

Investing in Human Capital: Does Long-Run K-12 Investment Fuel State Economic Growth?

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School Finance 101 Policy Paper, October 2026. Suggested citation: Baker, B. D. (2026). Investing in human capital: Does long-run K-12 investment fuel state economic growth? School Finance 101 Policy Paper. Data sources, variable definitions, model specifications and full results are in Appendix B.

K-12 spending is an investment in human capital. Across states it pays off through a chain of three links: skills, then attainment, then growth. The chain shows up only when the investment is measured against what it costs to produce those skills.

- 1. Cost-adjusted spending → achievement.** States that spend adequately, measured against the cost of reaching national-average outcomes, have higher 8th-grade NAEP scores. That holds for all students and for low-income students, and their score gaps are smaller. One standard deviation of adequacy goes with about 2 NAEP points. Spending adjusted only for labor costs shows no link.
- 2. Achievement → attainment.** States whose 8th graders scored a standard deviation higher in 2003 have about 1.75 points more adults with a BA today. They also added about half a point more BA holders between 2009 and 2024, as those students reached adulthood.
- 3. Attainment and achievement → growth.** A standard deviation more BA holders in 2009 goes with 0.21 points a year faster real income growth and 0.43 points faster GDP per-capita growth over 1997–2024. A standard deviation higher on 2003 NAEP goes with 0.12 and 0.23 points faster. Over 27 years, these add up to income and GDP levels several percent higher.

Each link holds with starting income controlled. Each is an association across 50 states, not a causal estimate. Need, migration and reverse causality intrude at different points, and the sections below note where each one matters most.

The stakes are national. The states are not converging in human capital; at the top and bottom they are pulling apart. States with more college graduates in 2009 added more by 2024, and Massachusetts's GDP per capita went from 1.6 times Mississippi's in 1997 to 2.2 times in 2024. On 8th-grade math, the distance between the highest- and lowest-scoring

states is already about the distance between Japan and Turkey. America's economic and scientific future depends on whether states invest in the human capital of all their children, or let a few states lead while others fall further behind.

The human capital frame

Human capital is the stock of skills and knowledge that makes people productive. A large international literature treats schooling as an investment in that stock, with returns measured the way economists measure returns to physical capital. Three of its findings frame this brief.

1. **Schooling earns a high, durable return.** Across 1,120 estimates from 139 countries over 1950–2014, the average private return to a year of schooling is about 9% a year ([Psacharopoulos & Patrinos, 2018](#)). Estimates harmonized across 819 household surveys in 139 economies tell the same story ([Montenegro & Patrinos, 2014](#)). Causal estimates are higher, not lower: 182 instrumental-variable estimates from 55 countries average 9.7%, about 38% above the OLS estimates ([Patrinos & Psacharopoulos, 2025a](#)). As Patrinos [put it](#) on the 50th anniversary of Psacharopoulos's first comparison, returns to education remain strong.
2. **Learning, not just years in school, is what pays.** A one standard deviation gain in test scores raises earnings by about 15%, roughly one and a half times the return to an extra year of school ([Patrinos & Psacharopoulos, 2025b](#)). Among adults in 23 countries, one standard deviation of numeracy goes with 18% higher wages, and the U.S. return, 28%, is the highest ([Hanushek, Schwerdt, Wiederhold & Woessmann, 2015](#)). With learning measured directly in harmonized test data for 164 countries, human capital accounts for one-fifth to one-half of cross-country income differences, and decades of rising enrollment have produced far smaller gains in learning ([Angrist, Djankov, Goldberg & Patrinos, 2021](#)).
3. **Skills drive growth.** Across countries, one standard deviation higher achievement goes with about 1.86 percentage points faster annual growth over 40 years ([Hanushek & Woessmann](#), as summarized by [Equitable Growth](#)). An update through 2016 finds 1.3 points ([Heller-Sahlgren & Jordahl, 2021](#)). Across U.S. states, knowledge capital accounts for 20–30% of differences in GDP per capita ([Hanushek, Ruhose & Woessmann, 2017](#)). Worldwide, at least two-thirds of young people lack basic skills (24% in North America), and closing that gap is worth more than \$700 trillion in output this century ([Gust, Hanushek & Woessmann, 2024](#)).

Human capital can also be lost. Pandemic school closures cost students about 0.17 of a standard deviation, roughly half a year of learning ([Patrinos, Vegas & Carter-Rau, 2022](#)). U.S. returns to education rose after COVID ([Patrinos & Rivera-Olvera, 2024](#)), so lost skills cost more. The World Bank's new Human Capital Index Plus puts the United States at 252 of a possible 325. That is below the high-income average of 254 and well below Australia's 270, and every 10 points is worth about 10% in future income ([World Bank, 2026](#); [Stacy et al., 2026](#)).

What this brief adds. The international literature measures human capital outputs carefully, but its school inputs are usually spending per pupil, adjusted at most for prices or wages. This brief follows the same production logic across U.S. states, from investment to skills to attainment to growth. It measures the investment against the cost of producing a common level of skills, given each state's students.

How the state estimates compare with the international evidence

Once put in common units, the state estimates fall inside the range the international studies imply. State averages vary far less than individual students do. One standard deviation across states on 2003 NAEP (6.5 points) is about 0.17 of a student-level standard deviation; grade 8 math scores span about 100 points from the 10th to the 90th percentile, a standard deviation of roughly 39.

Link	International or causal benchmark	Implied for a 1-SD state difference	This brief
Achievement → GDP per capita growth	+1.86 pts/yr per student SD (Hanushek & Woessmann); +1.3 (Heller-Sahlgren & Jordahl, 2021)	+0.22 to +0.31 pts/yr	+0.23 pts/yr (95% CI 0.04–0.43)
Achievement → earnings	+15% per SD (Patrinos & Psacharopoulos, 2025b); +28% per SD of numeracy in the U.S. (Hanushek et al., 2015)	+2.5% to +4.6% earnings	+0.12 pts/yr real income growth, about 3.3% higher income after 27 years

Link	International or causal benchmark	Implied for a 1-SD state difference	This brief
Spending → achievement	+0.032 SD per \$1,000 per pupil sustained for four years (Jackson & Mackevicius, 2024)	—	About +0.012 SD per \$1,000 of adequacy
Human capital → income differences	One-fifth to one-half across countries (Angrist et al., 2021); 20–30% across states (Hanushek, Ruhose & Woessmann, 2017)	—	Attainment and achievement both predict growth with 1997 income held constant

Conversions are approximate. State NAEP here averages math and reading, while the student-level spread uses grade 8 math. International growth estimates use a PISA-scale standard deviation of about 100 points. The per-dollar figure divides the 2019 NAEP estimate by the cross-state spread in 2021–23 adequacy gaps (about \$4,500 per pupil).

Three things follow:

- **The growth link is the size the international work predicts.** +0.23 points a year compounds to a GDP per capita level about 6% higher after 27 years.
- **The funding link is, if anything, modest.** Per dollar, the cross-state association is about a third of the causal estimate pooled from U.S. school finance evaluations. That eases the concern, raised under Link 1, that student need inflates it.
- **The return runs through learning.** As in the global evidence, achievement carries the payoff, and attainment follows achievement.

Measuring the investment: four ways to count a school dollar

In human capital terms, school spending is the investment, and the question is what return it earns. Whether it appears to earn any depends heavily on which dollar is counted. There are four common ways to measure it, each correcting for more than the last:

1. **Nominal spending per pupil.** Dollars as reported. It is useless across years and misleading across places.

2. **Inflation-adjusted spending.** It fixes comparisons over time, but treats a dollar in Jackson, Mississippi as worth the same as one in Greenwich, Connecticut.
3. **Labor-cost-adjusted spending.** Divides by a regional wage index, such as NCES's Comparable Wage Index for Teachers (CWIFT). It corrects for what teachers and other college-educated workers cost in each labor market. That is necessary but not sufficient.
4. **Fully cost-adjusted spending.** Compares what a state or district spends with what it would cost to reach a common outcome goal, given its wages, its scale and density, and especially its students' needs: poverty, English learners and disability. SFID's National Education Cost Model produces exactly this measure: spending relative to the cost of national-average outcomes.

Only the fourth measure asks whether the money is enough for the job: whether it matches the cost of producing a given level of skills with the students a state actually serves. It matters most in exactly the states where policy debates focus. High-poverty states like Mississippi face required costs far above their labor-cost-adjusted spending, while affluent, low-need states face costs well below theirs. I made this case with district-level illustrations in [Illustrations: Why "Cost" Matters in School Finance Research](#). In [Efficiently Mediocre](#) I showed how spending-versus-scores charts mislead without cost. In the EdWorkingPaper with Dan Losen, [Unpacking Racial Disparities in School Spending](#), nominal spending looks modestly progressive. Measured against the cost of common outcomes, districts serving more Black, Hispanic and low-income students fall further short of adequate funding.

Brookings stops at the third measure. Brookings's recent [A State-Level Perspective on School Spending and Educational Outcomes](#) (Reber & Goodman, September 2025) concludes that state spending bears little relationship to outcomes once state poverty and income are controlled. Its main spending measure is adjusted for inflation and for wages using CWIFT, and nothing more. Its historical analysis uses inflation-adjusted spending only. Student needs enter as controls in a regression, not as costs in the spending measure. That treats a dollar spent on a high-poverty student body as worth the same as a dollar spent on a low-poverty one, then controls away the poverty that makes those dollars unequal. The weak relationship Brookings reports is what a labor-cost-only dollar produces, as the analysis below confirms. With the same states and fully cost-adjusted spending, the relationships reappear along the whole chain, from funding to achievement to attainment to growth. (On the report's other limits, see Mark Weber's [NEPC review](#).)

Data and approach

The design is long-run: K-12 conditions early in the period are compared with economic outcomes over 1997–2024. Each model controls for each state’s starting real per-capita income in 1997. Without that control, richer states would look better on everything simply because they started ahead.

Measure	Source	Years
Real GDP per capita and its growth	BEA via FRED (chained 2017 dollars ÷ population)	1997–2024
Real personal income per capita and its growth	BEA via FRED, deflated by CPI-U	1997–2024
K-12 spending per pupil, labor-cost adjusted	SFID modeled current spending per pupil (10% poverty district), in 2023 dollars ÷ NCES ACS-CWIFT	1993–2002 average
Spending adequacy, all districts and highest-poverty fifth	SFID National Education Cost Model (actual ÷ cost of U.S.-average outcomes)	2009–13 average; gap 2021–23
NAEP grade 8, all students and students eligible for free/reduced lunch	NAEP Data Service	2003, 2019, 2024
Adults 25+ with BA or higher; with a graduate degree	ACS via FRED (BA+, 2009 and 2024); ACS 2019–23 Table B15003	2009–2024

Each investment measure is standardized: effects are per standard deviation across states. Regressions use robust (HC1) standard errors on 47–50 states. Alaska and Hawaii lack the SFID spending or adequacy measures. Results that hold when resource-heavy states (AK, ND, WY, WV, NM, OK, LA) are dropped are noted.

Why adequacy is measured in 2009–13. The SFID adequacy series runs from 2009 to 2023, and the main estimates use only its first five years. The aim is timing: the funding measure should come before the outcomes it is meant to predict, which are NAEP in 2019 and 2024, attainment through 2024 and growth through 2024. A window that overlaps those outcomes invites the reverse-causality objection: states that were already growing

or improving could afford to fund schools better. Using the earliest available years is the most conservative choice. It is still not fully clean, because 2009–13 falls inside the 1997–2024 growth period. Choosing the window has little effect on the results. States' adequacy positions barely move over the period: the 2009–13 and 2019–23 averages correlate at 0.92[‡]. Every estimate holds or strengthens with later or longer windows (Appendix).

Evidence: the measure changes the answer

The labor-cost adjustment, here the NCES Comparable Wage Index for Teachers, accounts for differences in what teachers cost. It does not account for differences in how much schooling it takes to reach the same outcomes. That cost depends on child poverty, English learners, disability and district scale, and it varies far more across states than wages do. SFID's National Education Cost Model estimates it directly. In 2009–13, the per-pupil cost of reaching U.S.-average outcomes ranged from about \$6,900 (Wyoming) to \$24,000 (DC)[‡].

State	Spending per pupil 1993–2002 (2023 \$, wage-adjusted only)	Cost of U.S.-average outcomes per pupil, 2009–13 (NECM) [‡]	Actual ÷ required spending, 2009–13
Connecticut	\$14,900	\$9,000	1.74
New Jersey	\$15,700	\$9,500	1.70
Massachusetts	\$12,300	\$8,900	1.57
New York	\$15,600	\$12,700	1.50
Florida	\$10,600	\$10,800	0.80
Texas	\$9,700	\$12,200	0.69
California	\$8,000	\$12,600	0.69
Mississippi	\$9,100	\$15,800	0.51

Ratios are exp(mean log ratio), 2009–13. [‡] Dollar costs are computed directly from the SFID workbook (Appendix B).

After the wage adjustment alone, Mississippi spends about three-quarters of what Massachusetts spends. Fully cost-adjusted, it is at about half of what its students need, while Massachusetts is at more than one-and-a-half times. The two measures tell different stories about the same dollars, and only the second predicts later outcomes.

Per 1 SD, both measures in the same model (with 1997 income)	Wage-adjusted spending	Adequacy (fully cost-adjusted)
Real income growth, 1997–2024 (pts/yr)	–0.31*	+0.39*
Real GDP per capita growth (pts/yr)	–0.45*	+0.45*
Adults with BA+ (pts)	–2.42*	+2.75*
NAEP grade 8 math, low-income students, 2019	–1.71†	+2.57*

* $p < .05$, † $p < .10$. $N = 48$. Spending and required cost are in nominal dollars of their period; the adequacy ratio is unaffected by inflation.

If an analysis concludes that school spending doesn't predict growth, check which dollar it measured. A spending measure that corrects only for labor costs treats a dollar spent on high-need students in Mississippi as equivalent to one spent on low-need students in Connecticut. Correcting fully for the cost of reaching common outcomes is what reveals the relationship.

Where states stand

State	Real GDP per capita, 2024	Personal income per capita, 2024	Real income growth, 1997–2024 (%/yr)	Real GDP per capita growth (%/yr)	Spending per pupil 1993–2002 (2023 \$, wage-adj.)	Adequacy gap, 2021–23 (per pupil)	High-poverty adequacy gap	NAEP grade 8 math, 2024	Adults with BA+ (%)	Graduate degree (%)
Massachusetts	\$88,600	\$94,700	1.67	1.94	\$12,300	+\$7,600	+\$2,300	283	46.6	21.4
New York	\$92,300	\$86,800	1.42	1.62	\$15,600	+\$9,900	+\$4,600	271	39.6	17.5
Connecticut	\$79,000	\$97,800	1.33	0.84	\$14,900	+\$8,900	+\$2,300	277	41.9	19.0
New Jersey	\$71,000	\$85,500	1.08	0.86	\$15,700	+\$9,500	+\$4,400	282	42.9	17.1
Texas	\$72,500	\$70,200	1.52	1.83	\$9,700	–\$5,800	–\$12,100	269	33.1	11.9
Florida	\$57,500	\$74,900	1.53	1.25	\$10,600	–\$3,200	–\$6,300	267	33.2	12.5

State	Real GDP per capita, 2024	Personal income per capita, 2024	Real income growth, 1997–2024 (%/yr)	Real GDP per capita growth (%/yr)	Spending per pupil 1993–2002 (2023 \$, wage-adj.)	Adequacy gap, 2021–23 (per pupil)	High-poverty adequacy gap	NAEP grade 8 math, 2024	Adults with BA+ (%)	Graduate degree (%)
Mississippi	\$41,300	\$51,600	1.18	0.91	\$9,100	–\$9,300	–\$25,100	269	24.2	9.4
50-state median	\$61,300	\$69,500	1.36	1.32	\$11,100	+\$200	–\$3,900	273	33.7	12.5

The states that invest most heavily, such as Massachusetts, New York, Connecticut and New Jersey, have the highest incomes and the most educated adults. Their growth since 1997 varies widely: Massachusetts and New York outpaced the median, while Connecticut and New Jersey trailed it. Texas and Florida grew at or above the median despite large adequacy gaps. That growth most likely reflects in-migration, energy (Texas) and retiree and investment income (Florida) more than schools they built a generation ago. Florida ranks 41st on 2024 NAEP grade 8 math, 30th in GDP per-capita growth and 26th in degree attainment.

Link 1: Investment → skills (cost-adjusted spending and 8th-grade achievement)

Per 1 SD (controlling for 1997 income)	NAEP grade 8, 2013	NAEP grade 8, 2019	NAEP grade 8, 2024	Low-income students, 2019	Gap between low-income and other students, 2019
Wage-adjusted spending, 1993–2002	+1.2	+0.5	0.0	+0.2	–1.0 [†]
Adequacy, all districts, 2009–13	+3.3*	+2.1*	+1.8*	+1.2*	–1.5*
Adequacy, high-poverty districts, 2009–13	+2.8*	+1.8*	+1.4*	+1.3*	–1.9*

NAEP scale points, math and reading averaged. * $p < .05$, [†] $p < .10$; robust standard errors. $N = 48\text{--}49$.

- **Adequacy predicts achievement; wage-adjusted spending does not.** A standard deviation of adequacy goes with about 2 points on the 2019 state average, roughly 0.4 of the spread across states. For low-income students it is about 1.2 points, a third of

their spread, and the gap with other students narrows by 1.5 points. In the same model, adequacy rises to +3.3 to +4.7 points and wage-adjusted spending turns negative.

- **The link is robust to the usual checks.** It holds with the Northeast dropped (+2.2 points, N = 39). It also holds when the income of public-school families replaces state income as the control: +1.2 overall ($p \approx .08$) and +1.2 for low-income students ($p < .05$).
- **This link is the one most entangled with student need.** NECM's required cost comes from a cost function that links spending to test outcomes, given student needs. Needier states have higher required costs and, for the same reasons, lower scores. Adequacy therefore carries some of that need, and these cross-state estimates may overstate the effect of money alone. Per dollar, though, they sit below causal estimates (see the international comparison above).
- **Adequacy explains differences in levels, not gains.** From 2003 to 2019, less adequately funded states gained more on NAEP, by about 2 points per SD of underfunding, with Mississippi the leading case. That reflects catch-up from a low base and reading and accountability reforms as much as funding.

The stronger causal evidence for this link comes from school finance reforms. Funding increases driven by court orders and legislation raised achievement in low-income districts ([Lafortune, Rothstein & Schanzenbach, 2018](#)).

Link 2: Skills → attainment (achievement and adult degrees)

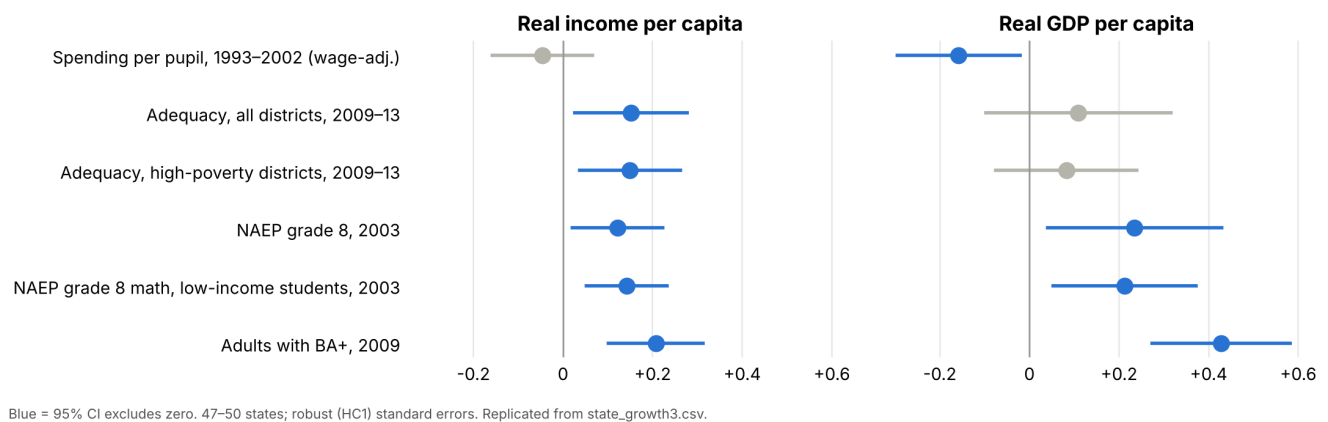
Per 1 SD (controlling for 1997 income)	Adults with BA+, 2019–23 (pts)	Change in BA+, 2009→2024 (pts)	Graduate degree share (pts)
NAEP grade 8, 2003	+1.75*	+0.49*	+0.34
NAEP grade 8 math, low-income students, 2003	+1.24*	+0.27 ⁺	+0.02
Adequacy, all districts, 2009–13 (direct)	+0.91	+0.07	+0.38
Wage-adjusted spending, 1993–2002 (direct)	–0.65	–0.23	–0.14

* $p < .05$, ⁺ $p < .10$. Across states, one SD is about 5.4 points of BA+ share and 3.0 points of graduate share.

- **Higher-achieving 8th graders become a more educated adult population.** A standard deviation higher on 2003 NAEP goes with about 1.75 points more adults with a BA today, and half a point more growth in BA holders over 2009–2024, as those students reached adulthood. The low-income students' scores show the same pattern. Both hold with resource states dropped (+1.9 and +1.5).
- **Funding works through achievement, not around it.** Adequacy's direct link to attainment is positive but not significant once income is controlled. Wage-adjusted spending shows none. Money that raises achievement shows up later in attainment; these data don't show money reaching attainment by another route.
- **Graduate degrees track income and universities more than K-12.** No K-12 measure predicts the graduate share once income is controlled.
- **Migration weakens this link most.** BA holders move toward high-wage labor markets, so a state's adult attainment reflects whom it attracts as well as whom it educates. The 2009–2024 change, which partly reflects the state's own students coming of age, is the cleaner measure.

Link 3: Human capital → growth (attainment, achievement, income and GDP)

Achievement, adequacy and attainment predict faster growth; spending alone does not
Change in annual growth rate, 1997–2024 (pct. pts), per 1 SD, controlling for 1997 income; 95% CI



BEA via FRED; SFID; NAEP Data Service; ACS. OLS of 1997–2024 annual growth on each measure plus log real 1997 income; HC1 errors. Regenerated from state_growth3.csv.

- **Attainment is the strongest predictor of growth.** A standard deviation more BA holders in 2009 (about 4.7 points) goes with 0.21 points a year faster real income growth and 0.43 points faster GDP per-capita growth afterward, with starting income

held constant. Of all the links, this one is most exposed to migration, because states that attract graduates also tend to attract the industries that employ them.

- **Achievement predicts growth too, especially low-income students' achievement.** A standard deviation higher on 2003 NAEP goes with 0.12 points faster income growth and 0.23 points faster GDP growth. Low-income students' scores predict growth about as well (+0.14 and +0.21). When resource-heavy states are dropped, the all-student effects weaken (+0.09, $p=.11$, and +0.16, $p=.08$), but the low-income effects hold (+0.10 and +0.16, $p<.05$).
- **Fully cost-adjusted funding has a direct link to income growth as well.** Adequacy, both statewide and in high-poverty districts, goes with about 0.15 points faster income growth. Adequacy is measured in 2009–13, partway through the growth period, so faster-growing states may simply have been able to fund schools better.
- **The labor-cost-only dollar points the wrong way.** On its own, high wage-adjusted spending in the 1990s goes with 0.16 points slower GDP growth. That is largely the slow-growing Northeast against fast-growing, low-spending Sunbelt and energy states. Its effect on growth is the same null-to-negative pattern Brookings reports for outcomes. Put the cost-adjusted measure beside it and the sign of the investment relationship reverses.

By income and poverty

The distributional pattern runs the same way: adequacy in high-poverty districts matters for low-income students, and low-income students' achievement matters for growth.

- **Adequacy for high-poverty districts goes with better low-income achievement and smaller gaps.** With 1997 income held constant, a standard deviation of high-poverty adequacy (2009–13) goes with 1.5 NAEP points higher grade 8 math for students eligible for free or reduced-price lunch in 2019 ($p<.05$). It also goes with a 2.1-point smaller gap between eligible and non-eligible students ($p<.01$). Spending per pupil alone predicts neither.
- **Low-income students' scores predict growth as well as the state average does.** States whose low-income 8th graders scored higher in 2003 grew faster afterward: +0.14 points a year in income and +0.21 in GDP per capita, per standard deviation. These are the estimates that hold up when resource states are dropped. A state's growth prospects depend on how well it educates the children who rely most on public schools, not only on its average.

- **Florida and Texas sit near the middle on low-income achievement despite deep adequacy gaps in high-poverty districts.** Florida's high-poverty districts are about \$6,300 per pupil short of adequacy and Texas's about \$12,100, yet their 2019 low-income NAEP math scores (267 and 270) are at or above the median. Their test-score gaps are also smaller than those of New Jersey or Connecticut, whose gaps come from very high scores among non-poor students. Some states have kept low-income scores at the median without adequate funding. The question is whether that carries through to attainment and earnings. Both states remain at or below the median on BA and graduate attainment.

The stakes: diverging states, diverging futures

The United States does not have one human capital system. It has fifty, and they are sorting into leaders and laggards. That matters for the nation, not just for each state.

Indicator	Earlier	Later
BA+ share, five most-educated states	36.0% (2009)	46.1% (2024)
BA+ share, five least-educated states	19.6% (2009)	26.8% (2024)
Gap between them	16.4 pts	19.3 pts
GDP per capita, Massachusetts ÷ Mississippi	1.63 (1997)	2.15 (2024)
Personal income per capita, Massachusetts ÷ Mississippi	1.61 (1997)	1.84 (2024)

Sources: ACS via FRED; BEA via FRED. Five-state averages are unweighted.

- **Attainment is diverging.** States with more college graduates in 2009 added more of them by 2024 (correlation 0.45). In 2024, 48% of Massachusetts adults held a BA, against 24% in West Virginia.
- **Income convergence has stalled.** For most of the twentieth century, poorer states caught up with richer ones. [Ganong and Shoag \(2017\)](#) show that convergence slowed dramatically over the past three decades, as rising housing costs in high-income places shut out less-skilled migrants. Across all states, the spread of GDP per capita barely changed from 1997 to 2024, but the extremes moved apart.

- **The skills gap between states is an international-scale gap.** In the most recent state-by-country comparison, the [2011 NAEP-TIMSS linking study](#), Massachusetts's 8th graders scored 561 in math, behind only five of 47 education systems, the closest being Japan. Alabama scored 466, statistically tied with Romania, Turkey, the United Arab Emirates and Armenia; Mississippi's predicted score was 476 ([Massachusetts DESE summary](#)). That 95-point spread is close to a full international standard deviation. Across countries, a gap that size goes with 1.3 to 1.9 points of annual growth.
- **The funding gaps behind it are persistent.** States' adequacy positions in 2009–13 and 2019–23 correlate at 0.92†. Mississippi spent about half of what its students needed in 2009–13 and was still about \$9,300 per pupil short in 2021–23, and \$25,100 short in its highest-poverty districts.

What this means. The knowledge economy concentrates where human capital is. Research universities, technology industries and scientific talent cluster in states with deep pools of skilled workers, and those states draw more of them. If current funding patterns hold, the leading states will keep compounding that advantage. The lagging states will keep producing fewer skilled workers, attracting fewer knowledge industries, and losing many of the graduates they do produce.

No state is about to become a developing country in income. Mississippi's GDP per capita, \$41,300 in 2024, is far above most of the world's, sustained by a national labor market and federal transfers. But on skills, the lowest-performing states already score alongside upper-middle-income countries such as Turkey and Armenia, and skills set the ceiling on what an economy can become. The country's capacity to lead in science, technology and economic growth depends on drawing talent from every state, not a handful. Because states and localities supply most K-12 funding, that capacity rests on state investment in human capital, measured against what it costs to build it.

Caveats, and what stronger designs find

- **Migration breaks the link between a state's schools and its adults.** College graduates move. A state's BA share and growth partly reflect the people it attracts, not the children it educates. Massachusetts imports talent; Florida imports retirees, whose investment and transfer income raises personal income without much K-12 involvement. Cross-state associations will overstate the payoff for importers and understate it for exporters.

- **Reverse causality and common causes.** Richer, faster-growing states can afford adequate schools, and the same civic and economic conditions can produce both strong schools and strong growth. The 1997 income control removes some of this, but not all of it. Adequacy is measured partway through the growth period.
- **Timing.** Children who were in school in the 1990s and 2000s are only now a large share of the workforce. A 27-year window captures the early part of the payoff at best.
- **Industry mix.** Energy states' GDP swings with oil and gas prices. Results are reported with and without them where it matters.
- **The causal evidence points the same direction.** Studies that use court-ordered school finance reforms as natural experiments find that money does matter when it is sustained. [Jackson, Johnson and Persico \(2016\)](#) find that a 10% increase in per-pupil spending for all 12 school years leads to 0.27 more years of completed education, 7.25% higher wages and a 3.67-point lower annual incidence of adult poverty. At the state level, [Hanushek, Ruhose and Woessmann \(2017\)](#) find that differences in knowledge capital account for 20–30% of state variation in GDP per capita, split roughly evenly between school attainment and cognitive skills. The findings here fit that picture. Spending matters for growth through what it buys, measured against need: achievement, attainment and adequacy. A level of spending that ignores cost differences tells us little.

The newest U.S. synthesis points the same way. Pooling school finance evaluations, [Jackson & Mackevicius \(2024\)](#) find that \$1,000 more per pupil sustained for four years raises test scores by 0.032 standard deviations and college-going by 2.8 percentage points. Internationally, the causal returns to schooling exceed the correlational ones ([Patrinos & Psacharopoulos, 2025a](#)). Both suggest that cross-sectional associations like these are more likely to understate the human capital return than to invent it.

Appendix A: Robustness to the adequacy window

Each row repeats the main models with adequacy averaged over a different window. Every model controls for log real per-capita income in 1997 and uses robust standard errors. N = 48 states; Alaska and Hawaii are not in the SFID adequacy series. Rows marked ‡ are computed directly from the SFID State Indicators Database workbook (Appendix B).

Adequacy window, per 1 SD	NAEP grade 8, 2019	NAEP grade 8, 2024	Low-income NAEP, 2019	Real income growth, 1997–2024 (pts/yr)	Real GDP per capita growth (pts/yr)	Adults with BA+ (pts)
2009–13 (main estimates)	+2.1*	+1.8*	+1.2*	+0.15*	+0.11	+0.9
2009–23 (full series)†	+2.3*	+2.1*	+1.3*	+0.18*	+0.16	+1.2
2014–18†	+2.3*	+2.2*	+1.2*	+0.18*	+0.18	+1.1
2019–23†	+2.4*	+2.3*	+1.2*	+0.20*	+0.21†	+1.0

NAEP in scale points (math and reading averaged). * $p < .05$, † $p < .10$. ‡ Computed from the SFID workbook; not reproducible from the analysis file alone.

- **The pattern is the same in every window.** Adequacy predicts NAEP for all students and for low-income students, and it predicts real income growth. Its links to GDP growth and BA attainment are positive in every window but not significant once 1997 income is controlled.
- **Later windows give slightly larger estimates.** That fits two readings. Funding closer in time to the outcome matters more: 2019–23 adequacy is the funding the 2024 8th graders actually received. Or faster-growing states raised their funding, which is the reverse-causality concern. The earliest window is the more conservative estimate, so the brief reports it.
- **States' positions are stable.** The 2009–13 and 2019–23 averages correlate at 0.92‡. States that were adequately funded early mostly still were a decade later, and underfunded states mostly still were too. Cross-state comparisons cannot tell early from sustained adequacy; only within-state changes, such as those from school finance reforms, can.

Appendix B: Technical documentation

B1. Sample and design

The unit of analysis is the state; the District of Columbia is excluded. All models are cross-sectional OLS regressions across states with heteroskedasticity-robust (HC1) standard errors. Hawaii lacks the SFID spending measure ($n = 49$). Alaska and Hawaii lack the SFID adequacy measures ($n = 48$). Alaska, Hawaii and Vermont lack the 2021–23 adequacy gap ($n = 47$). All other measures cover the 50 states.

B2. Variables

Variable	Construction	Source	Years
Real GDP per capita growth	$100 \times [(\text{GDP per capita 2024} \div \text{GDP per capita 1997})^{(1/27)} - 1]$, with real GDP (chained 2017 dollars) divided by population	BEA, via FRED series [ST]RGSP and [ST]POP	1997–2024
Real personal income per capita growth	Same formula, with 1997 personal income per capita converted to 2024 dollars using the CPI-U annual average	BEA, via FRED series [ST]PCPI; BLS CPIAUCSL	1997–2024
Starting income (control)	Log real personal income per capita in 1997, 2024 dollars, standardized	BEA, BLS via FRED	1997
Wage-adjusted spending	SFID modeled current spending per pupil for a district at 10% child poverty, converted to 2023 dollars with the CPI-U, averaged 1993–2002, divided by the state ACS Comparable Wage Index for Teachers; logged and standardized	SFID State Indicators Database 2026; NCES EDGE ACS-CWIFT 2022	1993–2002
Adequacy, all districts	Mean over 2009–13 of $\ln(\text{actual per-pupil spending} \div \text{NECM predicted cost of U.S.-average outcomes})$, state totals; standardized. Ratios shown in the text are $\exp(\text{mean})$.	SFID, National Education Cost Model	2009–13

Variable	Construction	Source	Years
Adequacy, high-poverty districts	Same, for the highest-poverty fifth of districts in each state	SFID, NECM	2009–13
Adequacy gap	Mean of NECM funding gap per pupil (actual minus required), all districts and highest-poverty fifth	SFID, NECM	2021–23
NAEP grade 8 composite	Simple average of state mean grade 8 math and reading scale scores	NAEP Data Service	2003, 2013, 2019, 2024
NAEP low-income	State mean grade 8 score for students eligible for the National School Lunch Program (math, or math and reading averaged, as labeled)	NAEP Data Service	2003, 2019
NAEP income gap	Mean score of non-eligible students minus eligible students	NAEP Data Service	2019
Adults with BA+	Share of adults 25+ with a bachelor's degree or higher	ACS 1-year via FRED (GCT1502[ST]), 2009 and 2024; ACS 2019–23 5-year, Table B15003	2009–2024
Graduate degree share	Share of adults 25+ with a master's, professional or doctoral degree	ACS 2019–23, Table B15003	2019–23
Public-school family income (robustness control)	Log income of families with children in public schools, standardized	Project analysis file (inc_pub)	—

B3. Model specification

Each main estimate comes from:

$$y_s = \alpha + \beta \cdot z(x_s) + \gamma \cdot z(\ln \text{Income}_{s,1997}) + \varepsilon_s$$

where y is the outcome for state s , $z(x)$ is the investment, achievement or attainment measure standardized across the states with data, and the control is standardized log real 1997 income per capita. β is the change in the outcome per standard deviation of x . The "both measures" models enter wage-adjusted spending and adequacy together. Scatterplots in the companion graphics are added-variable plots: both axes are residualized on the income control, so each fitted slope equals β .

Robustness samples drop resource-dependent states (AK, ND, WY, WV, NM, OK, LA) or the Northeast (CT, ME, MA, NH, RI, VT, NJ, NY, PA), or replace the 1997 income control with public-school family income. Appendix A varies the adequacy window.

For the international comparisons, the student-level standard deviation of grade 8 NAEP math is approximated as 39 points, from the 2017 10th–90th percentile range of 100 points under normality. One state-level standard deviation on 2003 NAEP (6.45 points) is therefore about 0.17 of a student-level standard deviation.

B4. Full results

OLS with HC1 standard errors; every model includes standardized log real 1997 income per capita. Coefficients are per standard deviation of the predictor. NAEP outcomes are in scale points (math and reading averaged); BA+ outcomes in percentage points; growth in percentage points per year.

Model	Outcome	Predictor (per 1 SD)	b	SE	95% CI	p	n	R ²
1	NAEP grade 8, 2019	Wage-adjusted spending, 1993–2002	+0.50	0.77	-1.00 to +2.00	0.513	49	0.24
1	NAEP grade 8, 2019	Adequacy, all districts, 2009–13	+2.12	0.58	+0.99 to +3.25	<.001	48	0.43
1	NAEP grade 8, 2019	Adequacy, high-poverty districts, 2009–13	+1.75	0.57	+0.63 to +2.87	0.002	48	0.40
1	NAEP grade 8, low-income, 2019	Wage-adjusted spending, 1993–2002	+0.19	0.56	-0.90 to +1.29	0.731	49	0.00
1	NAEP grade 8, low-income, 2019	Adequacy, all districts, 2009–13	+1.15	0.50	+0.16 to +2.13	0.022	48	0.10
1	NAEP grade 8, low-income, 2019	Adequacy, high-poverty districts, 2009–13	+1.30	0.54	+0.24 to +2.37	0.017	48	0.14

Model	Outcome	Predictor (per 1 SD)	b	SE	95% CI	p	n	R ²
1	NAEP gap, low-income vs. other, 2019	Wage-adjusted spending, 1993–2002	-1.03	0.57	-2.15 to +0.10	0.073	49	0.33
1	NAEP gap, low-income vs. other, 2019	Adequacy, all districts, 2009–13	-1.48	0.53	-2.51 to -0.45	0.005	48	0.38
1	NAEP gap, low-income vs. other, 2019	Adequacy, high-poverty districts, 2009–13	-1.92	0.38	-2.67 to -1.17	<.001	48	0.46
2	Adults with BA+, 2019–23	NAEP grade 8, 2003	+1.75	0.56	+0.65 to +2.84	0.002	50	0.65
2	Adults with BA+, 2019–23	NAEP grade 8 math, low-income, 2003	+1.24	0.43	+0.39 to +2.09	0.004	50	0.61
2	Adults with BA+, 2019–23	Adequacy, all districts, 2009–13	+0.91	0.76	-0.58 to +2.41	0.232	48	0.61
2	Adults with BA+, 2019–23	Wage-adjusted spending, 1993–2002	-0.65	0.67	-1.97 to +0.66	0.332	49	0.57
2	Change in BA+, 2009–24	NAEP grade 8, 2003	+0.49	0.18	+0.15 to +0.84	0.005	50	0.15
2	Change in BA+, 2009–24	NAEP grade 8 math, low-income, 2003	+0.27	0.16	-0.04 to +0.59	0.085	50	0.08
2	Change in BA+, 2009–24	Adequacy, all districts, 2009–13	+0.07	0.24	-0.39 to +0.53	0.777	48	0.06
2	Change in BA+, 2009–24	Wage-adjusted spending, 1993–2002	-0.23	0.24	-0.69 to +0.24	0.335	49	0.06
3	Real income growth, 1997–2024	Wage-adjusted spending, 1993–2002	-0.05	0.06	-0.16 to +0.07	0.424	49	0.07
3	Real income growth, 1997–2024	Adequacy, all districts, 2009–13	+0.15	0.06	+0.03 to +0.28	0.018	48	0.22
3	Real income growth, 1997–2024	Adequacy, high-poverty districts, 2009–13	+0.15	0.06	+0.04 to +0.26	0.009	48	0.23
3	Real income growth, 1997–2024	NAEP grade 8, 2003	+0.12	0.05	+0.02 to +0.22	0.018	50	0.19
3	Real income growth, 1997–2024	NAEP grade 8 math, low-income, 2003	+0.14	0.05	+0.05 to +0.23	0.002	50	0.26
3	Real income growth, 1997–2024	Adults with BA+, 2009	+0.21	0.05	+0.10 to +0.31	<.001	50	0.23

Model	Outcome	Predictor (per 1 SD)	b	SE	95% CI	p	n	R ²
3	Real GDP per capita growth, 1997–2024	Wage-adjusted spending, 1993–2002	-0.16	0.07	-0.30 to -0.02	0.023	49	0.09
3	Real GDP per capita growth, 1997–2024	Adequacy, all districts, 2009–13	+0.11	0.11	-0.10 to +0.32	0.301	48	0.04
3	Real GDP per capita growth, 1997–2024	Adequacy, high-poverty districts, 2009–13	+0.08	0.08	-0.07 to +0.24	0.305	48	0.03
3	Real GDP per capita growth, 1997–2024	NAEP grade 8, 2003	+0.23	0.10	+0.04 to +0.43	0.018	50	0.21
3	Real GDP per capita growth, 1997–2024	NAEP grade 8 math, low-income, 2003	+0.21	0.08	+0.05 to +0.37	0.009	50	0.19
3	Real GDP per capita growth, 1997–2024	Adults with BA+, 2009	+0.43	0.08	+0.27 to +0.58	<.001	50	0.30
Both	Real income growth, 1997–2024	Wage-adjusted spending, 1993–2002	-0.31	0.05	-0.40 to -0.22	<.001	48	0.61
Both	Real income growth, 1997–2024	Adequacy, all districts, 2009–13	+0.39	0.05	+0.28 to +0.49	<.001	48	0.61
Both	Real GDP per capita growth, 1997–2024	Wage-adjusted spending, 1993–2002	-0.45	0.11	-0.66 to -0.25	<.001	48	0.39
Both	Real GDP per capita growth, 1997–2024	Adequacy, all districts, 2009–13	+0.45	0.13	+0.19 to +0.71	0.001	48	0.39
Both	Adults with BA+, 2019–23	Wage-adjusted spending, 1993–2002	-2.42	0.55	-3.51 to -1.34	<.001	48	0.68
Both	Adults with BA+, 2019–23	Adequacy, all districts, 2009–13	+2.75	0.90	+0.97 to +4.52	0.002	48	0.68

R² includes the income control.

B5. Replication

All estimates not marked ‡ reproduce from the state analysis file with the code below, using Python 3 with pandas and statsmodels.

File	Contents
state_growth3.csv	State analysis file: growth, spending, adequacy, NAEP, attainment and standardized versions

File	Contents
fred_raw.csv, naep.csv, educ_attain.csv	Raw BEA/BLS series from FRED, NAEP state results, ACS attainment
build.py	Builds the analysis file from FRED, SFID, NCES CWIFT, NAEP and ACS
models.py, replicate.py	Estimates every model in the paper and writes the full results table
graphics.py	Produces the figures, scatterplots and maps

Estimates marked ‡ (NECM required-cost dollar figures, the 2009–23, 2014–18 and 2019–23 adequacy windows, and the correlation between windows) are computed directly from the SFID State Indicators Database workbook, available at schoolfinancedata.org. Replication files are available from the author.

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