

Test-Based Accountability and the Effectiveness of School Finance Reforms: Online Appendix

Christian Buerger*
Indiana University-Purdue University
Indianapolis

Seung Hyeong Lee†
Harvard University

John D. Singleton‡
University of Rochester

January 2021

Data Appendix

Our study draws on several data sources to combine student-level test performance and district-level variables with information about when states reformed their school finance system and implemented test-based accountability. To determine the year of school finance reforms, we utilize tabulations from Lafortune et al. (2018). These tabulations include court-ordered and legislative events and, when states have multiple reforms in the adequacy era, determine the most consequential reform by identifying events that had the largest impact on the state's finance system.

Information on test-based accountability prior to No Child Left Behind is taken from Dee and Jacob (2011), who provide the most recent and comprehensive effort to classify these policies. Dee and Jacob (2011) label accountability systems as consequential if they are accompanied with: (1) publicly available information on school performance and (2) sanctions for low achieving and rewards for high achieving schools. Only reforms that fulfill

*cbuerge@iupui.edu

†seunghyeong_lee@fas.harvard.edu

‡john.singleton@rochester.edu

both criteria are expected to create incentives for increasing student performance. We adopt this definition for our analysis and assign the arrival of consequential accountability with NCLB implementation for those states without accountability prior to 2002. 2003 is coded as the first post-accountability year for these states.

For outcomes, we employ information on student performance and school district resources. Student performance is measured utilizing restricted-access microdata from the National Assessment of Educational Progress (NAEP), administered by the U.S. Department of Education. The NAEP provides a representative sample of mathematics and reading test scores for grades four and eight, including over 100,000 students nationwide for every other year since 1990. We follow previous research (Lafortune et al., 2018; Brunner et al., 2020) and standardize individual test scores by subject and grade to the distribution in the first year tested. We also drop observations recorded for students attending charter and private schools, focusing only on public schools.

Information on school district resources is taken from the Local Education Agency (School District) Finance Survey (F-33), maintained by the National Center for Education Statistics (NCES). The F-33 contains detailed information on annual revenues and expenditures for all school districts in the United States starting in 1990. We exclude outlier districts following Lafortune et al. (2018): districts with a small number of students, with extreme increase/decrease in enrollment, and with extreme revenue and expenditure. The two missing years in the F-33 (1993 and 1994) are replaced with data from the Annual Survey of School System Finances, conducted by the U.S. Census Bureau, which contains the same fiscal information as the F-33. All the values were converted to 2011 dollars by using the annual average of the seasonally adjusted Consumer Price Index. There is no finance data available for the fiscal year 1991. We augment these variables with information on student enrollment and staff counts from the NCES Common Core of Data (CCD) school district universe survey.

We collapse the NAEP microdata to subject-grade-year-state averages by income quintile for the analysis. We classify districts as low- (first quintile) or high-income (fifth quintile) using the information on average household income in 1990 (the first year in our data) from the School District Data Book. In doing so, each test score observation is weighted by the NAEP student weight.¹ Similarly, we collapse district-level variables to the state-year level by income quintile (weighting by log enrollment).

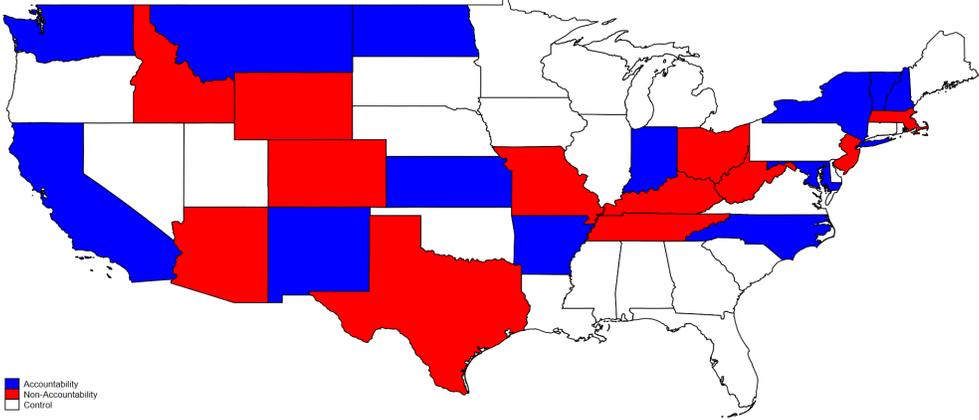
Our final sample covers the period from 1990 to 2011 for forty-eight states. We exclude Hawaii and the District of Columbia from the analysis, as both jurisdictions consist of a

¹We utilize a crosswalk provided by Jesse Rothstein for the years prior to 2000. For all other years, NCES's unique district ID is available in the NAEP.

single school district. Alaska is also dropped from the analysis because the cost of providing education differs greatly from other states, and transfers to school are based on a highly volatile severance tax.

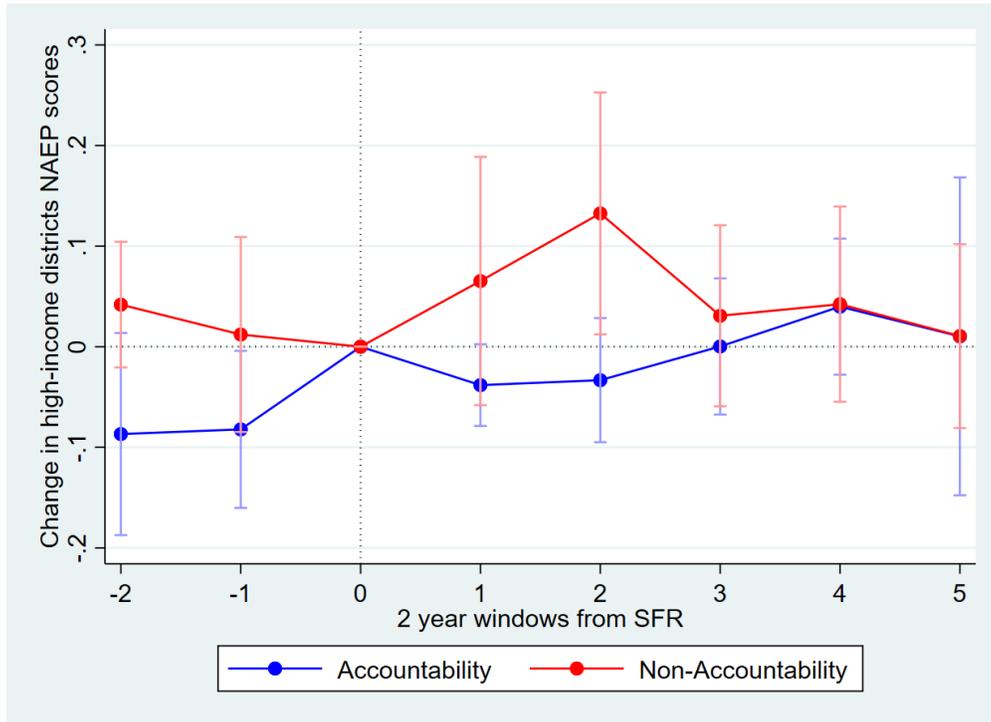
Figures and Tables

Figure A1: Geographic Distribution of State Category



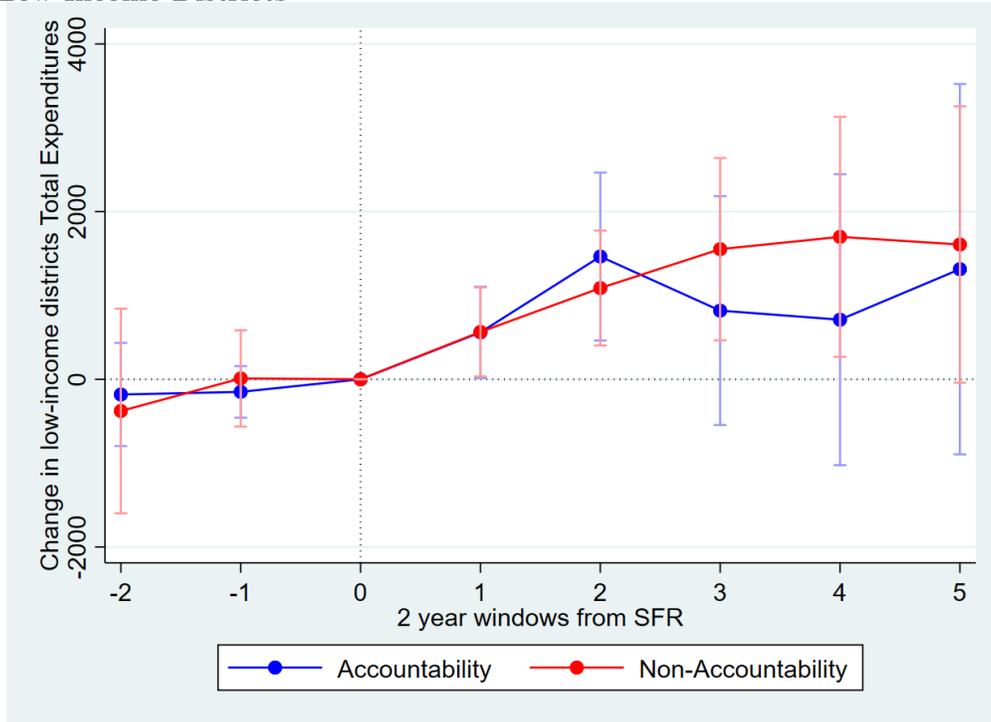
Notes: Map indicates state category as listed in Appendix Table A1.

Figure A2: Event Study Estimates of Effects of School Finance Reforms on Test Scores in High-Income Districts



Notes: We estimate effects in two-year windows up to 10 years after (window 5 includes years 9 and 10) and 5 years before (window -2 includes years -4 and -5) school finance reforms relative to window 0, which includes the year of and the year prior to finance reform (i.e. 0 and -1). Windows for years ≤ -6 and for years ≥ 11 are estimated but not represented in the figure. Standard errors clustered at the state level and whiskers represent 95% confidence intervals. The specification includes state and subject-grade-year fixed effects. We do not include control states in the sample.

Figure A3: Event Study Estimates of Effects of School Finance Reforms on Total Expenditures in Low-Income Districts



Notes: We estimate effects in two-year windows up to 10 years after (window 5 includes years 9 and 10) and 5 years before (window -2 includes years -4 and -5) school finance reforms relative to window 0, which includes the year of and the year prior to finance reform (i.e. 0 and -1). Windows for years ≤ -6 and for years ≥ 11 are estimated but not represented in the figure. Standard errors clustered at the state level and whiskers represent 95% confidence intervals. The specification includes state and year fixed effects. We do not include control states in the sample.

Table A1: States Information

State	SFR	Accountability	Category
Alabama		1997	Control
Arizona	1998	2002 (NCLB)	Non-Accountability
Arkansas	2002	1999	Accountability
California	2004	1999	Accountability
Colorado	2000	2002 (NCLB)	Non-Accountability
Connecticut		1999	Control
Delaware		1998	Control
Florida		1999	Control
Georgia		2000	Control
Idaho	1993	2002 (NCLB)	Non-Accountability
Illinois		1992	Control
Indiana	2011	1995	Accountability
Iowa		2002 (NCLB)	Control
Kansas	2005	1995	Accountability
Kentucky	1990	1995	Non-Accountability
Louisiana		1999	Control
Maine		2002 (NCLB)	Control
Maryland	2002	1999	Accountability
Massachusetts	1993	1998	Non-Accountability
Michigan		1998	Control
Minnesota		2002 (NCLB)	Control
Mississippi		2002 (NCLB)	Control
Missouri	1993	2002 (NCLB)	Non-Accountability
Montana	2005	2002 (NCLB)	Accountability
Nebraska		2002 (NCLB)	Control
Nevada		1996	Control
New Hampshire	2008	2002 (NCLB)	Accountability
New Jersey	1998	2002 (NCLB)	Non-Accountability
New Mexico	1999	1998	Accountability
New York	2006	1998	Accountability
North Carolina	1997	1996	Accountability
North Dakota	2007	2002 (NCLB)	Accountability
Ohio	1997	2002 (NCLB)	Non-Accountability

Table A1: States Information

State	SFR	Accountability	Category
Oklahoma		1996	Control
Oregon		2000	Control
Pennsylvania		2002 (NCLB)	Control
Rhode Island		1997	Control
South Carolina		1999	Control
South Dakota		2002 (NCLB)	Control
Tennessee	1995	2000	Non-Accountability
Texas	1992	1994	Non-Accountability
Utah		2002 (NCLB)	Control
Vermont	2003	1999	Accountability
Virginia		1998	Control
Washington	2010	2002 (NCLB)	Accountability
West Virginia	1995	1997	Non-Accountability
Wisconsin		1993	Control
Wyoming	2001	2002 (NCLB)	Non-Accountability

Notes: The years for school finance reforms are based on Lafortune et al. (2018) and the years for the accountability policies are based on Dee and Jacob (2011).

Table A2: Summary Statistics in 1990

	Treat.	Control	Diff.	Acc.	Non-Acc.	Diff.
Standardized NAEP score in Low-income	-0.32 [0.25]	-0.08 [0.32]	-0.24 (0.09)	-0.30 [0.27]	-0.35 [0.23]	0.05 (0.12)
Standardized NAEP score in High-income	0.36 [0.22]	0.49 [0.37]	-0.13 (0.10)	0.29 [0.22]	0.46 [0.21]	-0.17 (0.10)
Total revenue p.p in Low-income	8,341 [2,071]	7,935 [1,618]	406 (540)	8,994 [1,680]	7,633 [2,288]	1,360 (798)
Total revenue p.p in High-income	9,209 [3,126]	9,001 [2,362]	208 (811)	9,886 [3,435]	8,532 [2,763]	1,354 (1,273)
Total expenditure p.p in Low-income	8,363 [2,055]	8,060 [1,782]	303 (557)	9,089 [1,857]	7,577 [2,037]	1,512 (779)
Total expenditure p.p in High-income	9,287 [3,062]	9,269 [2,387]	18 (803)	9,871 [3,516]	8,704 [2,550]	1,167 (1,254)
Pupil teacher ratio in Low-income	16.7 [2.7]	16.1 [2.1]	0.5 (0.7)	16.9 [3.1]	16.4 [2.2]	0.4 (1.1)
Pupil teacher ratio in High-income	17.6 [2.3]	17.1 [2.5]	0.5 (0.7)	17.8 [2.6]	17.4 [2.0]	0.5 (1.0)
Mean teacher salary in Low-income	52,760 [10,792]	50,936 [12,017]	1,824 (3,363)	55,346 [12,645]	49,703 [7,553]	5,642 (4,358)
Mean teacher salary in High-income	62,486 [15,203]	58,985 [13,330]	3,501 (4,270)	66,183 [17,548]	58,453 [11,639]	7,731 (6,273)
Minority student share in Low-income	0.18 [0.17]	0.21 [0.23]	-0.03 (0.06)	0.17 [0.17]	0.20 [0.18]	-0.04 (0.08)
Minority student share in High-income	0.10 [0.09]	0.11 [0.11]	-0.02 (0.03)	0.10 [0.11]	0.09 [0.05]	0.01 (0.04)
Mean household income in Low-income	44,956 [6,188]	45,624 [5,499]	-668 (1,696)	46,333 [6,335]	43,464 [5,925]	2,869 (2,459)
Mean household income in High-income	90,462 [23,895]	88,759 [23,137]	1,703 (6,865)	90,097 [23,240]	90,827 [25,563]	-730 (9,973)
Average enrollment	5,332 [5,804]	7,464 [9,700]	-2,132 (2,285)	5,814 [7,852]	4,810 [2,379]	1,004 (2,364)
Number of states	25	23		13	12	

Notes: The entries represent mean of the variables in fiscal year 1990 with standard deviations in bracket and standard errors in parenthesis. “Low-income” corresponds to first quintile districts in each state in terms of household average income in 1990; “high-income” to fifth quintile. NAEP scores in 1990 are for eighth grade math and are only available for 36 states. NAEP variables are weighted by the sum of the NAEP student weights within the grade-subject-year-state-quintile. All finance variables are in 2011 dollars. See Appendix Table A1 for which states belong to which category.

Table A3: Estimates of Effects of School Finance Reforms on Test Scores in High-income Districts

	(1)	(2)	(3)
Accountability in place			
× Yrs. elapsed	0.008 (0.006)	0.004 (0.005)	0.005 (0.005)
× Pre-trend		0.013 (0.014)	0.010 (0.014)
No accountability			
× Yrs. elapsed	-0.003 (0.003)	-0.002 (0.003)	0.000 (0.003)
× Pre-trend		0.008 (0.009)	0.006 (0.007)
State FE	Y	Y	Y
Subject-grade-year FE	Y	Y	Y
Accountability controls	N	N	Y

Notes: Table presents results of estimating the effects of school finance reforms on student achievement for accountability and non-accountability states. The number of observations is 1,436. Standard errors clustered at the state level reported in parentheses. Observations are weighted by the sum of the NAEP student weights within the grade-subject-year-state-quintile. Columns (2) and (3) estimate pre-trends over the 5 years immediately prior to finance reforms (estimates on indicators that the calendar year is 6 or more years before finance reform not reported). Accountability controls include: post-accountability adoption intercept and linear pre- and post-accountability trends (each interacted with with whether accountability was NCLB).

Table A4: Sensitivity of Estimates of Effects of School Finance Reforms on Test Scores in Low-income Districts: Unweighted and Uncensored Pre-trends

	(1)	(2)	(3)
Robustness check 1: Unweighted			
Accountability in place			
× Yrs. elapsed	0.013 (0.006)	0.012 (0.006)	0.009 (0.005)
× Pre-trend		0.002 (0.010)	-0.001 (0.009)
No accountability			
× Yrs. elapsed	0.005 (0.004)	0.003 (0.004)	0.003 (0.004)
× Pre-trend		0.023 (0.011)	0.035 (0.014)
Robustness check 2: Uncensored pre-trends			
Accountability in place			
× Yrs. elapsed	0.012 (0.006)	0.012 (0.005)	0.011 (0.005)
× Pre-trend		-0.001 (0.004)	-0.004 (0.004)
No accountability			
× Yrs. elapsed	0.006 (0.003)	0.005 (0.003)	0.005 (0.004)
× Pre-trend		0.010 (0.007)	0.024 (0.008)
State FE	Y	Y	Y
Subject-grade-year FE	Y	Y	Y
Accountability controls	N	N	Y

Notes: Table presents results of estimating the effects of school finance reforms on student achievement for accountability and non-accountability states. The number of observations is 1,436. Standard errors clustered at the state level reported in parentheses. For the bottom panel, observations are weighted by the sum of the NAEP student weights within the grade-subject-year-state-quintile. Columns (2) and (3) of the top panel estimate pre-trends over the 5 years immediately prior to finance reforms (estimates on indicators that the calendar year is 6 or more years before finance reform not reported). Columns (2) and (3) of the bottom panel estimate uncensored pre-trends. Accountability controls include: post-accountability adoption intercept and linear pre- and post-accountability trends (each interacted with whether accountability was NCLB).

Table A5: Sensitivity of Estimates of Effects of School Finance Reforms on Test Scores

	Low-income	High-income
<hr/> Robustness check 1: Estimates with post-reform indicators <hr/>		
Accountability in place		
× Yrs. elapsed	0.010 (0.006)	0.008 (0.007)
× Pre-trend	-0.007 (0.010)	0.020 (0.015)
× Post-reform	0.018 (0.031)	-0.051 (0.035)
No accountability		
× Yrs. elapsed	0.005 (0.003)	-0.002 (0.003)
× Pre-trend	0.041 (0.016)	-0.005 (0.006)
× Post-reform	0.001 (0.049)	0.056 (0.046)
<hr/> Robustness check 2: Timing of school finance reforms <hr/>		
Accountability in place		
× Yrs. elapsed	0.012 (0.007)	0.007 (0.007)
× Pre-trend	-0.001 (0.012)	0.012 (0.013)
No accountability		
× Yrs. elapsed	-0.008 (0.007)	-0.008 (0.007)
× Pre-trend	0.055 (0.013)	0.014 (0.008)
Year of reform - 2000		
× Yrs. elapsed	-0.002 (0.001)	-0.001 (0.001)
State FE	Y	Y
Subject-grade-year FE	Y	Y
Accountability controls	Y	Y

Notes: Table presents results of estimating the effects of school finance reforms on student achievement for accountability and non-accountability states. The number of observations is 1,436. Standard errors clustered at the state level reported in parentheses. Observations are weighted by the sum of the NAEP student weights within the grade-subject-year-state-quintile. Pre-trends are estimated over the 5 years immediately prior to finance reforms (estimates on indicators that the calendar year is 6 or more years before finance reform not reported). Accountability controls include: post-accountability adoption intercept and linear pre- and post-accountability trends (each interacted with whether accountability was NCLB)

Table A6: Sensitivity of Estimates of Effects of School Finance Reforms on Test Scores in Low-income Districts: Characteristics of School Finance Reforms

	Only court-ordered reforms	Exclude reforms implemented close to accountability	Brunner et al. timing of reforms
	(1)	(2)	(3)
Accountability in place			
× Yrs. elapsed	0.007 (0.003)	0.014 (0.007)	0.012 (0.005)
× Pre-trend	-0.007 (0.019)	-0.011 (0.011)	-0.001 (0.014)
No accountability			
× Yrs. elapsed	0.003 (0.004)	0.003 (0.005)	0.006 (0.003)
× Pre-trend	0.031 (0.010)	0.032 (0.014)	0.018 (0.013)
State FE	Y	Y	Y
Subject-grade-year FE	Y	Y	Y
Observations	1,167	1,246	1,436

Notes: Table presents results of estimating the effects of school finance reforms on student achievement for accountability and non-accountability states. Standard errors clustered at the state level reported in parentheses. Observations are weighted by the sum of the NAEP student weights within the grade-subject-year-state-quintile. Column (1) considers only court-ordered school finance reforms. Column (2) eliminates states where school finance reforms and accountability policies were implemented within two years. Column (3) follows the years of school finance reforms from Brunner et al. (2020). Thus, there are changes in state categories. Pre-trends are estimated over the 5 years immediately prior to finance reforms (estimates on indicators that the calendar year is 6 or more years before finance reform not reported).

Table A7: Estimates of Effects of School Finance Reforms on District Components

	Accountability	Non-Accountability	Observations
	Mean		
Log total revenue p.p	0.041 (0.019)	0.055 (0.028)	1,008
Log total expenditure p.p	0.062 (0.024)	0.063 (0.031)	1,008
	Low-income districts		
Log total revenue p.p	0.049 (0.020)	0.073 (0.031)	1,008
Log state revenue p.p	0.089 (0.034)	0.096 (0.053)	1,008
Log local revenue p.p	-0.034 (0.089)	0.055 (0.048)	1,008
Log total expenditure p.p	0.070 (0.024)	0.092 (0.034)	1,008
Log instructional expenditure p.p	0.053 (0.020)	0.088 (0.035)	1,008
Log teacher salaries + benefits p.p	0.047 (0.020)	0.084 (0.045)	960
Log mean teacher salary	0.040 (0.015)	0.028 (0.023)	972
Log non-instructional expenditure p.p	0.087 (0.034)	0.091 (0.038)	1,008
Log total capital outlays p.p	0.280 (0.112)	0.343 (0.135)	1,008
Log student support p.p	0.040 (0.023)	0.053 (0.028)	1,008
Pupil teacher ratio	-0.338 (0.187)	-0.305 (0.174)	972
Local revenue share	-0.016 (0.015)	-0.006 (0.014)	1,008
Subsidized lunch share	0.003 (0.009)	-0.055 (0.040)	893
Minority student share	0.001 (0.007)	0.009 (0.011)	977

Notes: Table presents results of estimating the effects of school finance reforms on district components for accountability and non-accountability states. Standard errors clustered at the state level reported in parentheses. All finance variables are in 2011 dollars. The specification includes state and year fixed effects. Note that these results do not report estimates of pre-trends over the 5 years immediately prior to finance reforms (estimates on indicators that the calendar year is 6 or more years before finance reform not reported).

Table A8: Estimates of Effects of School Finance Reforms on Test Scores in Low-income Districts: State Characteristics

	(1)	(2)	(3)	(4)	(5)
Accountability in place					
× Yrs. elapsed	0.011 (0.006)	0.011 (0.005)	0.011 (0.005)	0.011 (0.005)	0.007 (0.004)
× Pre-trend	-0.003 (0.013)	-0.004 (0.013)	-0.004 (0.013)	-0.004 (0.013)	-0.002 (0.007)
No accountability					
× Yrs. elapsed	0.004 (0.004)	0.005 (0.004)	0.005 (0.003)	0.005 (0.004)	
× Pre-trend	0.041 (0.014)	0.040 (0.013)	0.041 (0.014)	0.040 (0.014)	0.019 (0.010)
1988 Democratic share					
× Yrs. elapsed	-0.003 (0.005)				
Median household income in 1990					
× Yrs. elapsed		0.002 (0.002)			
Fraction of B.A or higher in 1990					
× Yrs. elapsed			0.001 (0.002)		
Teacher union power score					
× Yrs. elapsed				0.001 (0.002)	
State FE	Y	Y	Y	Y	N
State × copy FE	N	N	N	N	Y
Subject-grade-year FE	Y	Y	Y	Y	Y
Accountability controls	Y	Y	Y	Y	Y
State-specific Yrs. elapsed	N	N	N	N	Y
Observations	1,436	1,436	1,436	1,436	2,543

Notes: Table presents results of estimating the effects of school finance reforms on student achievement for accountability and non-accountability states. Standard errors clustered at the state level reported in parentheses. Observations are weighted by the sum of the NAEP student weights within the grade-subject-year-state-quintile. For Columns (1)-(4), state characteristics are normalized. Median household income and fraction of B.A. or higher are weighted by average log enrollment. Teacher union power score is from Brunner et al. (2020). For Column (5) we stack separate copies of each state’s NAEP panel for each individual school finance reform. Pre-trends are estimated over the 5 years immediately prior to finance reforms (estimates on indicators that the calendar year is 6 or more years before finance reform not reported). Accountability controls include: post-accountability adoption intercept and linear pre- and post-accountability trends (each interacted with whether accountability was NCLB).

References

- Brunner, E., J. Hyman, and A. Ju (2020). School finance reforms, teachers' unions, and the allocation of school resources. *Review of Economics and Statistics* 102(3), 473–489.
- Dee, T. S. and B. Jacob (2011). The impact of no child left behind on student achievement. *Journal of Policy Analysis and Management* 30(3), 418–446.
- Lafortune, J., J. Rothstein, and D. W. Schanzenbach (2018). School finance reform and the distribution of student achievement. *American Economic Journal: Applied Economics* 10(2), 1–26.