School Finance Equalization Increases Intergenerational Mobility

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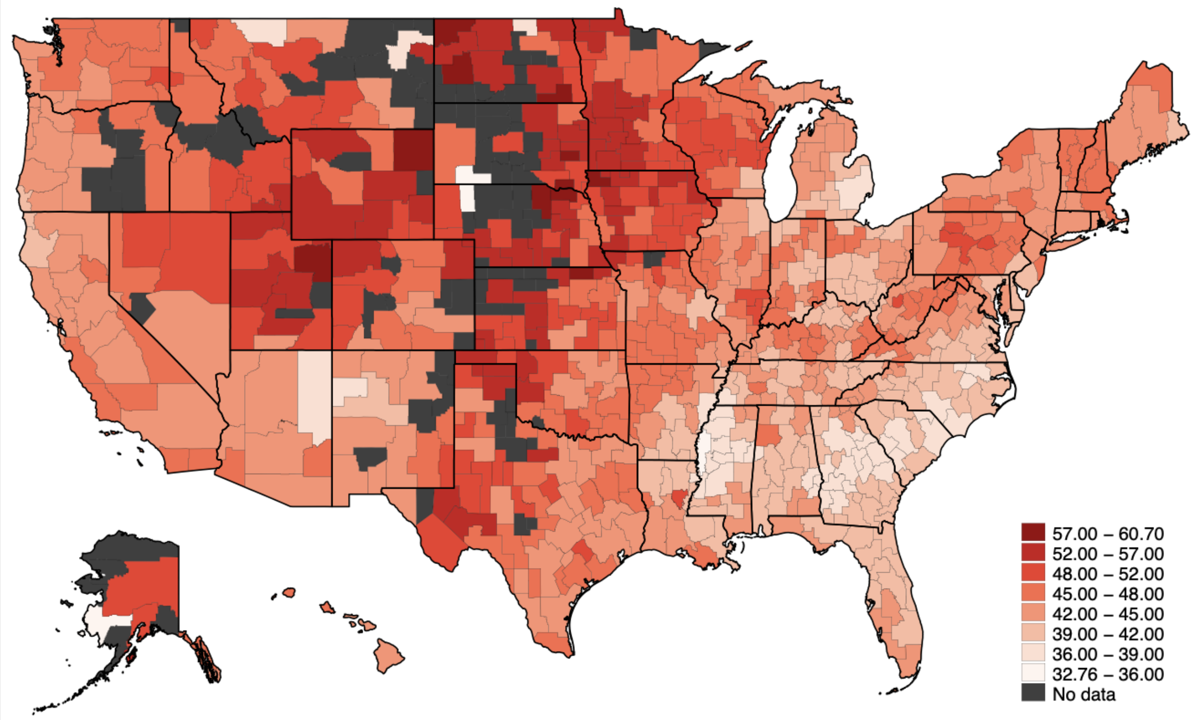
Appendix – For online publication only

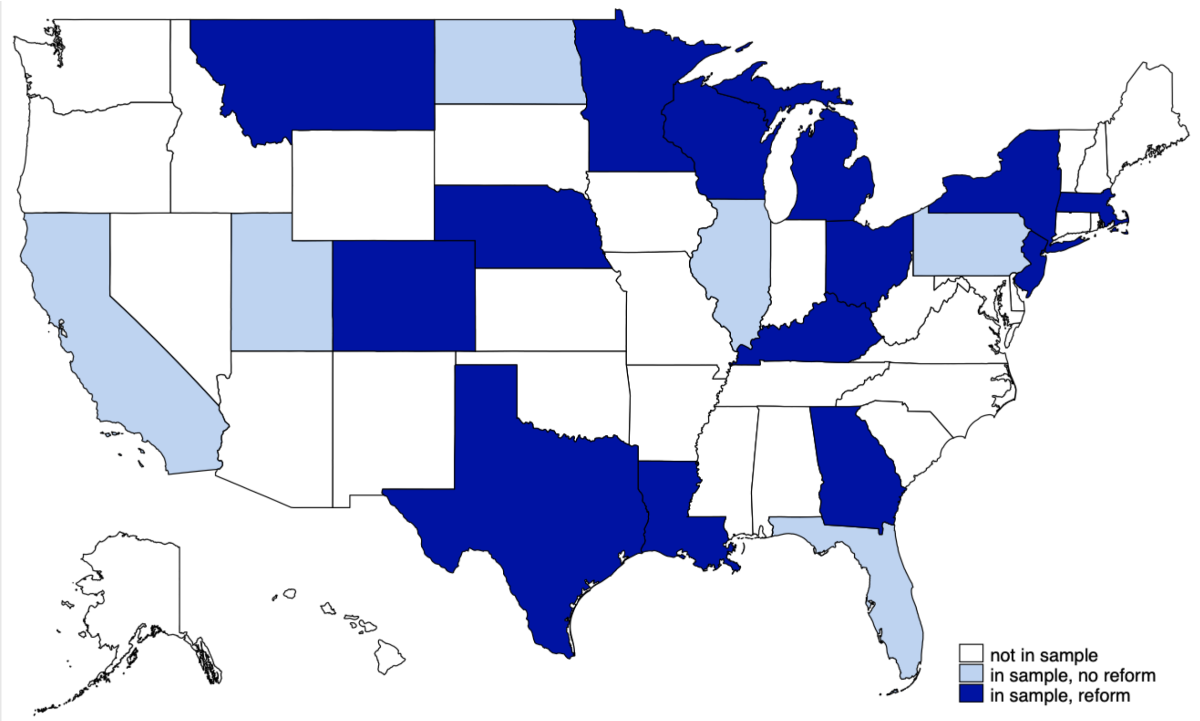
Appendix A Additional Figures and Tables

Figure AI: Intergenerational Mobility Across US Commuting Zones: Expected Income Percentile for Children with Parents on the 25th Percentile, Cohorts 1980-1986



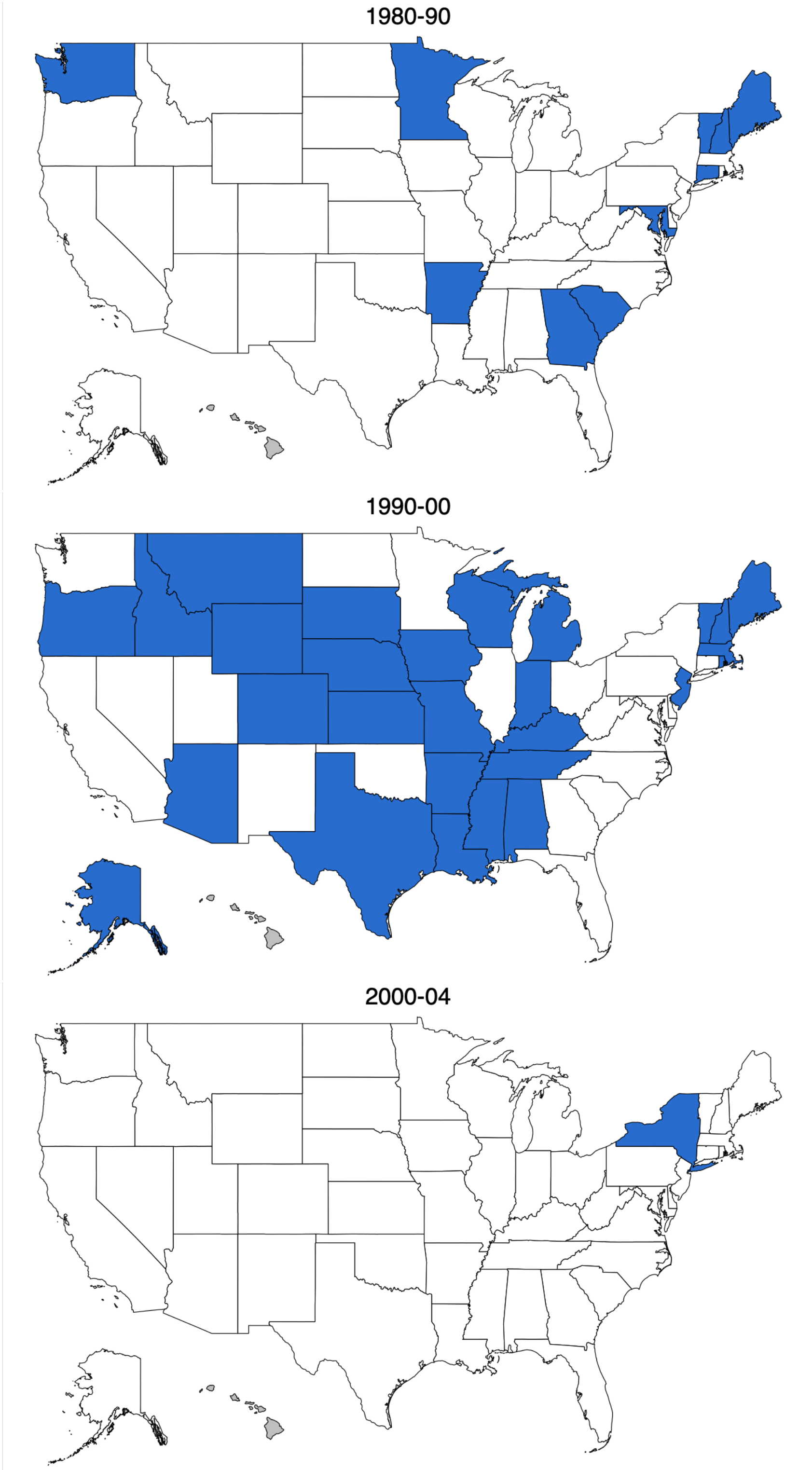
Note: Mean income percentile of children born between 1980 and 1986 with parents on the 25th national percentile. Each shaded area corresponds to a CZ. Weighted average across cohorts with number of children used as weights.

Figure AII: US States Included in The IV Sample With and Without A Reform and States Not Included



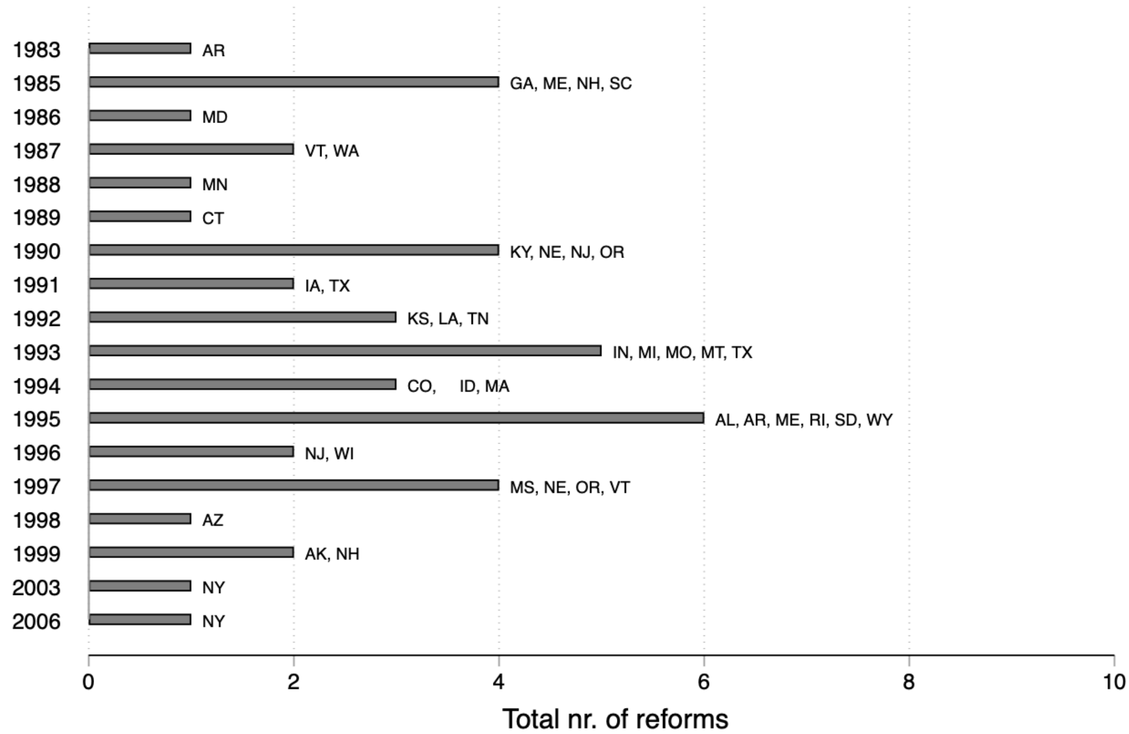
Note: The figure shows states included in the IV sample, with a reform and without a reform, as well as states not included in this sample. The first group includes CO, GA, KY, LA, MA, MI, MN, MT, NE, NJ, NY, TX, and WI. The second includes CA, FL, IL, ND, OH, PA, and UT. The third includes all remaining states.

Figure AIII: US States with School Finance Equalization Reforms, 1980-2010



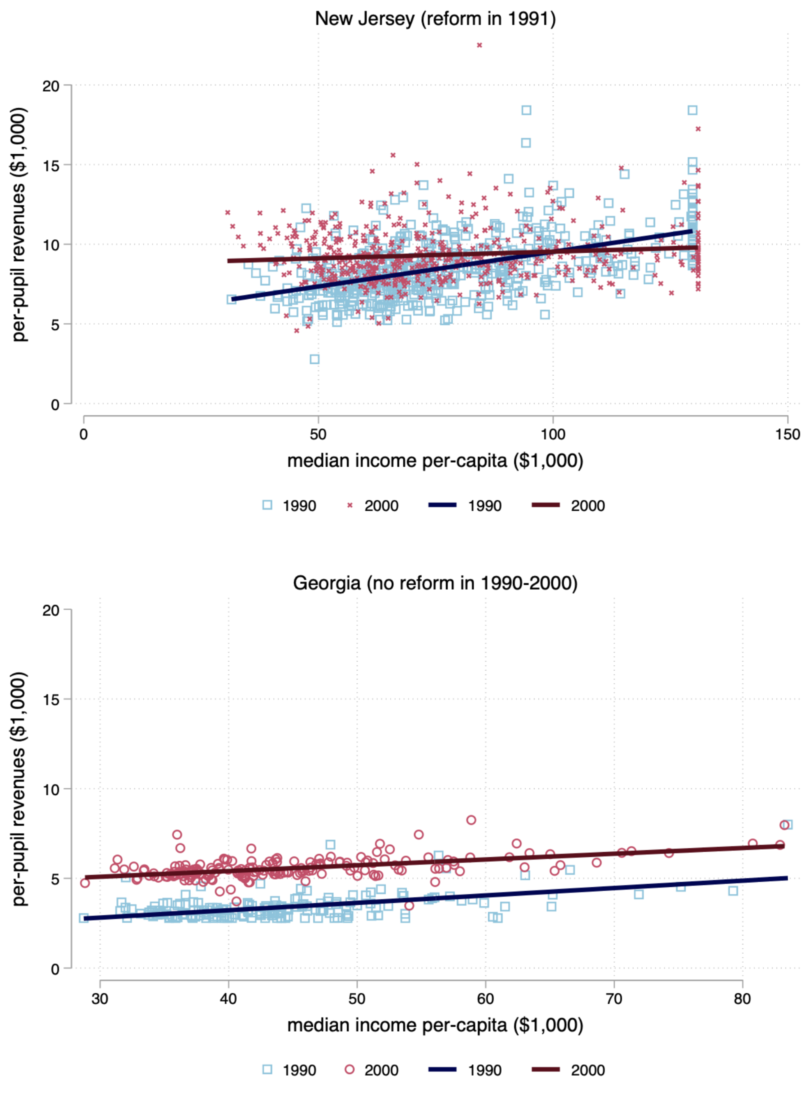
Note: Shaded areas denote states which passed a school finance equalization reform during each time period. AK (included in the estimation sample) had a reform in 1987; HI (excluded from the estimation sample) had no reforms. Source: "Public School Finance Programs of United States and Canada" (1990-1991 and 1998–1999), Verstegen and Jordan (2009), Jackson et al. (2015), and Lafortune et al. (2018).

Figure AIV: School Finance Reforms Over Time



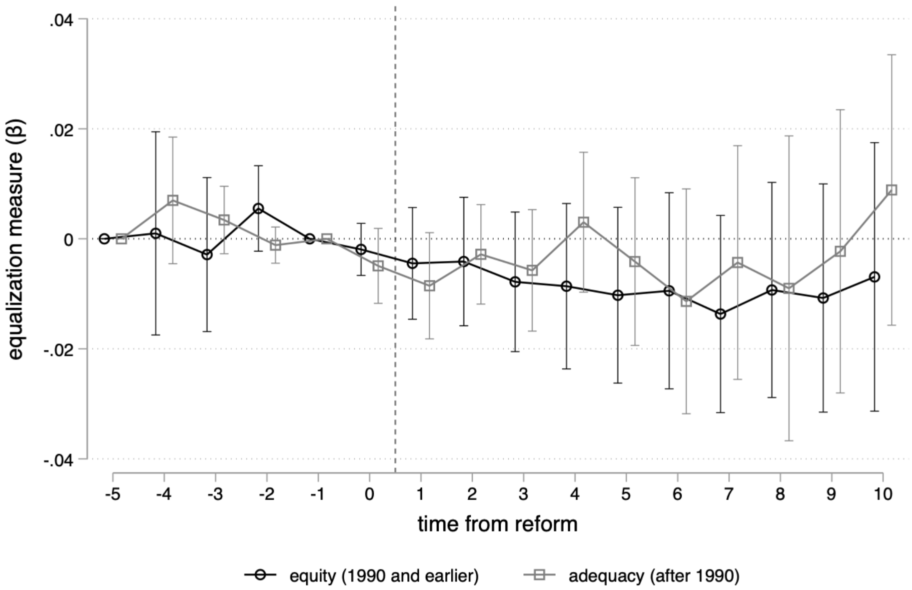
Note: Number of school finance reforms by year.

Figure AV: Per-pupil Revenues and Per-capita Income in New Jersey and Georgia, 1990 and 2000



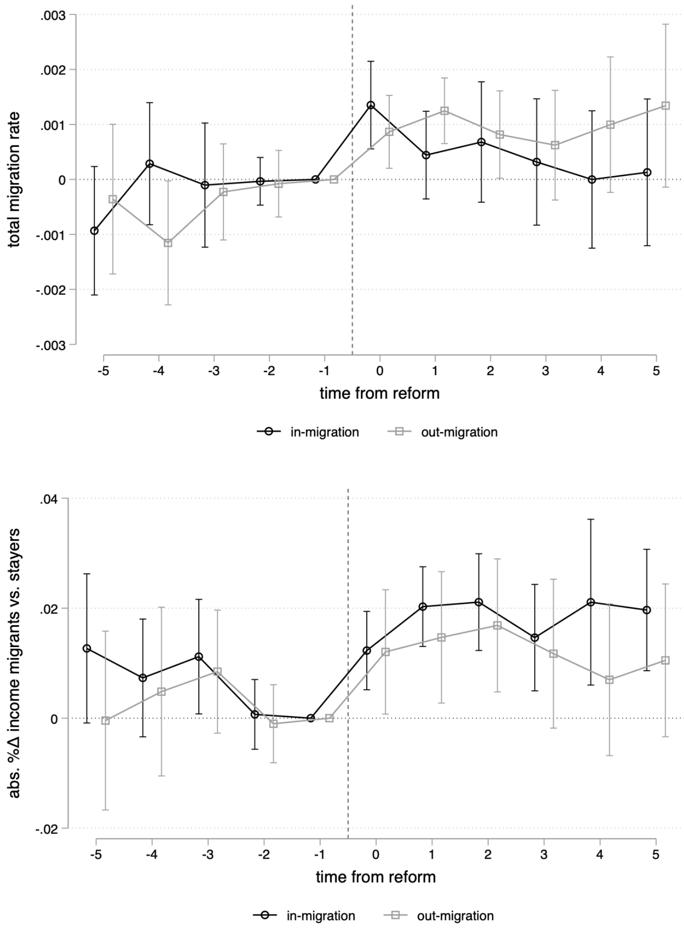
Note: Per-pupil revenues (y-axis) and per-capita income (x-axis) in 1990 and 2000, in New Jersey (which had a reform in 1991) and Georgia (which did not have a reform between 1990 and 2000). Each observation is a school district.

Figure AVI: Event Study of Equalization Measure β Around A School Finance Reform: "Equity" Reforms (passed before 1990) and "Adequacy" Reforms (passed after 1990)



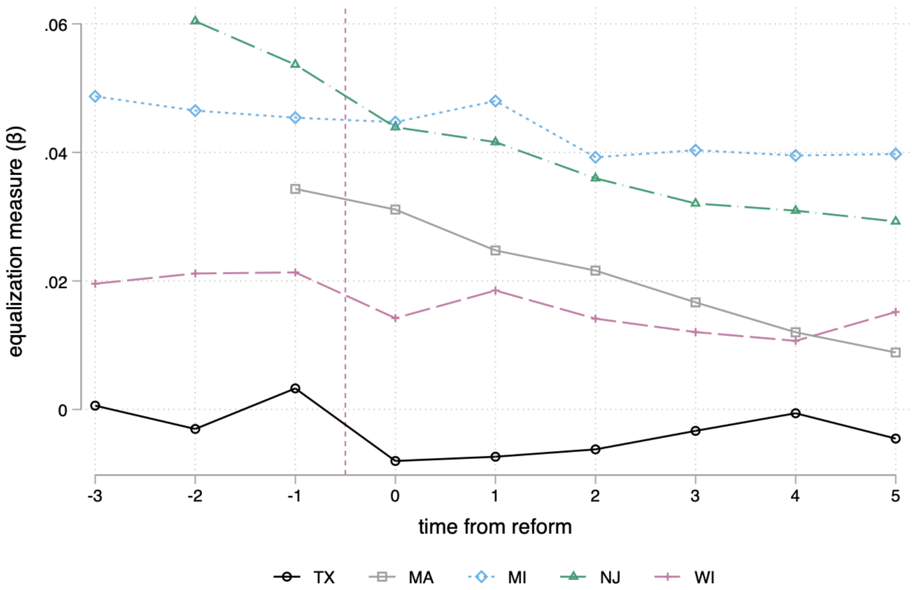
Note: Point estimates and 90 percent confidence intervals for the coefficients δ_k in regression $\beta_{st} = \sum_k \delta_k R_s 1(t - ryear_s = k) + \theta_s + \varepsilon_{st}$, where β_{st} is the slope coefficient in equation (7), estimated separately for each state s and year t from 1986 to 2004, R_s equals 1 if state s had a school finance reform in the years 1980-2004, $ryear_s$ is the year of the first reform in this time period, and θ_s are state fixed effects. The coefficient δ_{-1} is normalized to equal zero. Estimates are obtained and shown separately for reforms passed before or in 1990 ("equity", darker line) and for reforms passed after 1990 ("adequacy", lighter line). Standard errors are clustered at the state level.

Figure AVII: Event Studies of Migration Rates (Top Panel) and Incomes of Migrants vs Incumbents (Bottom Panel) Around A School Finance Reform



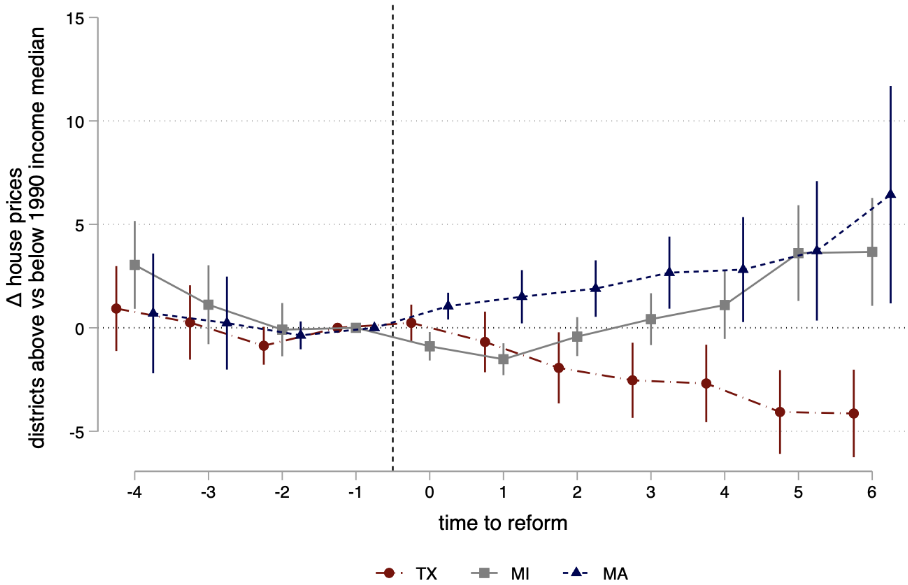
Note: Changes in total migration rates and incomes of migrants in a 10-year window around each school finance reform. Each point and spike represent the estimate and the 90 percent confidence interval of the coefficients δ_n in the regression $y_{kt} = \sum_{n=-5}^{5} \delta_n R_{s(k)} 1(t - ryear_k = n) + \gamma_k + \tau_t + \varepsilon_{kt}$, where $R_{s(k)}$ equals 1 if state s of county k experienced a school finance reform in the years 1980-2004, $ryear_{s(k)}$ is the year of the earliest reform, γ_k are county fixed effects, and τ_t are year fixed effects. In the top panel, y_{kt} is the total in-migration or out-migration rate in county k and year t (the ratio between the sum of in-migrants or out-migrants and the total population in each county). In the bottom panel, y_{kt} is the absolute percentage difference between incomes of in-migrants or out-migrants and incomes of stayers in county k and year t, divided by 100. Standard errors are clustered at the county level. County-year level observations are weighted by population. Data on migration are from the Statistics of Income of the Internal Revenue Service, covering years from 1991 to 2004.

Figure AVIII: Equalization Measure β Around A School Finance Reform - Selected States



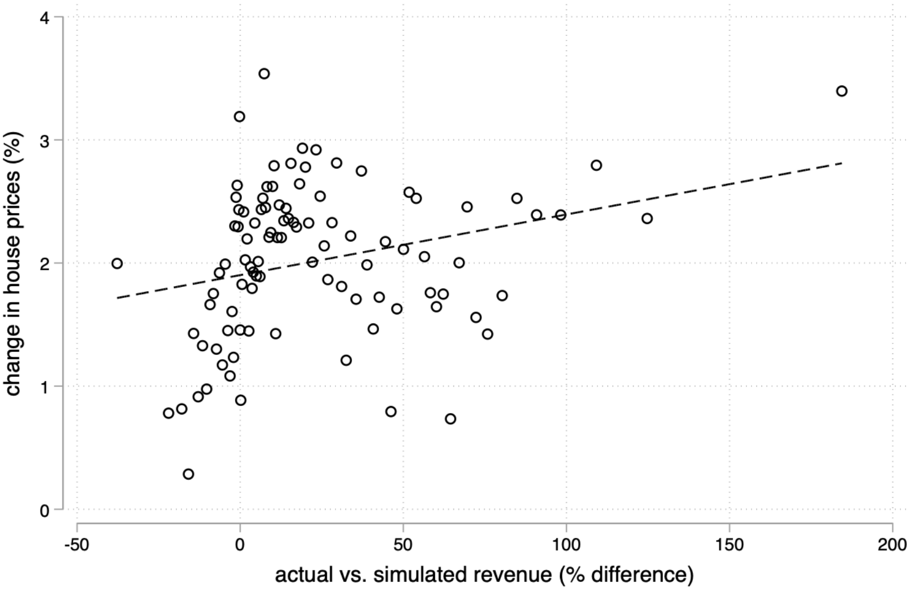
Note: Estimates of the coefficient β_{st} (defined in equation (7)) for a sample of states in the years surrounding each school finance reform.

Figure AIX: Variation in House Prices Around a School Finance Reform - Selected States



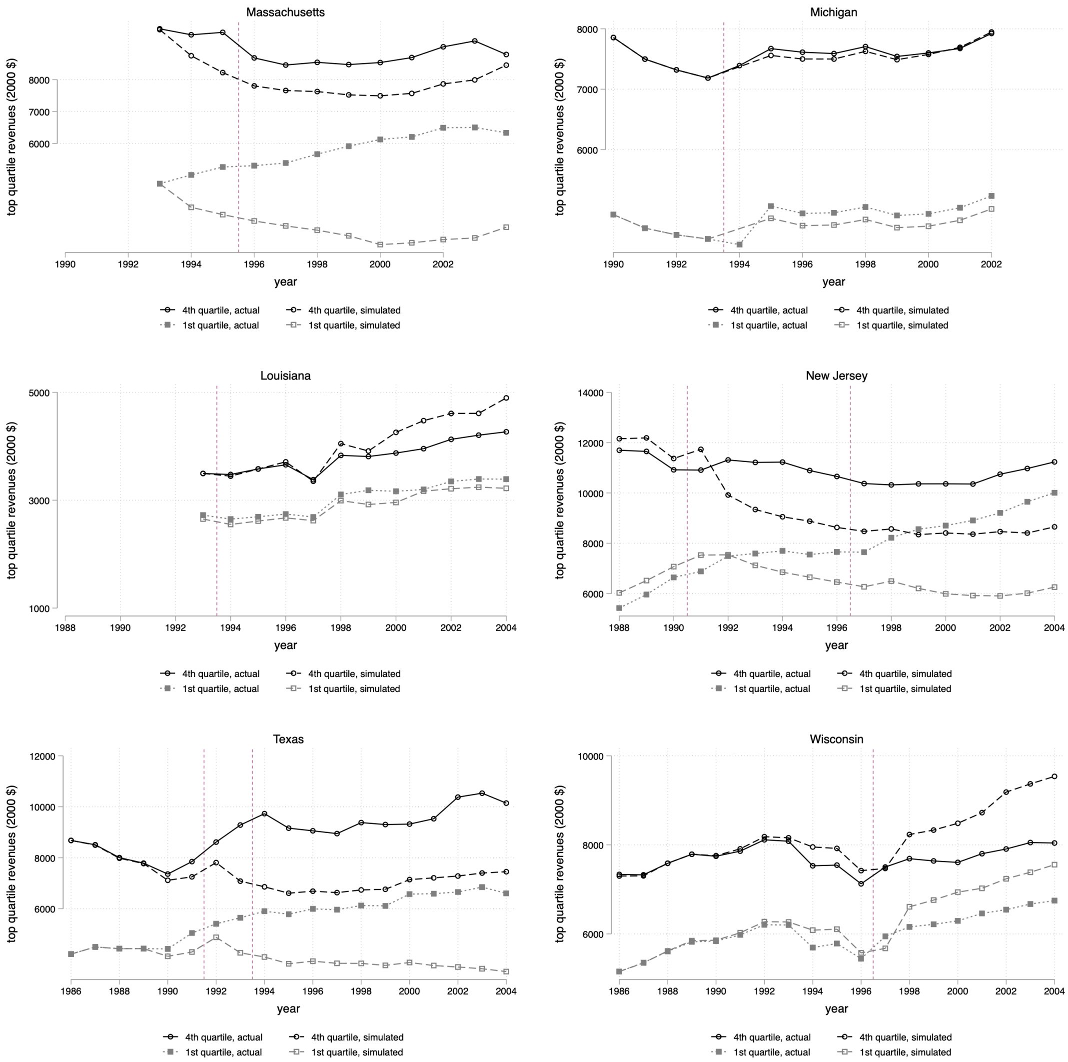
Note: Changes in the difference in house prices between households with incomes above and below the median in 1990, in a 10-year window around each reform and relative to the year before the reform. Each point and spike represent the estimate and the 90 percent confidence interval of the coefficients δ_n in the regression $HP_{dt} = \sum_{n=-4}^{6} \delta_n 1(Income_{d,1990} > Median_s)R_{s(d)}1(t - ryear_{s(d)} = n) + \theta_d + \tau_t + \varepsilon_{dt}$, where HP_{dt} is the house price index of district d in year t, $Income_{d,1990}$ is average household income of district d in 1990, $Median_s$ is median household income across districts in state s in 1990, $R_{s(d)}$ equals 1 if state s where the district is located experienced a school finance reform in the years 1980-2004, $ryear_{s(d)}$ is the year of the earliest reform, and θ_d and τ_t are district and year fixed effects. The coefficient δ_{-1} is normalized to zero. The parameters are estimated separately for each state. Standard errors are clustered at the district level. Observations are weighted by population. Annual House Price Indexes data from the FHFA, aggregated at the district level using population weights, covering years from 1986 to 2004.

Figure AX: Change in House Prices and Difference Between Actual vs. Simulated Revenues



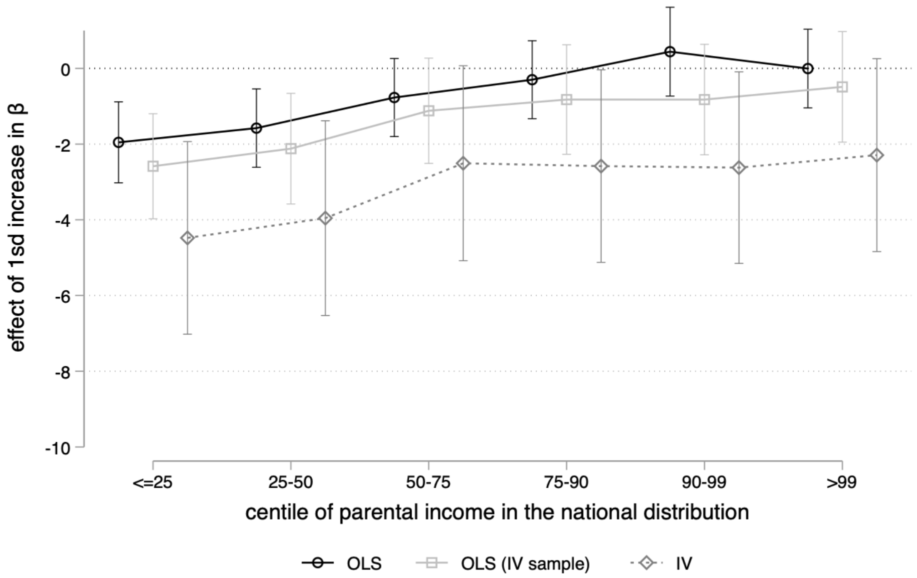
Note: Binned scatterplot of the annual percentage change in zip code-level annual house price indexes (y-axis) and the percentage difference between actual and simulated revenues in the corresponding school district (x-axis). Each dot corresponds to a percentile in the distribution of the percentage difference between actual and simulated revenues. Annual house price index data from the Federal Housing Finance Agency, covering years 1986 to 2004.

Figure AXI: Simulated and Actual Revenues, Districts In The Top And Bottom Quartiles of Expenditure - Selected States



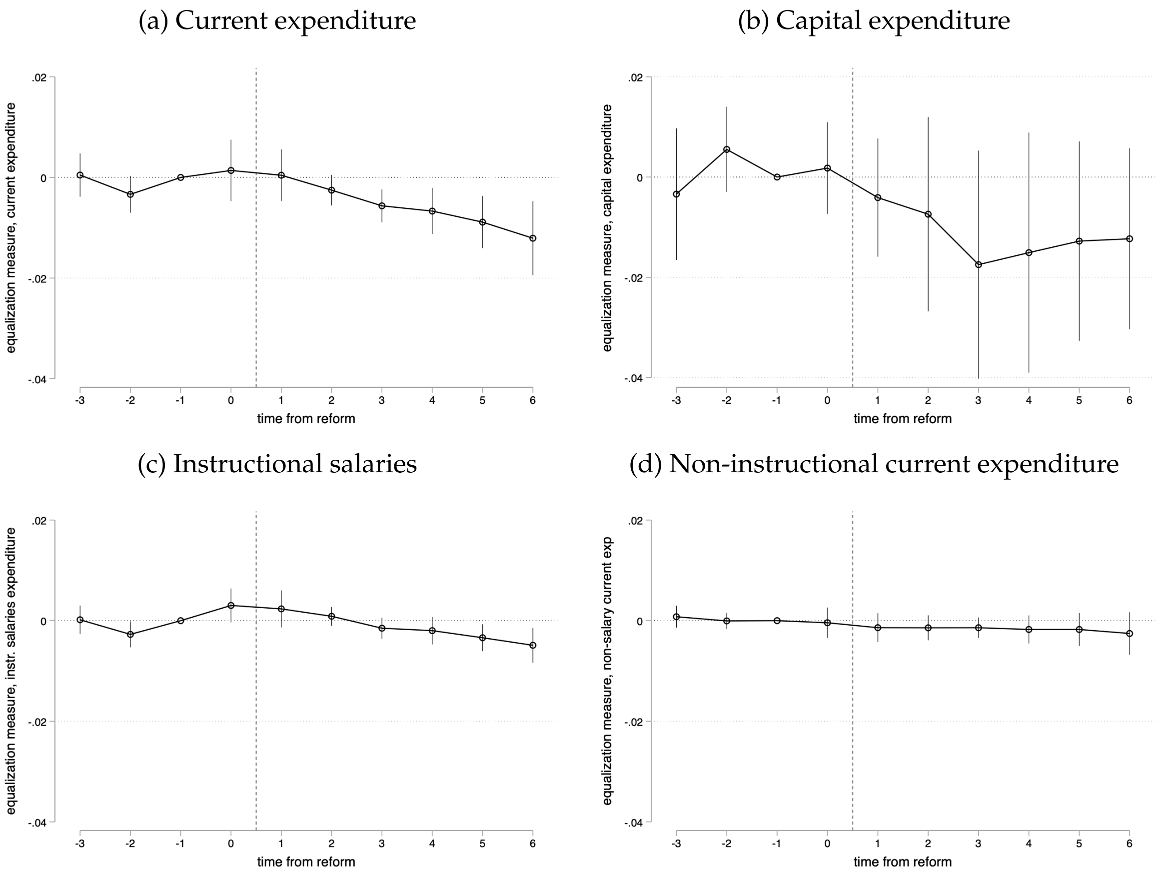
Note: Trends in average simulated and actual per pupil revenues, for districts in the top and bottom quartiles of the state's distribution of per pupil expenditure at the beginning of each sample. Vertical lines denote reform years. Simulated expenditures are calculated using the funding formula in place in every state and year and pre-reform district variables, using the procedure described in the text.

Figure AXII: Effect of an Increase in β, by Parents' Income Quantile



Note: OLS (black line) and 2SLS (grey line) estimates and 90-percent confidence intervals for the coefficients δ_d in the regression $M_{cxb} = \sum_d \delta_d D_{d(cx)} \hat{\beta}_{s(c)b} + \kappa_c + \theta_{n(xc)} + \sigma_b + \omega_{cxb}$, where M_{cxb} is the average national income percentile of children with parents on the x quantile of the state income distribution, born in cohort b in CZ c, $\hat{\beta}_{s(c)b}$ is the estimated, cohort-specific measure of school finance equalization, $D_{d(cx)}$ equals 1 if the income of the parents of children in cohort c and quantile x falls in quantile d of the national distribution, $\theta_{n(xc)}$ are fixed effects for the parent percentile in the national income distribution, κ_c are CZ fixed effects, and σ_b are cohort fixed effects. Standard errors are clustered at the state and birth cohort level. The IV sample is restricted to CA, CO, FL, GA, IL, KY, LA, MA, MI, MN, MT, NE, NJ, NY, ND, OH, PA, UT, TX, and WI. The full sample excludes HI.

Figure AXIII: Event studies of β, estimated using different spending categories



Note: OLS estimates and 90 percent confidence intervals for the coefficients δ_k in regression $\beta_{st} = \sum_k \delta_k R_s 1(t - ryear_s = k) + \sigma_s + \tau_t + \varepsilon_{st}$, where β_{st} is the slope coefficient in equation (7), estimated separately for each state s and year t from 1986 to 2004, R_s equals 1 if state s had a school finance reform in the years 1980-2004, $ryear_s$ is the year of the first reform in this time period, and σ_s and τ_t are state and year fixed effects. In each panel, β is calculated using the expenditure category in the title as the left-hand side in equation (7). The coefficient δ_{-1} is normalized to equal zero. Standard errors are clustered at the state level.

Table AI: Differences Between US States Included in The Sample and Other States

	(1) In sample	Not in sample	Difference
population (2000 Census)	3195978.4	9375981.8	-6180003.3***
			(1616818.3)
in urban area	0.50	0.53	-0.027
			(0.080)
racial segregation	0.13	0.15	-0.020
			(0.018)
income segregation	0.045	0.047	-0.0027
			(0.0064)
school expenditure in 1996 ($1,000)	6.27	6.33	-0.058
			(0.35)
Gini coefficient	0.41	0.41	0.0090
			(0.016)
crime rate	0.0018	0.0014	0.00046
			(0.00030)
share single mothers	0.21	0.20	0.014
			(0.011)
share divorced	0.10	0.093	0.0088**
			(0.0036)

Note: The table shows means and differences in means in a set of state-level variables between US states included in the IV sample (CA, CO, FL, GA, IL, KY, LA, MA, MI, MN, MT, NE, NJ, NY, ND, OH, PA, UT, TX, and WI) and all the other states (excluding HI). The variables are defined as in Figure VII of Chetty et al. (2014). *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table AII: Simulated Instrument, House Prices, and Migration. OLS, Dependent Variable is β^s

	β^s simulated		
	(1)	(2)	(3)
avg change in house prices	-0.0631	-0.0234	-0.0085
	(0.0607)	(0.0726)	(0.0633)
in-migration rate		0.2335	0.1081
		(0.8940)	(1.0961)
out-migration rate		-0.2285	-1.6457
		(0.8671)	(1.0383)
income in-migrants/ income incumbents			-0.1775
			(0.7535)
income out-migrants/ income incumbents			1.2091
			(0.8882)
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N (state $\times$ year)	289	247	223
F-stat of joint significance	1.082	0.048	0.723

Note: The dependent variable is β^s, estimated as β in equation (7) using simulated revenues instead of actual revenues. The variable *avg change in house prices* represents the average change in the house price index in each state and year. The variables *in-migration rate* and *out-migration rate* are ratios of the number of in-migrants and out-migrants in a county, respectively, and the county's population; these rates are averaged across all counties in a state and year using population weights. The variables *income in-migrants/ income incumbents* and *income out-migrants/ income incumbents* are ratios of incomes of in-migrants and out-migrants of a county and the incomes of the county's incumbent residents, also averaged across all counties in a state and year using population weights. All specifications include state and year fixed effects. Standard errors in parentheses are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

Table AIII: Household Sorting After a Reform. OLS, Dependent Variable is Migration Rates and Absolute Difference Between Incomes of Migrants and Non-Migrants

Dep. var.	Migration rates		Income of migrants vs natives	
	(1)	(2)	(3)	(4)
	In-migrants	Out-migrants	In-migrants	Out-migrants
after reform	0.0011∗	0.0009	0.0097∗	0.0094
	(0.0006)	(0.0006)	(0.0050)	(0.0063)
N	43738	43738	43738	43738
Mean of dep var	0.072	0.071	0.258	0.273

Note: The dependent variable is the ratio between the number of migrant households and the total number of households in the population, at the county level (columns 1 and 2) and the absolute value of the percentage difference between household incomes of migrants and non-migrants, at the county level (columns 3 and 4). The variable *after reform* equals 1 for years after the earliest school finance reform in the years 1980–2004. This variable equals zero for counties without a reform in those years. All specifications include year and county fixed effects. Observations are weighted by each county's population. Standard errors in parentheses are clustered at the county level. Data are from the IRS Statistics of Income and cover years 1991 to 2004. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table AIV: School Finance Equalization and Intergenerational Mobility. OLS and IV, Dependent Variable is Children's Income Percentile. Controlling for State Effects

	OLS	OLS, IV sample	IV, 1st stage		IV, 2nd stage	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	IGM	IGM	β	$\beta *$ par. pctl	IGM	IGM
β	-2.387***	-2.918***			-4.681***	
	(0.607)	(0.795)			(1.446)	
$\beta \times$ par. pctile	0.024***	0.024***			0.025***	
	(0.002)	(0.002)			(0.002)	
β sim.			0.853***	-3.630		-4.084***
			(0.101)	(6.497)		(1.244)
β sim. $\times$ par. pctile			0.000	0.925***		0.023***
			(0.000)	(0.012)		(0.002)
Par. pctile FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
KP Wald F-stat			18.10			
N	26688	13578	13578	13578	13578	13578
10th	2.145	2.681			4.436	3.857
10th [p-value]	0.000	0.001			0.002	0.002
25th	1.782	2.325			4.068	3.517
25th [p-value]	0.003	0.003			0.005	0.004
90th	0.210	0.783			2.473	2.044
90th [p-value]	0.733	0.324			0.080	0.096

Note: The table shows OLS and IV estimates of the parameters δ_0 and δ in equation (8). Column 1 shows OLS estimates on the full sample of US states. Column 2 shows OLS estimated on the IV sample. Columns 3 and 4 show the IV first stage, column 5 shows the second stage, and column 6 shows the reduced-form. In columns 1, 2, 5, and 6 the dependent variable is children's income percentile in the national distribution for each parental income quantile in the state distribution, for cohorts 1980 to 1986. The variable β is the OLS estimate of the slope coefficient in equation (7), computed separately for each state and cohort, and standardized across all states and cohorts. The variable *par. pctile* is the percentile of parents in the national income distribution. IV estimates are obtained using β^s and $\beta^s \times$ *par. pctile* as instruments for β and $\beta \times$ *par. pctile*; the variable β^s is estimated as β using simulated revenues instead of actual revenues. All specifications include parent percentile, state, and cohort fixed effects. Bootstrapped standard errors in parentheses are clustered at the state and birth cohort level. *KP Wald F-stat* refers to the Kleibergen-Paap Wald F-statistic as a test of weak instruments. *Xth* refers to the effects on children with parents in the Xth centile of the national distribution. The IV sample is restricted to CA, CO, FL, GA, IL, KY, LA, MA, MI, MN, MT, NE, NJ, NY, ND, OH, PA, UT, TX, and WI. The full sample excludes HI. *** p<0.01, ** p<0.05, * p<0.1.

Table AV: School Finance Equalization and Intergenerational Mobility. OLS and IV, Dependent Variable is Children's Income Percentile. Controlling for State Expenditure

	OLS	OLS, IV sample	IV
	(1)	(2)	(3)
e_s	1.096**	1.580*	
	(0.509)	(0.913)	
β	-2.304***	-2.913***	-4.681***
	(0.609)	(0.890)	(1.499)
$\beta\times$ par. pctile	0.024***	0.024***	0.025***
	(0.002)	(0.002)	(0.002)
Par. pctile FE	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes
CZ FE	Yes	Yes	Yes
N	26688	13578	13578
10th	2.062	2.676	4.436
10th [p-value]	0.001	0.003	0.003
25th	1.699	2.321	4.068
25th [p-value]	0.005	0.009	0.006
90th	0.128	0.783	2.473
90th [p-value]	0.835	0.377	0.091

Note: The table shows OLS and IV estimates of the parameters δ_0 and δ in equation (8). Column 1 shows OLS estimates on the full sample of US states. Column 2 shows OLS estimated on the IV sample. Column 3 shows IV. The dependent variable is children's income percentile in the national distribution for each parental income quantile in the state distribution, for cohorts 1980 to 1986. The variable β is the OLS estimate of the slope coefficient in equation (7), computed separately for each state and cohort, and standardized across all states and cohorts. The variable *par. pctile* is the percentile of parents in the national income distribution. The variable e_b is the average state spending per pupil in the years cohort b was in school. IV estimates are obtained using β^s and $\beta^s \times$ *par. pctile* as instruments for β and $\beta\times$ *par. pctile*; the variable β^s is estimated as β using simulated revenues instead of actual revenues. All specifications include parent percentile, state, and cohort fixed effects. Bootstrapped standard errors in parentheses are clustered at the state and birth cohort level. *KP Wald F-stat* refers to the Kleibergen-Paap Wald F-statistic as a test of weak instruments. *Xth* refers to the effects on children with parents in the Xth centile of the national distribution. The IV sample is restricted to CA, CO, FL, GA, IL, KY, LA, MA, MI, MN, MT, NE, NJ, NY, ND, OH, PA, UT, TX, and WI. The full sample excludes HI. *** p<0.01, ** p<0.05, * p<0.1.

Table AVI: OLS and IV Estimates of Equalization On Intergenerational Mobility: Equity and Adequacy Reforms

	OLS		OLS, IV sample		IV	
	(1) Equity	(2) Adequacy	(3) Equity	(4) Adequacy	(5) Equity	(6) Adequacy
β	-3.591**	-2.413**	-3.984**	-2.672*	-4.888*	-4.501**
	(1.250)	(0.962)	(1.473)	(1.220)	(2.031)	(1.793)
$\beta\times$ par. pctile	0.024***	0.022***	0.025***	0.018***	0.030***	0.018***
	(0.004)	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)
Par. centile FE	Yes	Yes	Yes	Yes	Yes	Yes
CZ FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
N	13716	20490	7884	9900	7884	9900
10th	3.353	2.194	3.729	2.489	4.591	4.318
10th [p-value]	0.036	0.061	0.042	0.089	0.063	0.054
25th	2.996	1.866	3.347	2.214	4.147	4.043
25th [p-value]	0.051	0.095	0.055	0.124	0.084	0.068
90th	1.450	0.447	1.690	1.025	2.223	2.855
90th [p-value]	0.283	0.649	0.252	0.466	0.308	0.185

Note: The table shows OLS and IV estimates of the parameters δ_0 and δ in equation (8). Columns 1-2 shows OLS estimates on the full sample of US states. Columns 3-4 shows OLS estimated on the IV sample. Columns 5-6 shows IV. The dependent variable is children's income percentile in the national distribution for each parental income quantile in the state distribution, for cohorts 1980 to 1986. The variable β is the OLS estimate of the slope coefficient in equation (7), computed separately for each state and cohort, and standardized across all states and cohorts. The variable *par. pctile* is the percentile of parents in the national income distribution. IV estimates are obtained using β^s and $\beta^s\times$ *parent pctile* as instruments for β and $\beta\times$ *par. pctile*; the variable β^s is estimated as β using simulated revenues instead of actual revenues. "Equity" ("Adequacy") specifications are obtained using only states with equity (adequacy) reforms, using states with no reforms as a control group. All specifications include parent percentile, state, and cohort fixed effects. Bootstrapped standard errors in parentheses are clustered at the state and birth cohort level. *KP Wald F-stat* refers to the Kleibergen-Paap Wald F-statistic as a test of weak instruments. *Xth* refers to the effects on children with parents in the Xth centile of the national distribution. The IV sample is restricted to CA, CO, FL, GA, IL, KY, LA, MA, MI, MN, MT, NE, NJ, NY, ND, OH, PA, UT, TX, and WI. The full sample excludes HI. *** p<0.01, ** p<0.05, * p<0.1.

Table AVII: OLS and IV Estimates of Equalization On Intergenerational Mobility: Reforms That Level Up vs Level Down

	OLS		OLS, IV sample		IV	
	(1)	(2)	(3)	(4)	(5)	(6)
	Level up	Level down	Level up	Level down	Level up	Level down
β	-2.513**	-3.127**	-2.852*	-3.525**	-4.685*	-4.450**
	(0.989)	(1.184)	(1.282)	(1.246)	(1.982)	(1.689)
$\beta\times$ par. pctile	0.025***	0.015***	0.023***	0.016**	0.024***	0.020**
	(0.004)	(0.002)	(0.004)	(0.006)	(0.004)	(0.008)
Par. centile FE	Yes	Yes	Yes	Yes	Yes	Yes
CZ FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
N	24924	9282	12924	4860	12924	4860
10th	2.267	2.974	2.620	3.368	4.444	4.248
10th [p-value]	0.059	0.046	0.085	0.038	0.065	0.049
25th	1.898	2.745	2.273	3.134	4.082	3.947
25th [p-value]	0.095	0.062	0.121	0.054	0.081	0.069
90th	0.297	1.751	0.766	2.117	2.513	2.639
90th [p-value]	0.764	0.209	0.557	0.215	0.234	0.258

Note: The table shows OLS and IV estimates of the parameters δ_0 and δ in equation (8). Columns 1-2 shows OLS estimates on the full sample of US states. Columns 3-4 shows OLS estimated on the IV sample. Columns 5-6 shows IV. The dependent variable is children's income percentile in the national distribution for each parental income quantile in the state distribution, for cohorts 1980 to 1986. The variable β is the OLS estimate of the slope coefficient in equation (7), computed separately for each state and cohort, and standardized across all states and cohorts. The variable *par. pctile* is the percentile of parents in the national income distribution. IV estimates are obtained using β^s and $\beta^s \times$ *par. pctile* as instruments for β and $\beta\times$ *par. pctile*; the variable β^s is estimated as β^s using simulated revenues instead of actual revenues. "Level Down" ("Level Up") specifications are obtained using only states with reforms which leveled down (up) revenues, using states with no reforms as a control group; a reform is defined as leveling down if it generated a decline in revenues two years after the reform, relative to the year prior to the reform, in at least 20 percent of the state's districts. All specifications include parent percentile, state, and cohort fixed effects. Bootstrapped standard errors in parentheses are clustered at the state and birth cohort level. *KP Wald F-stat* refers to the Kleibergen-Paap Wald F-statistic as a test of weak instruments. *Xth* refers to the effects on children with parents in the Xth centile of the national distribution. The IV sample is restricted to CA, CO, FL, GA, IL, KY, LA, MA, MI, MN, MT, NE, NJ, NY, ND, OH, PA, UT, TX, and WI. The full sample excludes HI. *** p<0.01, ** p<0.05, * p<0.1.

Table AVIII: Heterogeneous Effects of School Finance Equalization. OLS, Dependent Variable is Children's Income Percentile

	By competition		By inequality		By segregation	
	(1)	(2)	(3)	(4)	(5)	(6)
	Low	High	Low	High	Low	High
β	-1.771*	-5.888***	-2.305**	-2.865***	-2.765***	-3.026***
	(1.017)	(1.239)	(1.047)	(1.007)	(0.867)	(1.048)
$\beta\times$ parent pctile	0.027***	0.034***	0.025***	0.020***	0.026***	0.022***
	(0.010)	(0.004)	(0.006)	(0.002)	(0.004)	(0.002)
Parent pctile FE	Yes	Yes	Yes	Yes	Yes	Yes
CZ FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
N	8784	4794	5460	8076	5922	7656
10th	1.505	5.545	2.059	2.663	2.503	2.803
10th [p-value]	0.118	0.000	0.044	0.008	0.003	0.008
25th	1.106	5.029	1.690	2.359	2.111	2.469
25th [p-value]	0.216	0.000	0.088	0.020	0.011	0.019
90th	-0.621	2.795	0.094	1.045	0.410	1.019
90th [p-value]	0.476	0.041	0.922	0.315	0.605	0.341

Note: OLS estimates of the parameters δ_0 and δ in equation (8). The dependent variable is children's income percentile in the national distribution for each parental income quantile in the state distribution, for cohorts 1980 to 1986. The variable β is the OLS estimate of the slope coefficient in equation (7), computed separately for each state and cohort and standardized across all states and cohorts. The variable *par. pctile* is the percentile of parents in the national income distribution. IV estimates are obtained using β^s and $\beta^s\times$ *par. pctile* as instruments for β and $\beta\times$ *par. pctile*; the variable β^s is estimated as β using simulated revenues instead of actual revenues. All specifications include parent percentile, CZ, and and cohort fixed effects. "Low Competition" ("High Competition") refers to states below (above) the median level of cross-district competition, measured as the number of districts per student in the state in 1980. "Low Inequality" ("High Inequality") refers to CZs below (above) the median level of income inequality, measured as the percentage difference in average income between the richest and poorest district in each CZ in 1990. "Low Segregation" ("High Segregation") refers to CZs below (above) the median level of income segregation across all CZs, where income segregation is measured with a Theil index calculated across districts within each CZ using data from 1990. Bootstrapped standard errors in parentheses are clustered at the state and birth cohort level. *Xth* refers to the effects on children with parents in the Xth centile of the national distribution. The sample is restricted to CA, CO, FL, GA, IL, KY, LA, MA, MI, MN, MT, NE, NJ, NY, ND, OH, PA, UT, TX, and WI.*** p<0.01, ** p<0.05, * p<0.1.

Table AIX: Robustness Checks. OLS, Dependent Variable is Children's Income Percentile

	Interpolated income	By border		Alt. centile def.	
	(1)	(2)	(3)	(4)	(5)
		Without	With	National	Cz
β	-2.362***	-3.088***	-2.568***	-2.685***	-2.700***
	(0.853)	(0.970)	(0.829)	(0.790)	(0.812)
$\beta\times$ parent pctile	0.022***	0.025***	0.020***	0.022***	0.026***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
Parent pctile FE	Yes	Yes	Yes	Yes	Yes
CZ FE	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes
N	13578	11364	2214	13578	14458
10th	2.144	2.838	2.370	2.464	2.445
10th [p-value]	0.012	0.003	0.004	0.002	0.002
25th	1.817	2.463	2.072	2.131	2.062
25th [p-value]	0.032	0.011	0.010	0.007	0.010
90th	0.400	0.839	0.785	0.690	0.402
90th [p-value]	0.636	0.387	0.319	0.385	0.606

Note: The dependent variable is children's income percentile in the national distribution for each parental income quantile in the state distribution (columns 1-3), national distribution (column 4), or CZ distribution (column 5), for cohorts 1980 to 1986. The variable β is the OLS estimate of the slope coefficient in equation (7), computed separately for each state and cohort and standardized across all states and cohorts. The variable *par. pctile* is the percentile of parents in the national income distribution. The variable β is instrumented with β^s, estimated as β using simulated revenues instead of actual revenues. All specifications include parent percentile, CZ, and and cohort fixed effects. In column 1, β is calculated using income figures that are interpolated between Census years. In column 2 the sample is restricted to CZs entirely belonging to one state, and in column 3 the same includes only CZs belonging to two or more states. Bootstrapped standard errors in parentheses are clustered at the state and birth cohort level. *Xth* refers to the effects on children with parents in the Xth centile of the national distribution. The sample is restricted to CA, CO, FL, GA, IL, KY, LA, MA, MI, MN, MT, NE, NJ, NY, ND, OH, PA, UT, TX, and WI. *** p<0.01, ** p<0.05, * p<0.1.

Appendix B Construction of the dataset

Income

I use tabulations of household income at the school district level from the US Census of Population and Housing for the years 1980, 1990 and 2000, and from the American Community Survey 5-year estimates (2008-2012) for the year 2010. Income tabulations at the school district level are contained in the Census STF3F file for 1980, and published as part of the School District Demographic System for the years 1990, 2000, and 2010. Income data at the district level is reported in the form of tabulations of the counts of households in 17, 25, 16 and 16 income bins in each school district in 1980, 1990, 2000 and 2010 respectively. To calculate median income from these tabulations, I assume a uniform distribution of households in each bin, and I assign each district the level of income of the class containing the median household. I winsorize the top and bottom 1 percent of observations in the distribution of each year. In the final sample, median income is available for 15,960, 15,272, 14,373, and 13,576 districts in 1980, 1990, 2000, and 2010 respectively.

School Revenues

I use data from NCES's School District Finance Survey (F-33), which contains information on total revenues and expenditure by district and year, along with enrollment figures. I complement these data, available for the years 1990, 1992, and 1995-2004, with information from the Census of Government for 1980, and I interpolate between years to impute revenues per pupil for missing years. I winsorize the top and bottom 1 percent of observations in the distribution of total revenues per pupil in each year.

Simulated School Revenues

To obtain actual and simulated revenues for each district, I have collected data from each state's Department of Education on the variables entering the school funding formula in each available year between 1986 and 2004. These variables include, but are not limited to, assessments of property values, property tax rates, income, measures of enrollment (such as full-time-equivalents or average daily membership/attendance, weighted by type of students or unweighted). Detailed information on the variables used in each formula is contained in Appendix Table CI. I successfully obtained this information for the following states (years): California (data available for the years 1996-2004), Colorado (1993-2004), Florida (1986-2004), Georgia (1988-2004), Kentucky (1991-2004), Illinois (1987-2004), Louisiana (1993-2004), Massachusetts (1995-2004), Montana (1994-2004), Michigan (1993-2004), Minnesota (1991-2004), Nebraska (1993-2004), New Jersey (1998-2004), New York (1986-2004), North Dakota (1986-2004), Ohio (1986-2004), Pennsylvania (1995-2004), Utah (1986-2004), Texas (1986-2004), and Wisconsin (1986-2004), and for a total of 8,102 school districts.

After collecting data on the formula variables from each state, I constructed the funding formula preceding and following each school finance reform, which allows to calculate total revenue as a function of the various variables and of formula parameters set by each state.

These formulas are described in Appendix D.

Equalization measures

To estimate state-year specific β as in equation 7, I match per pupil revenues data with median district income data. I assign state-year estimates to states and cohorts using the timing of each reform, with the procedure described in the paper. I also match districts to CZs using the 1990 county-CZ crosswalk provided by Chetty et al. (2014) and Chetty et al. (2014) and information on districts' counties provided by the NCES Common Core of Data.

To construct the simulated β^{sim}, instrument for β, I simulate post-reform revenues keeping endogenous variables, such as property values and income, at their levels at the time of passage of each reform. I adjust property values using the US Annual Price Index (calculated by the Federal Housing Finance Authority using a repeated-sales method). Third, I estimate the simulated β^s using simulated revenues and median income at the district level, for each Census year as well as for the first and last year for which simulated revenues are available. I then impute β^{sim} to each school year using the same procedure described in the text for the imputation of β. To maximize the size of the sample, I set $\beta^{sim} = \beta$ for all states without a school finance reform in the years 1986-2004, which include California, Florida, Georgia, Illinois, New York, North Dakota, Ohio, Pennsylvania, and Utah. β^s is available for a total of 327 CZs with non-missing mobility information.

Intergenerational Mobility

Chetty et al. (2014) (Online Table 1) calculate and report intergenerational mobility measures, separately for each cohort of children and for each of the 637 out of 722 CZs in the US, using individual-level data from IRS tax records (estimates are not available for CZs with a very low number of children). These measures include the intercept and the slope of the linear relationship between parents' and children's income ranks (on the national income distribution of parents' income and children's income, respectively), separately for each CZ and for cohorts 1980-86.[42] Parents' income is calculated as the average yearly income in years 1996-2000, measured in 2010 dollars. Children's income is calculated as the average yearly income in years 2010, 2011 and 2012, measured in 2010 dollars.[43] Each child is matched to his or her parent (or parents), i.e. the taxpayer who claimed him or her as dependent when he or she was age 25 or younger in IRS tax records covering the period 1996-2011.[44] Matched parent-child pairs are assigned to a CZ based on the earliest non-missing zip code reported on the tax form of the parent. The sample is restricted to children of parents with non-missing zip codes and non-negative income. The final sample of children includes nearly 24 million US citizens born

[42] A CZ is defined by the Census Bureau and the United States Department of Agriculture as "[...] a geographic unit that better captures the economic and social diversity of non-metro areas." For confidentiality issues, mobility measures are not disclosed for 13 CZs with less than 250 children.

[43] See Chetty et al. (2014) for a detailed description of the income definitions used to compute intergenerational mobility measures.

[44] If an individual was claimed as dependent by more than one taxpayer, he or she is considered as the dependent of the taxpayer who claimed him or her in the earliest year.

in the period 1980-1986.[45]

My measure of mobility is the national income rank of children given their CZ, cohort, and percentile of parental income in the state. I construct this measure as follows. Chetty et al. (2014) (Online Data Table 7) report the parents' income distribution for each CZ. Specifically, they report income levels corresponding to the 10th, 25th, 50th, 75th, 90th, and 99th percentile in each CZ. I aggregate these distributions at the state level assuming a uniform income distribution within each percentile and using counts of children in each CZ as weights. This allows me to construct the income levels corresponding to the 10th, 25th, 50th, 75th, 90th, and 99th percentile in each state. I then match these income levels to the corresponding percentiles in the national distribution. Lastly, I use the slope and intercept of the linear relationship between parents' and children's national income ranks (provided in the Online Data Table 1 of Chetty et al. (2014)) to back out the national income rank of the child, for each of these parental income percentiles in each state, for each CZ, and for each cohort born between 1980 and 1986. Assuming that the income distributions did not change over time (and across cohorts) in each CZ, this procedure allows to approximate the distribution of income for children in each CZ and birth cohort, given each parent's income percentile in the state distribution.

[45]Differently from Chetty et al. (2014) who base their analysis of income mobility on a "core sample" of children born in 1980 and 1981, my sample also includes younger children. As explained by Chetty et al. (2014), measuring children's income at early ages can overestimate mobility with respect to lifetime income, because children with high lifetime incomes have steeper earnings profiles when young (which stabilize around age 30). Children in the younger cohort in my income mobility sample (born in 1986) are 26 in 2012. The measurement error generated by the inclusion of the younger cohorts, however, should be quite limited (see Chetty et al., 2014, Figure IIIA). In addition, younger cohorts are more likely to be correctly matched to the the zip code where they grew up.

Appendix C Simulated Instruments: Details

Appendix C.1 Explaining The Need for An Instrument

Testing the theoretical predictions of Section 2 and estimating the effects of a decline in β on IGM requires a source of exogenous variation in β. While school finance reforms are a natural candidate, extensively used as exogenous shifters of school spending to study a variety of children's outcomes (Jackson et al., 2015; Lafortune et al., 2018), their use is not without harms. In particular, if one is simply interested in the effect of the passage of any school finance reform on students' outcomes (as in Lafortune et al., 2018), the exogeneity in the timing is the only required identifying assumption. If, instead, one wants to estimate the causal effect of the changes in revenues and expenditures triggered by the reform, one must deal with an endogeneity problem.[46]

To see this, consider the following simplified version of equation (6), which expresses the income rank of children in CZ c and state s, cohort b, and with parents' income rank r as a function of β (for simplicity I focus only on one r):

$$M_{cb}^{r} = \delta\beta_{sb} + \theta_c + \tau_b + \tilde{\varepsilon}_{cb} \tag{A.1}$$

The variable $\tilde{\varepsilon}_{cb}$ is a residual component of IGM; it can include the composition of their group of peers or the community, summarized by $\tilde{X}_{cb}$:

$$\tilde{\varepsilon}_{cb} = \gamma\tilde{X}_{cb} + \varepsilon_{cb}$$

To simplify matters I express the variable β_{sb} as the product between a vector of parameters of the funding formula of state s, g_{sb}, and a vector of all the variables entering that formula, X_{sb}: $\beta_{sb} = X_{sb}'g_{sb}$ (where $Cov(\tilde{X}_{cb}, X_{sb} \neq 0)$). Suppose that, due to a school finance reform, the funding formula for cohort $b+1$ changes to g_{sb+1}. Changes to the funding formula affect the tax price (i.e., the dollars of tax revenues required to increase spending by one dollar), which represents the "price" of public schools to taxpayers, and – in turn – households' budget constraints. Households could respond to this change in the tax price by "voting with their feet" (Tiebout, 1956) and moving to a different district (Aaronson, 1999; Dee, 2000; Figlio and Lucas, 2004; Epple and Ferreyra, 2008; Chakrabarti and Roy, 2015). Due to this sorting, variables such as house prices and property tax revenues, which are included in X_{sb}, will change to X_{sb+1}. At the same time, this sorting could affect IGM through changes in $\tilde{X}_{cb}$.[47]

Due to the inclusion of θ_c, OLS estimates of δ can also be obtained from a first-differenced version of equation (A.1). These estimates are only consistent if the following exclusion restriction holds:

$$\mathbb{E}[(X_{sb+1}'g_{sb+1} - X_{sb}'g_{sb})(\gamma\tilde{X}_{cb+1} + \varepsilon_{cb+1} - \gamma\tilde{X}_{cb} - \varepsilon_{cb})] = 0$$

Since $\mathbb{E}(X_{sb+1}\tilde{X}_{cb+1}) \neq 0$, the exclusion restriction fails, causing an endogeneity problem.

[46] This is analogous to wanting to estimate a "structural" parameter, whereas Lafortune et al. (2018) estimate the reduced-form effect of equalization reforms.

[47] Note that this is the same justification for the IV strategy of Jackson et al. (2015), who also seek to estimate the causal effect of changes in expenditure levels on student outcomes (as opposed to just the effect of the reform).

How Prevalent Is Household Sorting After A School Finance Reform? The answer to this question determines the importance of addressing the endogeneity problem. To quantify this, I conduct an event study of county-level migration around an equalization event. I use data on county-level migration flows and incomes of migrants for the years 1991 to 2004 from the IRS Statistics of Income (SOI), and I calculate county-level individual migration rates as the ratio between the total number of in-migrants and out-migrants and the county's population. I then estimate:

$$m_{kt} = \sum_{n=-5}^{5} \delta_n R_{s(k)} \mathbb{1}(t - ryear_{s(k)} = n) + \gamma_k + \tau_t + \varepsilon_{kt} \tag{A.2}$$

where m_{kt} is the in-migration (out-migration) rate, defined as the total number of households moving (out) of county k in year t divided by the total number of households in k. The variable $R_{s(k)}$ equals 1 if state s of county k experienced a school finance reform in the years 1986-2004, and $ryear_{s(k)}$ is the year of the earliest reform. The vectors γ_k and τ_t are county and year fixed effects, respectively, and ε_{kt} is an error term. Estimates of the coefficients δ_n, shown in Figure AVII (top panel), capture year-specific changes in migration flows after each reform relative to the year preceding a reform. The differences between in-migration and out-migration rates of counties with and without a reform are indistinguishable from zero in the years leading up to a reform, and then they increase by 17 and 19 percent (or 0.13 and 0.14 percentage points) on average, respectively, in the years following the reform (Appendix Table AIII, panel A).[48]

These migration patterns, however, cause endogeneity in post-reform expenditure only if they are associated with sorting on income and wealth. To characterize these sorting patterns, I re-estimate equation (A.2) using the absolute value of the percentage difference between the incomes of migrants and stayers as the dependent variable. These estimates, shown in the bottom panel of Figure AVII, reveal that the absolute difference in the average income of both in-migrants and out-migrants and the average income of stayers is flat in the years leading up to a reform, and then it increases significantly (to a maximum of 9 and 7 percent, or 2.1 and 1.7 percentage points respectively) in the years after the reform.

Taken together, these results indicate that households sort across counties following a school finance reform. This sorting can affect house prices, change the composition of local communities, and in turn lead to the endogeneity of post-reform revenues.

Appendix C.2 Constructing the Simulated Instrument

I address this endogeneity issue with a simulated-instruments approach (as in Gruber and Saez, 2002) which, similarly to Hyman (2017), directly exploits changes in *each state's* formula type and parameters generated by a reform.[49] The goal of this strategy is to isolate the exogenous variation in funding inequality, driven by the timing of the reform and the funding

[48] Appendix Table AIII shows estimates of equation (A.2) obtained pooling together years before and after each reform.

[49] Hyman (2017) focuses on Michigan's 1994 school finance reform and directly uses changes in the foundation grant (the relevant policy parameter for this reform) as an instrument for expenditures. Goldsmith-Pinkham et al. (2018) illustrate how, in a simulated-instruments context, identification leverages variation in the change in the parameters of a given policy. The source of exogenous variation used in my analysis is thus the same as in Hyman (2017), which I expand to include a large sample of US states.

formula, from the endogenous variation driven by sorting and changes in the tax base.

It is useful to express the post-reform β_{sb+1} as the sum of an exogenous component and an endogenous one:

$$\beta_{st+1} = X'_{st}g_{st+1} + b_{st+1}, \text{ where } b_{st+1} = X'_{st+1}g_{st+1} - X'_{st}g_{st+1}$$

The quantity $X'_{st}g_{t+1}$ is the β_{st+1} that would have resulted had households not sorted (and house prices not changed). This "simulated" version of β_{st+1}, which I denote as β^{sim}_{st+1}, can be used as an instrument to obtain consistent estimates of δ^r in equation (A.1). The required exclusion restriction becomes:

$$\mathbb{E}[(X'_{sb}g_{sb+1} - X'_{sb}g_{sb})(\gamma\tilde{X}_{cb+1} + \varepsilon_{cb+1} - \gamma\tilde{X}_{cb} - \varepsilon_{cb})] = 0$$

This condition is satisfied if $g_{sb+1} - g_{sb}$ is unrelated to $X_{cb+1} - X_{cb}$ or, in other words, if the specific change in the funding formula is unrelated to sorting and the subsequent changes in the tax base. Appendix Table AII (described below) shows evidence in support of this assumption.

The correlation between b_{st+1} and IGM determines the sign of the bias of OLS estimates. If the effect of β on IGM is negative, a positive correlation implies that OLS will be biased toward zero, whereas a negative correlation implies that OLS will overstate the negative effect of β. The sign of this correlation is uncertain *ex ante* and depends on both X_{st} and g_{st+1}.

Appendix C.2.1 The Importance of Accounting for Differences in Funding Formulas Across States

While earlier studies of school finance reforms (such as Card and Payne, 2002) have not explicitly accounted for the endogeneity in post-reform revenues and expenditure, more recent studies (such as Jackson et al., 2015; Hyman, 2017) have recognized and addressed it. Jackson et al. (2015, JJP hereafter), for example, instrument spending using the timing of each reform, districts' initial position in the state's expenditure and income distributions, and the type of funding plan (e.g. foundation).

Although similar to JJP's, my approach bears one important difference. Their strategy relies on the assumption that all reforms of the same type had the same effect on expenditure, conditional on a district's initial position in the state's expenditure and income distributions. If one were to apply JJP's strategy in my context, the instrument would be specified as $\hat{\beta}^{sim}_{st+1} = \hat{X}'_{st}\hat{g}$.[50] In other words, the instrument formula would be the same across all states, and the set of characteristics considered $(\hat{X}_{st})$ would be a subset of all the ones entering the actual formula.

What happens when one uses $\hat{\beta}^{sim}_{st+1}$ instead of β^{sim}_{st+1} as an instrument? First, the formula $\hat{g}$ can be seen as a "restricted" or simplified version of g_{st+1}; as a result, using $\hat{g}$ implies using fewer instruments than there are available, which could lead to asymptotic inefficiency.[51] Second, in the presence of large differences in g_{st} across states, the standard IV

[50] Note that Jackson et al. (2015) instrument expenditure and not β.

[51] See Greene (2008, Chapter 12). Goldsmith-Pinkham et al. (2018) explain how, in a simulated instrument context, the parameters of the formula used to construct the instrument represent the actual instruments. Therefore, using a simplified version of the formula implies using fewer-than-available parameters.

monotonicity assumption (Angrist and Imbens, 1995; Angrist et al., 1996) is more likely to be violated when using $\hat{\beta}^{sim}_{st}$ than when using β^{sim}_{st}. To see this, consider an endogenous $\beta_{st+1} = X'_{st+1}g_{st+1}$ with a corresponding value of JJP's instrument $\hat{\beta}^{sim}_{st+1} = \hat{X}'_{st}\hat{g}$. Suppose now that all states' formulas change to $g^0_{kt+1}\forall k$, such that the resulting instrument for state s would be $\hat{\beta}'^{sim}_{st+1} = \hat{X}'_{st}\hat{g}^0 \leq \hat{\beta}^{sim}_{st+1}$. Monotonicity requires that $\beta'_{st+1} = X'_{st+1}g^0_{st+1} \leq \beta_{st+1}$ for all s; this condition would be violated if there is a state where the instrument predicts an increase in equalization, but the actual changes in the formula and in X_{st} lead to a decline in equalization (or vice versa). If instead one uses an instrument $\beta^{sim}_{st+1} = X'_{st}g_{st+1}$, this assumption would fail only if the endogenous change in X_{st} *alone* were so dramatic to yield a change in β_{st+1} of the opposite sign as the the change in β^{sim}_{st+1}, since the function g^0_{st+1} is the same in β_{st+1} and β^{sim}_{st+1}.[52]

Clearly, the extent to which β^{sim}_{st} will be a better instrument than $\hat{\beta}^{sim}_{st}$ depends on the actual heterogeneity in funding formulas across states (Hoxby, 2001). Figure AVIII shows the trend in β around a reform in five states with reforms between 1989 and 1996. While some reforms were effective in reducing β (such as the one in Wisconsin in 1996, which reduced it from 0.021 in the year before the reform to 0.003 four years after the reform), some others were considerably less effective (such as the one in Michigan, which only reduced β from 0.045 to 0.041).[53]

Different reforms also had different effects on house prices. To show this, I use transaction-based annual house price indexes at the 5-digit zip code level for the years 1986 to 2004, published by the Federal Housing Finance Agency (FHFA).[54] I use information from the 1990 Census to link zip codes to school districts and aggregate house prices at the district level based on the population in each zip code. The coverage of this dataset varies across time, with 48 percent of all zip codes in 1986, 70 percent in 1995, and almost 100 percent in 2004. The available information allows me to obtain a measure of house prices for 64 percent of all districts in 1986, 82 percent in 1995, and 100 percent in 2004.

Figure AIX shows trends in the house price difference between districts with average incomes above and below the state median in 1990. While some reforms (e.g. in Texas) were followed by a decline in this difference (i.e., an increase in house prices in poorer relative to richer districts), others did not trigger any changes (e.g. Michigan) or were followed by an increase (e.g. Massachusetts).[55]

Differences in the effectiveness of each reform and in the house price responses across states

[52] Mogstad et al. (2019) explain how, in the context of 2SLS with many instruments, the validity of the strategy is guaranteed by a (milder) "partial" monotonicity assumption, which essentially requires the standard monotonicity assumption to apply individually to each instrument. My argument still applies: when using β^{sim}_{st+1}, the instruments are the actual parameters of the funding formula entering β_{st+1}, whereas when using $\hat{\beta}^{sim}_{st+1}$ they are not.

[53] These differences are consistent with the fact that Jackson et al. (2015) find that, on average, school finance reforms increase expenditure more in *ex ante* lower-spending districts, Hyman (2017) finds that Michigan's Proposal A increased expenditure more in low-poverty districts.

[54] The construction of this index is explained in detail in Bogin et al. (2016).

[55] Each point and spike in Figure AIX represent the estimate and the 90 percent confidence interval of the coefficients δ_n in the regression $HP_{dt} = \sum_{n=-4}^{6} \delta_n 1(Income_{d,1990} > Median_s) R_{s(d)} 1(t - Ryear_{s(d)} = n) + \theta_d + \tau_t + \varepsilon_{dt}$, where HP_{dt} is the house price index of district d in year t, $Income_{d,1990}$ is average household income of district d in 1990, $Median_s$ is median household income in state s in 1990, $R_{s(d)}$ equals 1 if state s where the district is located experienced a school finance reform in the years 1986-2004, $Ryear_{s(d)}$ is the year of the earliest reform, and θ_d and τ_t are district and year fixed effects. The parameters are estimated separately for each state. Observations are weighted by population. Standard errors are clustered at the state level.

suggest that the use of β_{st}^{sim} instead of $\hat{\beta}_{st}^{sim}$ could improve both the consistency and the efficiency of the estimates.

Implementation I construct β^{sim} as follows. First, I obtain the funding formulas in place in each school district and year. These formulas express total and per pupil revenues as a function of district-specific characteristics (such as enrollment, property tax rates, property values, and average gross income) and parameters set by state laws. I construct each formula using information from Gold et al. (1992), Sielke et al. (2001), Verstegen and Jordan (2009), and various state legislative bills (see Appendix D for details on each specific formula). I then use the formulas to simulate each district's post-reform revenues, holding endogenous characteristics (i.e., property values, property tax rates, and income) fixed at their pre-reform values.[56] Lastly, I construct β^{sim} for each state and year, re-estimating equation (7) using simulated instead of actual revenues.[57]

Assumptions The validity of this approach relies on the exogeneity of the timing of each reform and of the type and parameters of the funding formula. This assumption could be violated if the funding formula chosen by each state or the timing of the reform were related to the state's socioeconomic or political conditions. Hoxby (2001), however, explains that equalization schemes are more likely to be a reflection of a particular legal rhetoric rather than of specific objectives in terms of school spending and redistribution. This would explain why some of these reforms have had smaller-than-intended effects. In addition, the timing of a reform often depends on the length of a legislative process or on the timing of a court ruling. This suggests that both the timing and the type of reforms can be plausibly considered exogenous.

Appendix Figure AXI shows trends in simulated and actual revenues in some of the largest states, separately for districts in the top and bottom quartile of the state's initial distribution of per pupil expenditure. The extent to which actual revenues differ from simulated revenues varies across states; it depends on the changes in property values in each district following a reform, driven by the *ex ante* characteristics of the district and by the change in the funding formulas. Districts where a reform triggered an increase in house prices experienced higher revenues than they would have had house prices not changed, and vice versa (Appendix Figure AX).[58]

[56] I adjust property values using the FHFA's US All Transactions Index (quarterly data, available at https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx) to account for nationwide changes in house prices, and I correct for inflation using the CPI.

[57] For states with no reform between 1986 and 2004, I simply set $\beta = \beta^{sim}$ for all years and cohorts.

[58] Appendix Figure AX shows the relationship between the percentage change in house prices after a reform and the difference between actual and simulated revenues.

Appendix D School Finance Equalization Reforms

California

The school finance plan in place in 1986 in California is the product of the *Serrano* vs. *Priest* lawsuit, and the passage of Proposition 13 (1978), which limited property tax rates to 1% of assessed property value. The passage of Proposition 98 in 1988 slightly modified the funding scheme, by earmarking a fixed minimum percentage of the state budget to education. After these changes, control of school finance has been shifted more and more to the state. State aid is distributed through a foundation plan. The foundation base, called Revenue Limit, is based on historical revenues adjusted by the cost of living, with increases inversely related to the level of revenues. The formula, although very complicated, can be summarized as follows:

$$\begin{aligned} R &= \max\{\max\{2,400, 400 \times n\}, \max\{\mathrm{RL} - 0.01p\}\} + 0.01p \\ RL &= \bar{RL}_{-1} \times CODB \end{aligned}$$

where RL is the revenue limit, $\bar{RL}_{-1}$ is the average of previous year's revenue limit, $CODB$ is the cost of doing business, proxy for the cost of living, and p is property value.

Years data are available: 1996-2004

Baseline year: 1996

Available data elements: p, RL, district's share of county-levied property tax levy, enrollment (ADA).

Issues with data consistency over the years? No; formula elements are consistent for available data years

Colorado

Until 1993, Colorado had a Guaranteed Tax Base formula with a fixed tax rate. Local revenues came from property taxes as well as from appropriations of revenues from an ownership tax on all registered vehicles. The formula was as follows:

$$\begin{aligned} R &= \min\{t * max\{p, B\} + t * 10, ARB\} \\ \text{where } t &= \text{tax rate in district} = 1\% \text{ fixed (collected and redistributed at county/city level)} \\ R^o &= \text{per-pupil revenues from ownership tax base} \\ B &= \text{minimum guaranteed tax base, comes from the state} \\ ARB &= \text{authorized revenue base} \end{aligned}$$

The Public School Finance Act of 1994 changed the formula to a foundation plan. The foundation amount is determined by the Per-Pupil-Revenue and it is district-specific, to account for differences in the cost of living in the number of at-risk children. The formula in place between 1994 and 2004 is as follows:

$$
\begin{aligned}
R &= t * p + \max\{0, PPR - t * p - R^o\} \\
\text{where } t &= \text{tax rate in district } = 1\% \text{ (fixed)} \\
R^o &= \text{per-pupil revenues of ownership tax base} \\
p^o &= \text{per-pupil ownership tax base} \\
PPR &= \text{per-pupil revenue, function of "base" and cost of living, as well as number of "at risk" childre}
\end{aligned}
$$

Years data are available: 1994-2004

Baseline year: 1994

Available data elements: R^o, p^o, PPR, enrollment

Issues with data consistency over the years? No; formula elements are consistent for available data years

Florida

Florida's school funding scheme in the years 1988-2004 involved a combination of a Foundation Grant and a Guaranteed Tax Base. The formula was as follows:

$$
\begin{aligned}
R &= f * cost\_diff + \max\{t - \bar{t}, 0\} * p \\
\text{where } t &= \text{tax rate in district} \\
t - \bar{t} &\leq 0.0005 \\
\bar{t} &= \text{required tax rate (decided by the state)} \\
\bar{t} * p &\leq 0.9 * f \\
p &= \text{per-pupil property value} \\
f &= \text{foundation grant (\$3,223.06 in 1998-1999)} \\
cost\_diff &= \text{cost of living adjustment}
\end{aligned}
$$

Years data are available: 1988-2004

Baseline year: 1988

Available data elements: t, $\bar{t}$, f, state and local revenues (used to calculate property values p), $cost\_diff$

Issues with data consistency over the years? No; formula elements are consistent for available data years

Georgia

Georgia's school finance plan for the years 1987-2004 was introduced in 1985 as part of the Quality Basic Education program. It involves a Foundation grant and a Required Local Effort component. The formula is as follows:

$$\begin{aligned}
R &= f + t1 * p + t2 * \max\{p90, p\} + t3 * p \\
&\quad \text{such that } t1 + t2 + t3 \leq 0.02 \\
\text{where } f &= \text{foundation grant base amount (\$2038.74 in 1998-99)} \\
t1 &= \text{compulsory local effort (5 mills)} \\
t2 &= \text{optional additional effort subject to equalization (max. 3.25 mills)} \\
t3 &= \text{optional additional effort in addition to 5 + 3.25 mills}
\end{aligned}$$

Years data are available: 1987-2004

Baseline year: 1987

Available data elements: f, $t1$, $t2$, $t3$, p, enrollment (FTE)

Issues with data consistency over the years? No; formula elements are consistent for available data years

Illinois

The school finance plan in place in 1986 had been implemented in 1980. The funding formula has three tiers: Foundation, Alternate Method and Flat Grant. Per pupil property wealth in each district determines which formula must be used to compute the funding. The state aid formula compares the district valuation to a guaranteed wealth per ADA. The guaranteed level varies by the type of school district: in 1999 it was equal to \$188,478 for elementary districts, \$361,250 for secondary districts, and \$144,500 for unit districts. Districts qualifying under the Foundation formula have per pupil valuation less than 93% of the foundation level. Districts qualifying under the Alternate Method formula have per pupil valuation of at least 93% but less than 175% of the foundation level. Districts qualifying under the Flat Grant formula have per pupil valuation greater than 175% of the foundation level. The foundation level was \$4,225 in 1999, the flat grant was \$218. The formula can be summarized as follows:

$$\begin{aligned}
R &= \text{Aid} + \tau * p * n \\
\text{Aid} &= \text{Foundation or AM or FG} \\
\text{Foundation} &= n(f - \text{Local Resources}) \\
\text{AM} &= nf[0.07 - ((\text{Local Percentage} - 0.93)/0.82)0.02] \\
\text{FG} &= n * 218 \\
\text{Local Resources} &= np_i\hat{\tau} + \text{CPPRT}/n \\
\text{Local Percentage} &= 100 \times \text{Local Resources}/f
\end{aligned}$$

where τ is the property tax rate, p is per pupil property valuation, n is the weighted count of pupils, f is the foundation level, $\hat{\tau}$ is equal to 2.3% for elementary districts, 1.2% for secondary districts and 3.0% for unit districts, and CPPRT denotes the Corporate Personal Property Replacement Taxes.

Years data are available: 1987-2004

Baseline year: 1998

Available data elements: Aid, p, τ, n (WADA), ADA, f, FG.

Issues with data consistency over the years? No; formula elements are consistent for available data years

Kentucky

Kentucky changed its school finance plan in 1990, with the Kentucky Education Reform Act (KERA). The post-reform plan is a mix between a Foundation plan and a Power Equalization. The formula is as follows:

$$
\begin{aligned}
R &= t*p + t2*\max\{\bar{p},p\} + \max\{f - t*p - t2*\max\{\bar{p},p\},0\} + t3*p \\
\text{where } t &= \text{tax rate, compulsory effort and fixed at 0.003} \\
t2*\max\{\bar{p},p\} &\leq 0.15*f \\
p &= \text{property valuation per pupil} \\
t2 &* \max\{\bar{p},p\} \leq 0.3*f \\
\bar{p} &= \text{level of guaranteed tax base, 1.5 * average state} \\
t2 &= \text{discretionary additional fiscal effort (tier 1, power equalization)} \\
t3 &= \text{discretionary additional fiscal effort (tier 2, no equalization)} \\
f &= \text{foundation base: \$2,839 in 1998-99}
\end{aligned}
$$

Years data are available: 1991-2004

Baseline year: 1991

Available data elements: $t*p$, t, $t2$, $t3$ f, enrollment

Issues with data consistency over the years? No; formula elements are consistent for available data years

Louisiana

Louisiana had a school finance reform in 1992; this reform introduced the Minimum Foundation Plan. The post-reform formula involves two tiers: a foundation plan and a required local effort plan. Tier 1 is as follows:

$$
\begin{aligned}
R_1 &= t * p + (p/P * n * f/N * 0.65) \\
\text{where } t &= 0.005 \text{ (but can be bigger)} \\
\text{Local + State} &= f * n \\
\text{Local share} &= p/P * n * f/N * 0.35 \\
\text{State share} &= p/P * n * f/N * 0.65
\end{aligned}
$$

and where f is the foundation amount, n is district enrollment, N is state enrollment, p is local revenue capacity (encompassing both property and sales tax base) per pupil, and P is the state revenue capacity per pupil.

Tier 2 funding is only awarded to districts with $p/P \leq 1.66$ and $t * p > p/P * n * f/N * 0.35$:

$$R_2 = t * p * (1 - 0.6 * p/P)$$

Total revenues are therefore $R = R_1 + R_2$.

Years data are available: 1993-2004

Baseline year: 1993

Available data elements: n, f, t, p

Issues with data consistency over the years? No; formula elements are consistent for available data years

Massachusetts

Massachusetts' school finance plan was implemented in 1994, with a reform that introduced the so-called Chapter 70 state aid. The formula involves a foundation plan with required local spending. The state establishes a foundation budget (F) as the sum of per pupil cost categories, which are a function of student enrollment in different grades and student categories (e.g. special education students), and a net school spending (NS), which is a function of the foundation amount in the previous year. If $NS \geq F$, districts receive the same aid as the previous year, plus a minimum \$100 increase per pupil. If $NS < F$, districts receive $F - NS + \$100$ per pupil. Districts and the state then share the burden of this required spending: specifically, districts are required to contribute a local share, which is a function of property values and income. The formula is therefore as follows:

$$R = \min NS, F + \$100$$

Years data are available: 1993-2004

Baseline year: 1994

Available data elements: F, NS, local required share, enrollment

Issues with data consistency over the years? No; formula elements are consistent for available data years

Michigan

The school finance plan in place in 1986 dates back to 1974. Under this finance scheme, district revenues came from local property taxes (constitutionally capped at 50 mills) and from state aid, distributed to districts using a Guaranteed Tax Base plan and a foundation allowance. The formula worked as follows:

$$
\begin{aligned}
R &= \tau p + \max\{f + \tau(\bar{p} - p), 0\} \\
f &= \text{Foundation allowance (\$400)} \\
\tau &= \text{actual property tax rate} \\
p &= \text{value of property per pupil} \\
\bar{p} &= \text{guaranteed tax base (\$102,500)}
\end{aligned}
$$

By 1993-94, however, only approximately 60 percent of districts were receiving any aid, and differences in per pupil expenditure spending between the highest- and lowest-spending districts had increased considerably. Further, school property tax rates were very close to the constitutional limit for most districts. For this reason, in 1993 governor John Engler signed P.A. 145. The Act reduced the share of operating revenue for public schools coming from local property taxes, and increased the importance of state aid.

The nature of the new funding scheme is a foundation plan. The state guarantees each district a basic level of funding per pupil, provided that the district levies a minimum local voter-approved property tax at a millage rate set by the Legislature (equal to 18 mills). Districts' foundation allowances each year have been based upon their foundation allowances of the immediately preceding year. In the first year of the reform (1994-95), the foundation allowance was set at \$5,000; however, districts whose revenues were above and below this level the preceding year were assigned an allowance between \$4,200 and \$6,500, and gradually moved towards \$5,000. The formula can be summarized as follows:

$$
\begin{aligned}
R &= f + \tau p - \bar{\tau} p \\
f &= \text{Foundation allowance} \\
\tau &= \text{actual property tax rate} \\
\bar{\tau} &= 0.018 \\
p &= \text{non-homestead property per pupil}
\end{aligned}
$$

Years data are available: 1990-2004

Baseline year: 1993

Available data elements: f, τ, p, $\bar{p}$

Issues with data consistency over the years? No; formula elements are consistent for available data years

Minnesota

The funding plan in place in Minnesota was implemented in 1988 and it is a simple foundation amount. The cost of the foundation is split between the state and the school districts based on the ratio between a district's adjusted net total capacity per pupil (ANTC, proxy for property tax base) and a guaranteed ANTC (GANTC) set by the state. Districts raise their share of the foundation through local property taxes. The formula is as follows:

$$\begin{aligned} R &= \text{Basic Revenue (foundation amount - \$3,530 in 1998-99)} \\ \text{Local Share} &= \text{Basic Revenue} * \min\{1, ANTC/GANTC\} \\ \text{State Share} &= \text{Basic Revenue - Local Share} \end{aligned}$$

Years data are available: 1991-2004

Baseline year: 1991

Available data elements: foundation amount, revenues by source, enrollment (adjusted daily membership or ADM)

Issues with data consistency over the years? No; formula elements are consistent for available data years

Montana

Montana's school funding formula was introduced in 1993. It involves a foundation amount and a guaranteed tax base; the foundation amount must cover 80 percent of the total budget. The formula is as follows:

$$R = f + tp + t * \max\{1.74 * P/F - p, 0\} - t^F * p$$

where t is the tax rate chosen by the district, t^F is the state tax rate intended to finance the foundation aid (equal to 0.095), p is per pupil property value, f is the foundation amount, F is the sum of all foundation grants in the state, and P is the total property value in the state.

Years data are available: 1994-2004

Baseline year: 1994

Available data elements: tax levy, state aid, guaranteed tax base, enrollment

Issues with data consistency over the years? No; formula elements are consistent for available data years

Nebraska

The school plan in Nebraska was implemented in 1990. The formula consists in a foundation plan with incentives for local effort. The formula is as follows:

$$R \;=\; \max\{f - LC, 0\} + t * p$$

where f is the foundation amount, p is the property value per pupil, t is the district's property tax rate, and LC is the local capacity, defined as the local tax revenue a district could raise at a "normal" tax rate.

Years data are available: 1993-2004

Baseline year: 1993

Available data elements: local property tax revenue, enrollment (adjusted daily attendance or ADA, or ADM), annual costs, state aid

Issues with data consistency over the years? No; formula elements are consistent for available data years

New Jersey

In 1986 school finance in New Jersey followed the provisions of Chapter 212, as mandated by the *Public School Education Act* of 1975. State aid was distributed to districts under the form of an equalization grant. The formula is as follows:

$$R = \tau p + \max\{0.1\bar{S}, \max\{0, (1 - \frac{p}{1.35\bar{p}}) \min\{e, \bar{S}\}\}\}$$

where τ is the property tax rate chosen by the district, p is property value, $\bar{S}$ is the state aid limit, $\bar{p}$ is the average property value, and e is previous year's current expenditures.

Following a court declaration of unconstitutionality of the funding scheme resulting from the *Abbott* vs. *Burke* lawsuit started in 1981, in 1990 Governor Florio signed the *Quality Education Act* (QEA) into law. Among other provisions, the QEA substantially changed the financing formula, which became a foundation program. The local share had to be determined considering a district's property valuation and average income. The new formula, in place from 1992, is as follows:

$$R = \tau p + \max\{0, f - 0.5(Pp + Yy)\}$$

where f is the foundation amount ($6,640 in 1992); P and Y are, respectively, the property and the income multipliers, used to compute a district's fiscal capacity; p is property valuation and y is average income.

The formula introduced with the QEA was declared unconstitutional by the NJ Supreme Court in 1994 (*Abbott* vs. *Burke* III), because it did not equalize funding or guarantee needed supplemental programs. In 1996, Governor Whitman signs into law the *Comprehensive Education Improvement and Financing Act* (CEIFA). The act leaves the formula substantially unchanged, but it allocates $246 million ("parity aid") to 28 designated poor urban districts, denominated "Abbott districts". The funding scheme designed with CEIFA was ruled unconstitutional already in 1997, but the formula remained unchanged through 2004.

Years data are available: 1988-2004

Baseline year: 1990

Available data elements: τ, τp, y, f, state aid, enrollment

Issues with data consistency over the years? No; formula elements are consistent for available data years

New York

The school finance plan in place in New York from 1986 to 2004 consisted in a combination of state and local funds. The largest part of local revenues came from property taxes. State aid was distributed through a variety of programs. The largest of them were:

- Basic Operating Aid (BOA), proportional to a district's Approved Operating Expenses (AOE, including salaries of administrators, teachers and non- professionals, fringe benefits, utilities, and maintenance of school facilities), and inversely proportional to its wealth:

$$\begin{aligned}
\text{BOA} &= \max\{\text{Formula Aid}, 400\} \\
\text{Formula Aid} &= \text{OAR} \times \text{Ceiling} \\
\text{OAR} &= \min\{\max\{0, [1.37 - (1.23 \times \text{CWR})], \\
&\quad [1.00 - (0.64 \times \text{CWR})], \\
&\quad [0.80 - (0.39 \times \text{CWR})], \\
&\quad [0.51 - (0.22 \times \text{CWR})]\}, 0.9\} \\
\text{CWR} &= 0.5[(p/\bar{p}) + (y/\bar{y})) \\
\text{Ceiling} &= 3,900 + [\min\{8,000, \text{AOE}/n\} - 3,900] \times [\max\{0.075, 0.075/\text{CWR}\}] \\
n &= \text{weighted pupil count (TAPU)} \\
p &= \text{property value per pupil} \\
\bar{p} &= \text{mean property value per pupil} \\
y &= \text{average gross income per pupil} \\
\bar{y} &= \text{mean average gross income value per pupil}
\end{aligned}$$

- Extraordinary Needs Aid (ENA), which provides extra funds to districts with high concentration of at-risk pupils:

$$\begin{aligned}
\text{ENA} &= (3,900 + \text{Ceiling}) \times \text{ENA Ratio} \times \text{ENC} \times 0.11 \times \text{Concentration Factor} \\
\text{ENA Ratio} &= (1 - (p/\bar{p}) \times 0.40) \\
\text{Concentration Factor} &= \max\{1 + [(\text{ENC/Enrollment}) - 0.745]/0.387, 1\} \\
\text{ENC} &= \text{Free \& Reduced Price Lunch Students} \\
&\quad +\text{Limited English Proficiency Students} \\
&\quad +\text{Sparsity Count} \\
\text{Sparsity Count} &= 25\text{–(Enrollment/Square Mile)}/58
\end{aligned}$$

- Growth Aid, which supplements operating aid for districts experiencing enrollment growth:

$$\begin{aligned}
\text{Growth Aid} &= (\text{Growth Index } - 1.004) \times \text{BOA} \\
\text{Growth Index} &= \text{Enrollment/Enrollment}_{-1}
\end{aligned}$$

- Tax Effort Aid (TEffA), for districts with particularly low levels of property valuation per pupil:

$$\begin{aligned}
\text{TEffA} &= 912.48 \times \text{Tax Effort Factor} \times n \\
\text{Tax Effort Factor} &= [\min\{(\text{Tax levy}/yn) \times 100, 7\} - 3]/4
\end{aligned}$$

- Tax Equalization Adjustment (TEqA), for districts with exceptionally high tax rates:

$$\begin{aligned}
\text{TEqA} &= (\text{Expense per pupil} - \text{Tax levy per pupil}) \times n \\
\text{Expense per pupil} &= \min\{8,000, \text{AOE}_{-1}/n_{-1} - \text{BOA}/n\}
\end{aligned}$$

Years data are available: 1986-2004

Baseline year: 1986

Available data elements: CWR, AOE, enrollment (TAPU), ENC, p, y, tax levy

Issues with data consistency over the years? No; formula elements are consistent for available data years

North Dakota

The school finance plan in place North Dakota between 1986 and 2004 consisted in an equalized foundation formula:

$$R = t * p + \max\{f + T + tr - 0.0032t * p\}$$

where t is the property tax rate (capped at 0.185 and with some restrictions on its increase from one year to the other), p is the property valuation per pupil, f is the foundation base ($2,032 per pupil in 1998-99), T is a tuition apportionment ($223 per child aged 6-17 living in the school district and not necessarily enrolled in public schools), and tr is transportation aid, determined on a per district basis.

Years data are available: 1986-2004

Baseline year: 1995

Available data elements: t, p, $f + T + tr$, enrollment

Issues with data consistency over the years? No; formula elements are consistent for available data years

Ohio

The school finance plan in place in Ohio in 1986 was implemented in 1982. The formula in place is based on a foundation plan with a required minimum local effort. The formula is as follows:

$$R = \tau p + \max\{nf(C) - \bar{\tau}p\} + \tau^y y$$

where R is total revenues, f is the per pupil foundation amount, function of C (the cost of doing business), n is the weighted count of pupils, $\bar{\tau}$ is the required local effort (or "charge-off mileage", 0.23 percent in 1998-99), p is local property valuation, τ is the property tax rate chosen by the district, τ^y is the income tax rate, and y is gross income. In order for the districts to receive state aid, τ must be at least 20 mills.

The lawsuit *DeRolph vs. Ohio*, started in 1991, has led to a series of court rulings (including in 1997 and 2002) which have found the funding scheme unconstitutional and have led to an overall increase in state aid (i.e. a gradual increase in f over time). The funding formula, however, has remained the same.

Years data are available: 1986-2004

Baseline year: 1995

Available data elements: t, p, $f(C)$, t^y, y enrollment

Issues with data consistency over the years? No; formula elements are consistent for available data years

Pennsylvania

In the period 1986-2004, Pennsylvania did not have a school finance reform. Its funding formula involved a percentage-equalized foundation plan as follows:

$$R = t_1 p + t_2 y + f(0.6(1 - p/\bar{p}) + 0.4 * (1 - y/\bar{y})) * 1(0.6 * (1 - p/\bar{p}) + 0.4 * (1 - y/\bar{y}) \geq 0.4)$$

where t_1 is the property tax rate (capped at 25 mills), p is per pupil property valuation, t_2 is the income tax rate, y is per pupil taxable income, $\bar{p}$ is a statewide average of per pupil property valuation, $\bar{y}$ is a statewide average of income, and f is the foundation base.

Years data are available: 1995-2004

Baseline year: 1995

Available data elements: f, enrollment (ADM), p,y, t_1, t_2

Issues with data consistency over the years? No; formula elements are consistent for available data years

Texas

In 1986, school district revenues in Texas stemmed mainly from state aid and local revenues. State aid was provided through a Foundation Program. The foundation amount was calculated as the sum of a Basic per pupil Allotment, a supplemental Experienced Teacher Allotment (which provided extra funds to districts employing more experienced, and therefore more costly, teachers), an Education Improvement Allotment, and an Enrichment Equalization Allotment, which provided districts with a matching transfer based on district fiscal effort and wealth. Districts were required to cover a share of the total cost of the Foundation Program with local revenues, raising at least \$0.33 for every \$100 of property valuation (Stevens, 1989). The resulting revenues formula is the following:

$$R = \max\{nf(X) - \bar{\tau}_1 p\} + \tau p + e(\tau_{1i}^e, \bar{p}_1, p) + gn$$

where R is total revenues, f is the foundation amount, function of n (weighted count of pupils) and X (characteristics of the district, such as price index, small size, etc.), $\bar{\tau}_1$ is the mandatory share of local effort (\$0.33 per \$100), p is local property valuation, τ is the property tax rate chosen by the district, e is the Enrichment Equalization Allotment, which depends on the district's property valuation, the average property valuation in the state, and local effort as summarized by a reference tax rate τ_1^e, and g is a flat grant.

The formula changed in October 1989, when the Texas Supreme Court declared the state school finance system to be unconstitutional, as part of the *Edgewood* vs. *Kirby* lawsuit. The legislature responded with Senate Bill 1019, which modified the formula as follows. First, it modified some parameters of the original formula. Second, it eliminated the Equalization Allotment, substituting it with a Guaranteed Tax Yield, which provides a specified amount per weighted pupil per penny of tax effort ($\bar{p}_2$), for up to 36 cents above the local fund assignment tax rate ($\bar{\tau}_2$). The flat grant was eliminated. The resulting formula, implemented in 1991, is as follows:

$$R = \max\{nf(X) - \bar{\tau}_2 p\} + \tau p + \tau_2^e \max\{\bar{p}_2 - p, 0\}$$

Senate Bill 1019 was declared unconstitutional in 1992 (Picus and Hertert, 1993). In 1994, a new bill (Senate Bill 351) was enacted to design a new school finance scheme. The 1989 formula was preserved, but its parameters changed:

$$R = \max\{nf(X) - \bar{\tau}_3 p\} + \tau p + \tau_3^e \max\{\bar{p}_3 - p\}$$

Years data are available: 1986-2004

Baseline year: 1989

Available data elements: τ, p, $f(X)$, e, τ_2^e, p_2, τ_3^e, p_3, g enrollment (ADA/WADA)

Issues with data consistency over the years? No; formula elements are consistent for available data years

Utah

The funding plan in place in Utah between 1986 and 2004 was a foundation plan. The formula was as follows:

$$R = t * p + \max\{f - t_l * p\}$$

where t is a district's property tax rate, p are property values, f is the foundation amount, and t_l is a "required" local effort.

Years data are available: 1986-2004

Baseline year: 1995

Available data elements: f, t, p, t_l, enrollment (ADA)

Issues with data consistency over the years? No; formula elements are consistent for available data years

Wisconsin

Until 1996, Wisconsin used a two-tiered Guaranteed Tax Base (GTB) formula to allocate state aid to the districts. A third tier has been added in 1996. With this formula, the state shares part of the costs (such as operating expenses, capital outlays, and debt service) with the districts, by guaranteeing districts with a certain amount of local revenues per mill of tax levied. The formula can be summarized as follows:

$$\begin{aligned}
R &= T^1 + \max\{T^2 + T^3, 0\} + \tau p \\
T^1 &= (1 - p/\bar{p^1}) * \min\{C, \bar{C}^1\} \\
T^2 &= (1 - p/\bar{p^2}) * \min\{C - \bar{C}^1, \bar{C}^2\} \\
T^2 &= (1 - p/\bar{p^3}) * \max\{C - \bar{C}^2, 0\}
\end{aligned}$$

where R is per pupil revenue, τ is its local property tax rate, p is the district's per pupil equalized expenditure, and T^1, T^2, and T^3 are the three tiers of state aid. The variables p^1, p^2, p^3 represent per pupil guaranteed tax base in each tier, whereas $\bar{C}^1$ and $\bar{C}^2$ are the cost ceilings for the first two tiers of expenditure. In words, the state guarantees a certain level of tax revenue for different portions of the total shared costs. In addition, while a negative third-tier aid can decrease second-tier aid, a negative sum of second- and third-tier aid cannot decrease first-tier aid. In addition, districts are subject to a limit on the annual increase in their revenue per pupil derived from state aid and property taxes. In 1999, this increase could not exceed $208.88. A school district that exceeds its revenue limit is subject to a penalty, in the form of reduced state aid, in the amount of the excess revenue.

Years data are available: 1986-2004

Baseline year: 1995

Available data elements: p, τ, T^1, T^2, T^3, p^1, p^2, p^3, $\bar{C}^1$, revenue limit, enrollment

Issues with data consistency over the years? No; formula elements are consistent for available data years

Table DI: Details on the elements of the funding formula

state	data starts	data ends	reform in	variables of the formula (kept constant in simulation)	parameters of the formula
California	1996	2004		property values, enrollment	property tax rate (1 percent); revenue limit
Colorado	1994	2004	1994	assessed property value (tax base for property tax); specific ownership tax revenue (tax on registered vehicles); enrollment	per-pupil revenue formula (function of cost-of-living and enrollment)
Florida	1988	2004		property values, property tax rates, enrollment	foundation amount, limits on property tax rate, "required" property tax rate, cost-of-living adjustment
Georgia	1987	2004	1985	property values, property tax rates, enrollment	foundation amount, upper bound on equalization mills, minimum tax rate to receive guaranteed tax base aid
Illinois	1987	2004		equalized property valuation, property tax rate, enrollment	foundation amount, flat grant amount, thresholds for property values to assign tiers
Kentucky	1991	2004	1990	property values, property tax rates, enrollment	foundation amount, thresholds between tiers
Louisiana	1993	2004	1992	local revenue capacity, district enrollment, tax rates	foundation amount, state revenue capacity, state enrollment
Massachusetts	1993	2004	1994	property values, income, enrollent	foundation amount, net spending, tax rates
Michigan	1990	2004	1993	non-homestead property values, enrollment, property tax rates	foundation amount, threshold tax base
Minnesota	1991	2004	1988	enrollment, property tax rates, adjusted net total capacity (measure of property tax base)	foundation amount (basic revenue), guaranteed adjusted net total capacity
Montana	1994	2004	1993	enrollment, property values, tax rates	foundation amount, tax rate to finance the foundation amount
Nebraska	1993	2004	1990	enrollment, property values, tax rates	foundation amount
New Jersey	1988	2004	1990	property values, enrollment, property tax rates, average district income	foundation amount, property and income multipliers
New York	1986	2004		enrollment, property values, income	maximum amount of Basic Operation Amount, threshold to Ceiling for Formula aid,
North Dakota	1986	2004		enrollment, property values, income, number of children aged 6-17 living in the district	foundation amount, transportation aid, tuition apportionment
Ohio	1986	2004		property values, property tax rates, enrollment	foundation amount, cost-of-doing-business, required local effort tax rate, lower bound for tax rate
Pennsylvania	1995	2004		property values, property tax rates, income, income tax rate, enrollment	foundation amount, cap on local property tax rate
Texas	1986	2004	1989, 1993	property values, property tax rates, enrollment	foundation amount, local fund assignment tax rate, parameters of guaranteed tax yield
Utah	1986	2004		property values, property tax rates, enrollment	foundation amount, required local effort
Wisconsin	1986	2004	1996	property values, property tax rates, enrollment	guaranteed tax base in each tier, ceilings of expenditure in each tier, revenue limit

Appendix E List of School Finance Reforms

State	Reform?	Pre-Reform Formula	Reform Year	Reform Name	Reform Type	Reform Formula
Alabama	Yes	Foundation w/equalization	1995	*Ace v. Hunt*, 624 So.2d 107 (Ala. 1993)	Court-ruled	Foundation w/equalization
Arizona	Yes	Foundation w/equalization + maximum spending	1998	*Roosevelt vs. Bishop*	Court-ruled	Foundation w/equalization + maximum spending + extra aid for minimum infrastructure
Arkansas	Yes		1983	*Dupree v. Alma School District No. 30* (Ark. 1983)	Court-ruled	
			1995	Equitable School Finance Plan (Acts 917, 916, and 1194)	Legislated	Foundation w/equalization
California		Foundation + flat grant				
Colorado	Yes	Guaranteed tax base	1994	Public School Finance Act of 1994	Legislated	Foundation
Connecticut	Yes	Guaranteed tax base	1989	Education Cost Sharing	Legislated	Foundation w/ equalization
Delaware		Guaranteed tax base				
Florida		Foundaton + guaranteed tax base				
Georgia		Foundation + required local effort + equalization	1985	Quality Basic Education (QBE)	Legislated	Foundation + required local effort + equalization
Idaho	Yes	Foundation + equalization	1994	Senate Bill 1560	Legislation	Foundation (allocation based on salaries) + equalization
Illinois		Hybrid: foundation, alternate, flat grant				
Indiana	Yes	Foundation	1993	*Lake Central v. State of Indiana*	Court-ruled	Guaranteed tax base
Iowa	Yes	Foundation + equalization	1991	Code of Iowa, Chapter 257	Legislated	Foundation + equalization
Kansas	Yes	Guaranteed tax base	1992	School District Finance and Quality Performance Act (SDFQPA, 1992)	Legislated	Foundation + recapture
Kentucky	Yes	Foundation with power equalization	1990	*Rose v. Council for Better Education*, 790 S.W.2d 186 (Ky. 1989), followed by Kentucky Education Reform Act (1990)	Court-ruled	Minimum foundation with power equalization

Louisiana	Yes	Foundation	1992	Legislature	Legislated	Foundation
Maine	Yes		1985	School Finance Act of 1985	Legislated	Foundation
			1995	School Finance Act of 1995	Legislated	Foundation (minimum change in how state aid is calculated)
Maryland	Yes	Foundation	1986	Action Plan for Education Excellence (APEX),	Legislated	Foundation with required local effort
Massachusetts	Yes	Foundation	1994	*Mc Duffy v. Secretary of the Executive Office of Education*, 1993; Chapter 70	Court-ruled	Foundation
Michigan	Yes	Foundation + Guaranteed Tax Base	1993	P.A. 145 2 of 1993	Legislated	Foundation
Minnesota	Yes	Foundation	1988	General Education Revenue Program	Legislated	Foundation
Mississippi	Yes	Foundation	1997	Mississippi Adequate Education Program	Legislated	Foundation with required local effort
Missouri	Yes	Foundation + Guaranteed Tax Base	1993	Committee for Educational Equality v. Missouri; Outstanding Schools Act (OSA)	Court-ruled	Foundation with required local effort
Montana	Yes	Foundation	1993	*Montana Rural Ed. Association v. Montana*; House Bill 667	Court-ruled	Foundation + Guaranteed Tax Base
Nebraska	Yes	Foundation	1990	Tax Equity and Educational Opportunities Support Act (LB1059)	Legislated	Foundation
			1997	LB 806 (minor changes)	Legislated	Foundation
Nevada		Foundation				
New Hampshire	Yes	Foundation	1985	Statute	Legislated	Flat grant + equalization
			1999	*Claremont v. Governor*	Court-ruled	Flat grant + equalization
New Jersey	Yes	Guaranteed tax base	1990	*Abbott v. Burke* 575 A.2d 359 (N.J. 1990)	Court-ruled	Foundation
			1996	"Comprehensive Educational Improvement and Financing Act of 1996	Legislated	Foundation
New Mexico		Foundation				
New York	Yes	Percentage equalization + flat grant	2003	*Campaign for Fiscal Equity, Inc. v. State*	Court-ruled	Percentage equalization + flat grant
			2006	*Campaign for Fiscal Equity, Inc. v. State*	Court-ruled	Percentage equalization + flat grant
North Carolina		Flat grant				

North Dakota		Equalized foundation				
Ohio		Foundation with local effort				
Oklahoma		Foundation + Guaranteed Tax Base				
Oregon	Yes	Foundation	1990	Measure 5; Chapter 780, Oregon Laws 1991	Legislated	Foundation (caps on local tax rates)
			1997	Measure 50	Legislated	Foundation (caps on local tax rates)
Pennsylvania		Foundation + percentage equalization				
Rhode Island	Yes	Foundation	1995	Legislation	Legislated	Flat grant
South Carolina	Yes	Foundation	1985	Education Improvement Act (EIA)	Legislated	Foundation + categorical (with required local effort)
South Dakota	Yes	Expenditure-driven formula	1995	Legislation	Legislated	Foundation
Tennessee	Yes	Foundation	1992	Education Improvement Act	Legislated	
Texas	Yes	Foundation	1989	Edgewood Independent School District v. Kirby	Court-ruled	Foundation
			1993	Senate Bill 7	Court-ruled	Foundation (tier 1) + Guaranteed Tax Yield (tier 2) + Recapture component
Utah		Foundation + required local effort				
Vermont	Yes	Percentage equalization	1987	Legislation	Legislated	Foundation
			1997	*Brigham v. State*, followed by Act 60	Court-ruled	Flat grant + guaranteed tax yield
Virginia		Foundation				
Washington	Yes	Foundation	1987	Legislation	Legislated	Foundation + Guaranteed Tax Yield
West Virginia		Foundation				
Wisconsin	Yes	Guaranteed tax base - 2 tiers	1996	Legislation	Legislated	Guaranteed tax base - 3 tiers
Wyoming	Yes	Foundation	1995	*Campbell County v. State*	Court-ruled	Foundation