.210)			
Dep. Var. = Frac. Pass 4th Grade Math Test, Replication Specification Plus:				
District-Year Demographic and Economic Covariates	0.314***	0.678	0.745	397
	(0.102)			
District-Year Demographic, Economic, and School Choice Covariates	0.295***	0.678	0.758	373
	(0.100)			
All Covariates Plus District-Specific Linear Time Trends	3.764	0.678	-0.038	0.35
	(6.41)			
All Covariates Plus Interactions with Quadratic Time Trends	0.218	0.678	0.692	254
	(0.135)			

Notes: Sample is at the district-year level and includes 518 districts in 1995 through 2004 (5,180 observations). Each point estimate is from a separate two-stage-least-squares (2SLS) regression of the fourth grade pass rate on the average of the contemporaneous, one, two, and three year lagged logged spending, covariates (logged enrollment and fraction free lunch), and year and district fixed effects. The average spending variable is instrumented for by the log of the foundation allowance in that district-year. Standard errors, in parentheses, are clustered at the district level.
*** = significant at the 1% level, ** = 5% level, * = 10% level.

Appendix Table 4. The Effects of Spending on Attrition, Mobility, and Achievement Using Student-Level Data

Dependent Variable:	(1)	(2)	(3)	(4)	Dep. Var. Mean (5)	Sample Size (6)
Attrition: Observed in Grade Four…						
…But Not in Grade Seven	-0.005	-0.007	-0.005	-0.004	0.139	746,834
	(0.009)	(0.011)	(0.016)	(0.016)		
…But Not in Grade Eleven	-0.065***	-0.043***	-0.027*	-0.027*	0.258	746,834
	(0.012)	(0.012)	(0.015)	(0.015)		
District Switching: Observed Not in Grade Four District…						
...In Grade Seven	-0.029**	-0.008	-0.005	-0.005	0.267	746,834
	(0.014)	(0.013)	(0.019)	(0.019)		
...In Grade Eleven	-0.079***	-0.026*	-0.022	-0.024	0.428	746,834
	(0.020)	(0.013)	(0.017)	(0.017)		
Achievement						
Grade Seven Math Percentile	2.843**	1.096	-1.070	0.139	50.0	613,767
	(1.294)	(1.331)	(1.767)	(1.893)		
Grade Eleven Math Percentile	2.981***	2.580**	2.331	3.077*	49.7	483,413
	(0.944)	(1.091)	(1.431)	(1.572)		
Grade Seven Composite Percentile	2.931**	0.996	-0.775	-0.070	48.2	634,978
	(1.349)	(0.983)	(1.288)	(1.470)		
Grade Eleven Composite Percentile	2.435***	2.279**	2.255*	2.759*	49.1	492,331
	(0.845)	(1.028)	(1.312)	(1.482)		
Grade Eleven Imputed Math Percentile	2.093***	1.472*	0.838	1.796	47.1	639,291
	(0.776)	(0.895)	(1.170)	(1.466)		
Grade Eleven Imputed Composite Prcntl.	1.847***	1.379*	1.234	1.889	46.2	652,889
	(0.708)	(0.827)	(1.040)	(1.350)		
District & Cohort Fixed Effects	Y	Y	Y	Y		
Student Demographics	Y	Y	Y	Y		
District-Cohort Covariates	N	Y	Y	Y		
Trend * District-Cohort Covariates	N	N	Y	Y		
Student Fourth Grade Scores	N	N	N	Y		

Notes: The sample is all first-time fourth graders in Michigan public (non-charter) schools during 1994-95 through 1999-2000. Each coefficient is from a separate 2SLS regression of the dependent variable on average real spending during grades 4-7 (in thousands of 2012 dollars). The instrument is the average allowance during those grades (also in thousands of 2012 dollars). Mean spending during grades 4-7 for all samples in this table is approximately $9,800. Composite scores are the average of math and reading. Imputed grade eleven scores replace missing grade eleven scores with non-missing grade seven scores. Standard errors, in parentheses, are clustered at the district level. First stage F-statistics are between 84 and 162 depending on the sample and specification.
*** = significant at the 1% level, ** = 5% level, * = 10% level.

Appendix Table 5. Effects of Spending on Postsecondary Enrollment by Postsecondary Institution Type

	Any College	2-Year	4-Year	Public	Private	In-State	Out-of-State	Not Very Selective	Very Selective
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	0.030**	-0.014	0.044***	0.028**	0.002	0.017	0.012*	0.016	0.014
	(0.014)	(0.012)	(0.014)	(0.014)	(0.006)	(0.015)	(0.007)	(0.013)	(0.009)
Dependent Variable Mean	0.448	0.209	0.239	0.395	0.053	0.379	0.069	0.358	0.090
District & Cohort Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Student Demographics	Y	Y	Y	Y	Y	Y	Y	Y	Y
District-Cohort Covariates	Y	Y	Y	Y	Y	Y	Y	Y	Y
Trend * District-Cohort Covariates	Y	Y	Y	Y	Y	Y	Y	Y	Y
Student Fourth Grade Scores	N	N	N	N	N	N	N	N	N

Notes: The sample is all first-time fourth graders in Michigan public (non-charter) schools during 1994-95 through 1999-2000 (N=746,834). Each coefficient is from a separate 2SLS regression of the dependent variable on average real spending during grades 4-7 (in thousands of 2012 dollars). The instrument is the average allowance during those grades (also in thousands of 2012 dollars). The dependent variable in columns (1), (3), (5), (7), and (9), is a dummy for whether the student ever attends the college type, and for columns (2), (4), (6), and (8), is whether a student only attends that type, such that each pair is mutually exclusive. Standard errors, in parentheses, are clustered at the district level.
*** = significant at the 1% level, ** = 5% level, * = 10% level.

Appendix Table 6. Effects of Spending on Educational Attainment: Reduced Form and OLS

Dependent Variable:	Reduced Form Effect of Allowance on Educational Attainment				OLS Effect of Spending on Educational Attainment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Enroll in Postsecondary Schooling	0.009	0.020***	0.017**	0.019**	0.010**	0.007	0.005	0.004
(Mean = 0.448)	(0.012)	(0.007)	(0.008)	(0.008)	(0.005)	(0.006)	(0.006)	(0.005)
Earn a Postsecondary Degree	0.017***	0.019***	0.013*	0.016*	0.014***	0.013***	0.012***	0.011***
(Mean = 0.201)	(0.006)	(0.007)	(0.007)	(0.008)	(0.003)	(0.003)	(0.003)	(0.003)
District & Cohort Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Student Demographics	Y	Y	Y	Y	Y	Y	Y	Y
District-Cohort Covariates	N	Y	Y	Y	N	Y	Y	Y
Trend * District-Cohort Covariates	N	N	Y	Y	N	N	Y	Y
Student Fourth Grade Scores	N	N	N	Y	N	N	N	Y

Notes: The sample is all first-time fourth graders in Michigan public (non-charter) schools during 1994-95 through 1999-2000 (N=746,834). Each coefficient is from a separate OLS regression of the dependent variable on the average allowance during grades 4-7 in columns 1-4 or on average real spending during grades 4-7 in columns 5-8 (both measured in thousands of 2012 dollars) . Standard errors, in parentheses, are clustered at the district level.
*** = significant at the 1% level, ** = 5% level, * = 10% level.

Appendix Table 7. Heterogeneity of Effects by Student Characteristics

| Dependent Variable: | Male | Female | Grade 4 Math Score | | Free Lunch | Non Free Lunch |
| | | | <Median | >Median | | |
	(1)	(2)	(3)	(4)	(5)	(6)
Enroll in Postsecondary Schooling	0.033*	0.024	0.004	0.060***	-0.010	0.013
	(0.017)	(0.016)	(0.016)	(0.020)	(0.035)	(0.021)
	0.410	*0.490*	*0.343*	*0.574*	*0.390*	*0.573*
Earn a Postsecondary Degree	0.023	0.022	0.009	0.038*	-0.010	-0.001
	(0.014)	(0.015)	(0.011)	(0.020)	(0.021)	(0.018)
	0.170	*0.234*	*0.110*	*0.304*	*0.101*	*0.286*
First Stage F-Statistic	98	96	97	89	94	85
N (Students)	380,234	364,308	366,956	356,548	111,490	409,206
District & Cohort Fixed Effects	Y	Y	Y	Y	Y	Y
Student Demographics	Y	Y	Y	Y	Y	Y
District-Cohort Covariates	Y	Y	Y	Y	Y	Y
Trend * District-Cohort Covs	Y	Y	Y	Y	Y	Y
Student Fourth Grade Scores	N	N	N	N	N	N

Notes: The sample and estimating equation are the same as in column 4 of Table 4. Standard errors, in parentheses, are clustered at the district level. Means of the dependent variable are in italics below the standard errors. The sum of the sample sizes across groups does not equal 746,834 due to missing demographic and test score data.

*** = significant at the 1% level, ** = 5% level, * = 10% level.

Appendix Table 8. Correlations Between School-Level Characteristics From Table 7

	By Level			Title I Status		Within District Poverty		Within District Fraction Proficient	
	Elem.	Middle	High	Yes	No	Poorest Quarter	Least Poor 3/4	<Median	>Median
Elementary	1.000								
Middle	-0.617	1.000							
High	-0.630	-0.223	1.000						
Title I	0.347	-0.038	-0.401	1.000					
Not Title 1	-0.347	0.038	0.401	-1.000	1.000				
Poorest Quarter	0.260	-0.120	-0.201	0.271	-0.271	1.000			
Least Poor 3/4	-0.260	0.120	0.201	-0.271	0.271	-1.000	1.000		
<Median	-0.307	0.284	0.075	0.040	-0.040	0.062	-0.062	1.000	
>Median	0.307	-0.284	-0.075	-0.040	0.040	-0.062	0.062	-1.000	1.000

Notes: The sample is the same as in Table 7. It is at the school-year level and includes all schools in the main sample during years 1995-2003.

Appendix Table 9. Effects of Spending on Attainment (Table 4) Robustness Checks

Dependent Variable:	(1)	(2)	(3)	(4)
Panel A: Log Grades 4-7 Operating Expenditures				
Enroll in Postsecondary Schooling	0.047	0.196***	0.153	0.185*
	(0.157)	(0.075)	(0.100)	(0.102)
Earn a Postsecondary Degree	0.171***	0.179**	0.110	0.141
	(0.059)	(0.070)	(0.082)	(0.092)
First Stage F-Statistic	287	336	191	192
Panel B: Total Expenditures				
Enroll in Postsecondary Schooling	0.013	0.028***	0.025**	0.028**
	(0.017)	(0.009)	(0.012)	(0.012)
Earn a Postsecondary Degree	0.026***	0.026***	0.019*	0.024*
	(0.008)	(0.010)	(0.011)	(0.012)
Mean Spending (2012 $)		10,092		
First Stage F-Statistic	127	203	142	142
Panel C: Grades 4-12 Operating Expenditures				
Enroll in Postsecondary Schooling	0.019	0.040***	0.034**	0.038**
	(0.024)	(0.013)	(0.016)	(0.017)
Earn a Postsecondary Degree	0.038***	0.038***	0.026*	0.032*
	(0.012)	(0.014)	(0.015)	(0.017)
Mean Spending (2012 $)		9,906		
First Stage F-Statistic	86	187	156	157
Means of Dependent Variables:				
Enroll in Postsecondary School		0.448		
Earn a Postsecondary Degree		0.201		
Sample Size		746,834		
District & Cohort Fixed Effects	Y	Y	Y	Y
Student Demographics	Y	Y	Y	Y
District-Cohort Covariates	N	Y	Y	Y
Trend * District-Cohort Covariates	N	N	Y	Y
Student Fourth Grade Scores	N	N	N	Y

Notes: The sample is as in Table 4. Each coefficient is from a separate 2SLS regression of the dependent variable on logged average operating expenditures during grades 4-7 (Panel A), average total expenditures during grades 4-7 (Panel B), and average operating expenditures during grades 4-12 (Panel C). Standard errors, in parentheses, are clustered at the district level.

*** = significant at the 1% level, ** = 5% level, * = 10% level.

Appendix Table 10. Effects of Spending on Inputs to Education Production (Table 5) Robustness Checks

	Total Expenditures				Grades 4-12 Operating Expenditure				Including Student Fourth Grade Scores			
			Pupil / Administrator Ratio				Pupil / Administrator Ratio				Pupil / Administrator Ratio	
	Class Size	Average Teacher Salary	School and District Admin.	District Admin. Only	Class Size	Average Teacher Salary	School and District Admin.	District Admin. Only	Class Size	Average Teacher Salary	School and District Admin.	District Admin. Only
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	-1.53***	1,232	-7.79	-77.95**	-1.38***	953	-32.20*	-142.90***	-1.83***	1,472	-9.31	-92.69**
	(0.24)	(1,003)	(8.26)	(39.18)	(0.21)	(926)	(17.33)	(42.29)	(0.31)	(1,186)	(9.80)	(47.26)
Dependent Variable Mean	21.7	71,806	117	468	21.8	70,075	120	487	21.7	71,806	117	468
District & Cohort Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Student Demographics	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
District-Cohort Covariates	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Trend * District-Cohort Covs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Student Fourth Grade Scores	N	N	N	N	N	N	N	N	Y	Y	Y	Y

Notes: The sample is all first-time fourth graders graders in Michigan public (non-charter) schools during 1994-95 through 1999-2000 (N=746,834). Each coefficient is from a separate 2SLS regression of the education input on average total expenditures during grades 4-7 in columns 1-4, average operating expenditures during grades 4-12 in columns 5-8, and average operating expenditures during grades 4-7 in columns 9-12. All expenditures are in thousands of 2012 dollars. The education inputs are measured during grades 4-7 in columns 1-4 and 9-12 and measured during grades 4-12 in columns 5-8. The instrument is the average allowance during grades 4-7 (also in thousands of 2012 dollars). Standard errors, in parentheses, are clustered at the district level.

*** = significant at the 1% level, ** = 5% level, * = 10% level.

Appendix Table 11. The Effect of Spending on Attainment by District Characteristics (Table 6) Robustness Checks

	Poor	Non-Poor	Low Grade 4 Scores	High Grade 4 Scores	Rural	Non-Rural	Non-Rural Urban	Non-Rural Suburban
Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: With Fourth Grade Scores								
Enroll in Postsecondary Schooling	0.011	0.041*	0.010	0.043**	0.002	0.064***	0.037	0.059**
	(0.020)	(0.021)	(0.018)	(0.021)	(0.020)	(0.021)	(0.045)	(0.023)
Earn a Postsecondary Degree	0.000	0.037*	0.002	0.040*	-0.004	0.053**	0.046***	0.057**
	(0.015)	(0.021)	(0.013)	(0.024)	(0.016)	(0.021)	(0.017)	(0.023)
Mean Spending (2012 $)	10,043	9,578	9,973	9,625	8,628	10,370	11,081	10,026
First Stage F-Statistic	47	79	55	62	108	48	24	45
Panel B: Total Expenditures								
Enroll in Postsecondary Schooling	0.002	0.038**	0.007	0.035**	-0.011	0.060***	0.016	0.059***
	(0.015)	(0.018)	(0.015)	(0.018)	(0.015)	(0.017)	(0.035)	(0.020)
Earn a Postsecondary Degree	-0.004	0.031*	0.001	0.030*	-0.013	0.046***	0.028*	0.052***
	(0.011)	(0.016)	(0.010)	(0.017)	(0.011)	(0.016)	(0.016)	(0.018)
Mean Spending (2012 $)	10,331	9,880	10,253	9,936	8,955	10,650	11,306	10,333
First Stage F-Statistic	75	120	81	80	143	72	38	63
Panel C: Grades 4-12 Operating Expenditures								
Enroll in Postsecondary Schooling	0.003	0.050**	0.009	0.052**	-0.017	0.074***	0.020	0.072***
	(0.022)	(0.024)	(0.018)	(0.026)	(0.024)	(0.022)	(0.043)	(0.025)
Earn a Postsecondary Degree	-0.005	0.042*	0.001	0.044*	-0.020	0.056***	0.036*	0.064***
	(0.016)	(0.022)	(0.013)	(0.024)	(0.017)	(0.020)	(0.021)	(0.022)
Mean Spending (2012 $)	10,208	9,636	10,128	9,689	8,836	10430	11,195	10,060
First Stage F-Statistic	69	146	130	99	156	89	81	92
Dependent Variable Mean								
Enroll in Postsecondary	0.361	0.526	0.370	0.524	0.451	0.447	0.363	0.487
Earn Postsecondary Degree	0.119	0.273	0.128	0.272	0.205	0.199	0.116	0.239
Number of Districts	259	259	259	259	341	177	19	158
Number of Students	351,913	395,069	368,550	378,284	245,471	501,176	163,465	337,711

Notes: The sample is as in Table 6. Each coefficient is from a separate 2SLS regression of the dependent variable on operating expenditures during grades grades 4-7 (Panel A), average total expenditures during grades 4-7 (Panel B), and average operating expenditures during grades 4-12 (Panel C). Fourth grade test scores are included as a control in Panel A. Standard errors, in parentheses, are clustered at the district level.
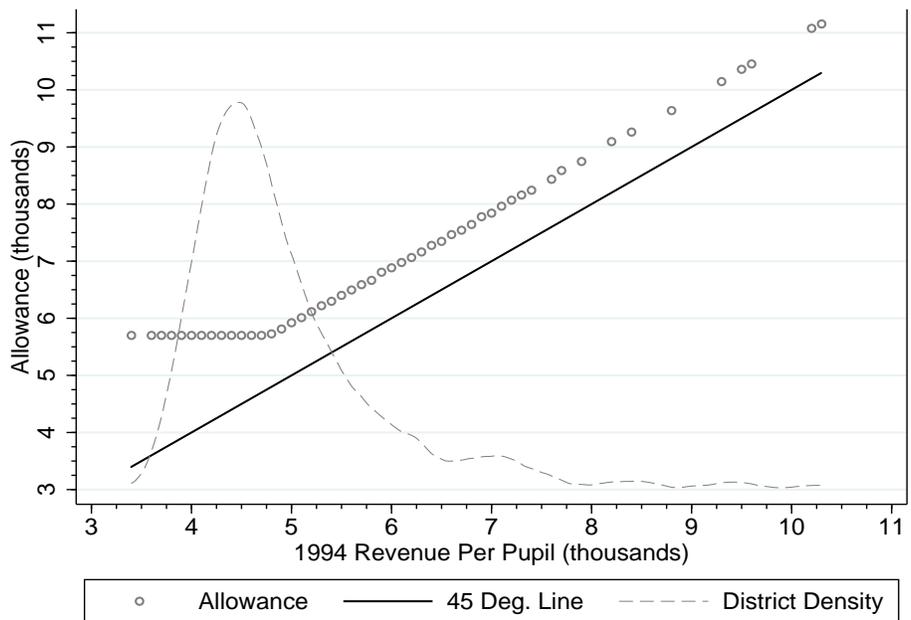*** = significant at the 1% level, ** = 5% level, * = 10% level.

Appendix Figure I: Foundation Allowance in 1995 and 2000, by 1994 District Revenue

(a) 1995
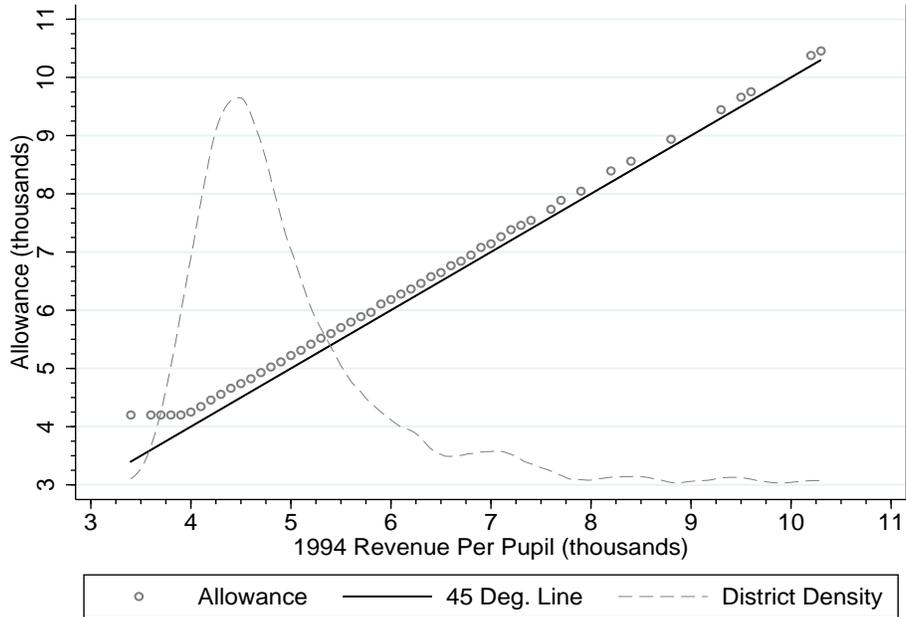
(b) 2000

Notes: Figures show the average foundation allowance for districts in $100 bins of 1994 revenue. The dashed line gives the density of the number of districts in each bin. Figure (a) shows that the allowance was equalizing in its first year mostly through boosting revenue for the lowest districts. Figure (b) shows that the allowance was further equalizing over time, by bringing more districts into the flat portion of the allowance curve. All dollars are in nominal dollars.

Appendix Figure II: Foundation Allowance and Operating Expenditures Over Time by 1994 Revenue

(a) Foundation Allowance - ECI Adjusted

(b) Operating Expenditures - ECI Adjusted

(c) Foundation Allowance - CPI Adjusted

(d) Operating Expenditures - CPI Adjusted
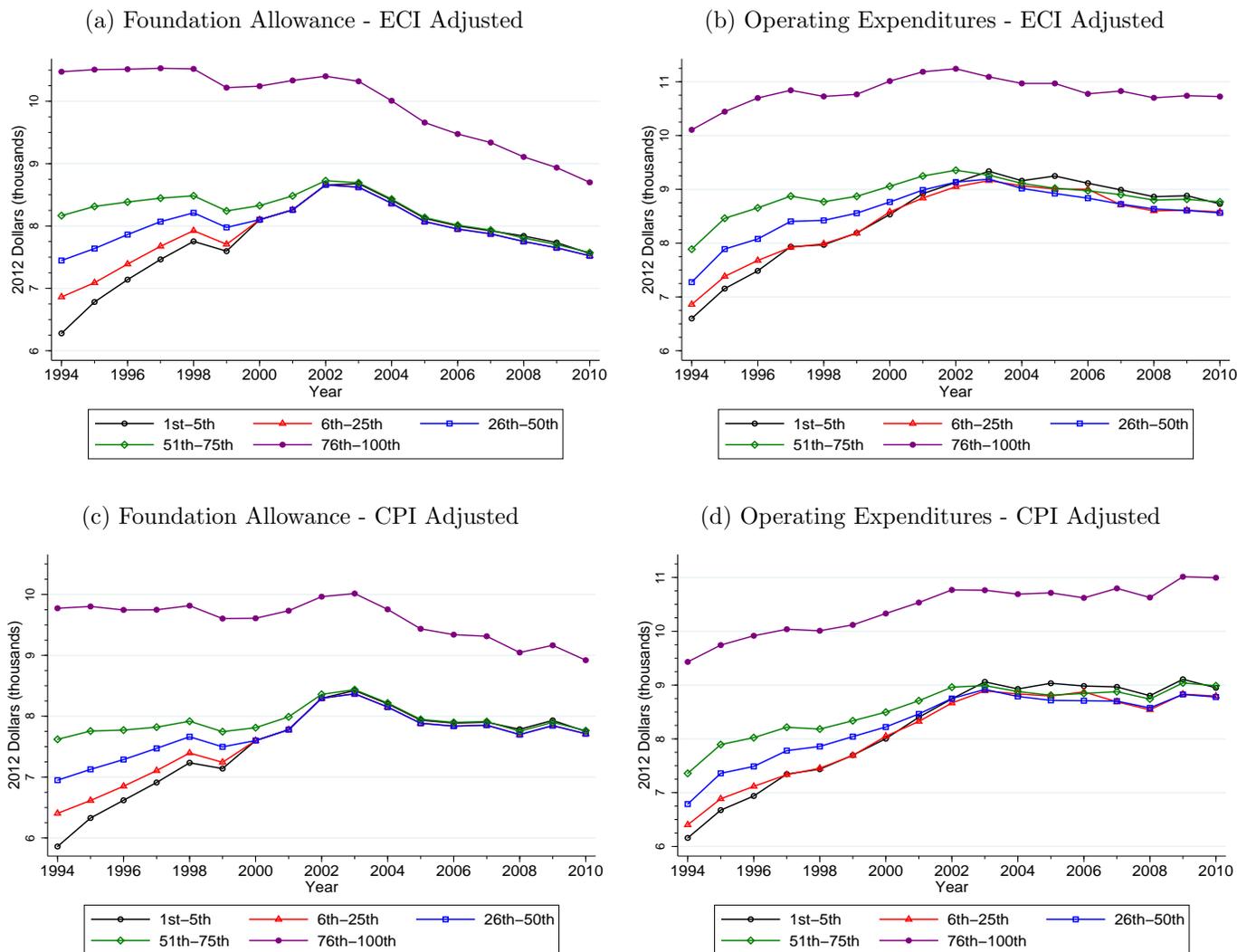
Notes: Figure shows the average foundation allowance for subfigures (a) and (c) and average per-pupil operating expenditures for subfigures (b) and (d) over time for districts grouped by 1994 revenue percentiles. Subfigures (a) and (b) use real 2012 dollars deflated using the Employment Cost Index (ECI) for Elementary and Secondary School Employees. Subfigures (c) and (d) use real 2012 dollars deflated using the Consumer Price Index (CPI).