How We Developed the National Education Cost Model

JUNE 25, 2020 — BRUCE BAKER

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Introduction

This report explains the process behind estimating the National Education Cost Model and generating from that model, projections of per pupil costs to achieve 2016 national average outcomes (reading and math grades 3 to 8) across all districts in the United States, from 2019–20 to 2020–21. This report is a follow up to a preliminary report prepared in 2018 in which we made our first attempts to estimate a national education cost model. Here, we have expanded significantly on this process, to develop a two-step method to take us from an estimated cost model using district level data on approximately 10,000 districts per year from 2009 to 2016, to a simulation of estimated costs for over 13,000 districts for 2019 through 2021. That process involves the following steps to be explained in detail in this conceptual and technical report:

Step 1: Estimating a National Education Cost Model
Step 2: Developing a Formula Simulation to Apply to District Level Data

From this formula simulation, we are then able to compare the most recent years of district level actual spending reports (fiscal year 2017) to what would be needed for children in each district to have equal opportunity to achieve a given outcome goal. Here, that modest goal is to raise the national floor to the national average of past years. Step by step, year by year, that bar can be raised.

Caveats, Cautions, and Forging a New Path for Federal Policy

From the outset, it is particularly important to understand that statistical modeling of the type used herein yields estimates. These estimates are imperfect but useful. They are guideposts where previously there were none. But, one must be careful not to overinterpret these estimates, or assume them to be exact or perfect targets for the amount of money that must be spent to precisely achieve an exact outcome. The goal of education cost modeling, whether for evaluating equal educational opportunity or for producing adequacy cost estimates, is to establish reasonable guideposts for developing more rational state school finance systems. To summarize, the goals and advantages of the approach provided herein are:

- Cost model estimates provide reasonable marks, where previously there were none.

This report can be found online at: https://tcf.org/content/report/closing-americas-education-funding-gaps/

- Specifically, they provide estimates related to common outcome goals, which was not previously possible.

- These marks can guide policy but may not necessarily dictate it.

- Introducing this evidence into deliberations over a new federal aid formula can help to "bend" public policy, specifically federal aid distribution formulas, in a better direction than if such evidence did not exist or was simply ignored.

- Ultimately, the goal of introducing rigorous empirical evidence on education costs (tied to outcomes) into formula deliberations is to achieve an end result (from the necessarily political process) that is "less bad than it might otherwise be."

Statistical cost modeling is the most appropriate method for understanding education costs, cost variation across children and settings, toward achieving a commonly measured outcome goal. Back in 2004, economist Thomas Downes of Tufts explained (in a review of cost analysis methods), that "Given the econometric advances of the last decade, the cost-function approach is the most likely to give accurate estimates of the within-state variation in the spending needed to attain the state's chosen standard, if the data are available and of a high quality."[1] In particular, significant advances in data quality, statistical computing and econometric techniques since 2004 have improved education cost modeling.[2] The primary objective of this exercise is to better understand the variation in costs toward common, measured outcome goals.

Downes focused on "within-state" variation here, because, at the time researchers lacked the ability to compare outcomes of districts across states. With the release and updating of the Stanford Education Data Archive, we now have eight years of nationally equated district level reading and math scores, grades 3 to 8. We also have a rich archive of district level fiscal, economic context and student enrollment data in the School Finance Indicators Database. Finally, two new sources of useful information have been released through the EDGE (Education Demographic and Geographic Estimates) system of the National Center for Education Statistics. First, statisticians at EDGE in collaboration with the original author Lori Taylor of Texas A&M, have produced a new Comparable Wage Index for Teachers (CWIFT).[3] In addition, the same group has produced a new Neighborhood Poverty Index for Schools which captures the poverty rages of residential surroundings for all schools nationally. These advancements are both important statistically and methodologically, but also in revealing the capacity of the U.S. Department of Education to advance the ball on endeavors equally if not even more complex than that which we propose herein.

Finally, this report includes some discussion of differences in efficiency across schools and districts nationally, toward producing common outcomes. Indeed, it is reasonable to assume that some school districts allocate their resources more efficiently than do others toward achieving a common goal. The methods we apply herein, in a world of perfect data and complete models, can theoretically be used to parse some of these efficiency differences, and some such evidence may come to bear eventually in this project. We attempt, herein, to capture variables that might predict a district's ability or likelihood of choosing to spend more than might be necessary to achieve a given outcome goal, so as not to overstate "costs" or embed excessive inefficiencies in our cost predictions. But on this point, we offer a few cautions.

- First, between-state differences are especially difficult to interpret, despite SEDA attempts to equate outcomes and Census Bureau and NCES/USDOE attempts to align spending measures. If these measures are not perfectly equated, between state differences may reflect data and measurement differences, not "real" efficiency differences.

- Second, we estimate relatively thorough models of education costs, but there are always things that go unmeasured or aren't included in these models predicting costs. Those omitted variables may lead us to false conclusions of differences either between states, or across districts within states. But,we have estimated what we believe to be a sufficiently thorough while not excessively complex set of models.

- Third and finally, the outcomes measured herein are narrow: reading and math, grade 3 to 8. Some districts identified as spending more than needed to achieve those goals, may in fact be spending to achieve other, equally important goals.

Despite the various caveats and cautions laid out here, we believe this approach and these particular estimates provide a groundbreaking opportunity for a new path forward in federal education policy—specifically, the design of a new major federal aid program to raise the bar for our nation's public schools.

Conceptions of Equity, Adequacy, and Equal Opportunity

As early as 1979, Robert Berne and Leanna Stiefel synthesized conceptual frameworks from public policy and finance and evidence drawn from early litigation challenging inequities in state school finance systems to propose a framework and series of measures for evaluating equity in state school finance systems.[4] This seminal work laid the foundation for subsequent conceptual and empirical developments regarding equity measurements applied to PK–12 settings.[5] Berne and Stiefel used two framing questions: (1) Equity of what? and (2) Equity for whom? On the "what" side, Berne and Stiefel suggested that equity could be framed in terms of financial inputs to schooling, real resource inputs such as teachers and their qualifications, and student outcomes. Berne and Stiefel's framework, however, predated (a) judicial applications of outcome standards to evaluate school finance systems and (b) the proliferation of state outcome standards, assessments, and accountability systems, first in the 1990s and then in the 2000s under the federal mandate of No Child Left Behind. The "who" side typically involved students and taxpayers—that is, a state school finance system should be based on fair treatment of both the citizens who fund public schools, and the students who attend them.

Drawing on literature from tax policy, Berne and Stiefel (1984) adopted a definition of "fairness" that provided for both "equal treatment of equals" (horizontal equity) and "unequal treatment of unequals" (vertical equity). That is, if two taxpayers are equally situated, their tax treatment (effective rate, burden, or effort) should be similar; likewise, if two students have similar needs, their access to educational programs and services or financial inputs should be similar. But if two taxpayers are differently situated (e.g., homeowner versus industrial property owner), then different taxation might be permissible. Similarly, if two students have substantively different educational needs requiring different programs and services, then different financial inputs might be needed to achieve equity.

While Berne and Stiefel provided a useful initial conception of school funding fairness, scholars of school finance eventually came to realize the limitations of horizontal and vertical equity delineations. First and foremost, horizontal equity itself does not preclude vertical equity. Equal treatment of equals does not preclude the need for differentiated treatment for some (non-equals). Further, vertical equity requires value judgments leading to categorical determinations as to just *who* is unequal, and just *how unequal* must their treatment be in order to be fair. That is, vertical equity prompts questions such as: Who needs special or additional programs and services? How intensive and differentiated must those programs and services be? What outcomes would lead us to declare a program "fair"? Federal laws (adopted in the 1970s) continue to operate under this model, applying *bright line* (you're in or you're out) categorical declarations as to who is eligible for differentiated treatment and frequently requiring judicial intervention to determine *how much* differentiation is required for legal compliance. To be clear, the focus on specific categories of disadvantaged children is important and remains necessary. But most children do not fall under the categories set forth under federal (or state) laws, such as disability status or English learner status, even though there are vast differences in needs among these uncategorized children. This ambiguity necessitates an alternative approach if education funding systems are to be reformed so as to meet the needs of all students and the goals of our society.

One such approach—one that would encompass all children and would unify existing approaches to achieve vertical equity in schools—posits that differentiated programs and services ought not be determined only by the inputs the child receives, but also by the outcomes that are expected of all children under state standards and accountability systems. That is, within the framework of *equal treatment of equals,* the treatment in question is the outcome expectation, which is equal for all children. The attainment of equal treatment thus requires the provision of appropriate programs and services to equalize their opportunity to achieve the common outcome expectation. The obligation of the state is to ensure that all children, regardless of their background and where they attend school, have *equal educational opportunity* to achieve those common outcome standards.[7]

Where appropriate programs and services are required to provide equal opportunity to achieve common outcomes (i.e. *equal treatment*), there exists a viable *equal protection* argument on behalf of the most disadvantaged children who are not presently explicitly classified under federal statutes. Equal protection requires that *similarly situated* individuals not be unequally deprived of rights. While no federal right to any level or quality of education presently exists, the right to equal protection under the Fourteenth Amendment of the U.S. Constitution applies to unequal treatment and deprivation of rights under state (or local) laws. The "right" in this case is the right articulated by many state courts (relying on state, but not federal, constitutional language) that all children should be able to achieve common outcome goals.[8] Children from low-income families and impoverished communities often attend under-resourced schools resulting in disproportionate deprivation of this right—the right to at least have equal opportunity to achieve the outcomes in question.[9]

The late 1980s and early 1990s saw a shift in legal strategy regarding state school finance systems away from an emphasis on achieving equal revenues across settings (neutral of property wealth) and toward identifying some benchmark for minimum educational *adequacy*. Politically, some advocates for this approach viewed it infeasible for states to raise sufficient state aid to close the spending gap between the poorest and most affluent districts, because achieving fiscal parity would likely require *leveling down* the amount of revenue spent on schools and the expected educational outcomes in affluent districts. Focus on a minimum adequacy bar for the poorest districts would alleviate this concern and potentially garner the political support of affluent communities who no longer had anything to lose.[10] Koski and Reich (2006) explain that this approach is problematic, in part, because minimum adequacy standards are difficult to define and because, when some are provided merely minimally adequate education but others are provided education that far exceeds minimum adequacy, the former remain at a disadvantage.[11] Further, reliance on the minimum adequacy bar is detrimental because, by tolerating an adequacy gap, it potentially creates an even larger outcome gap. Education is, in fact, is a *positional good* for which individuals compete, based on their relative position, in order to gain access to higher education and economic prosperity.[12] Setting a minimal adequacy bar effectively acquiesces to this reality; it continues to allow for a wide range of outcomes, correlated with community wealth, just so long as that range never drops below a minimal threshold.[13]

Others have adopted a more progressive *adequacy* view that focuses on state standards and accountability systems, and holds legislators accountable for providing sufficient resources for all children to meet those standards. In this view, state constitution education articles—which, unlike the federal constitution, explicitly require the state to provide its citizens with an education—are used to enforce this mandate.[14] Under the more progressive view, equal opportunity and adequacy goals are combined (but remain separable). That is, the state must provide equal opportunity for all children to achieve adequate educational outcomes. Funding must be at a sufficient overall level, and resources, programs and services must be provided to ensure that children with varied needs and backgrounds have the additional supports they require to achieve the mandated outcomes.

It remains important, however, to be able to separate equal opportunity and adequacy objectives both for legal claims and for empirical analysis. The adequacy bar can be elusive.[15] Equal opportunity is applicable to *any* level of common outcome, adequate or not. State courts are not always willing to declare that adopted assessments and outcome standards measure the state's minimum constitutional obligation.[16] Some state courts may be unwilling to delve into deliberations over "adequacy" altogether, given the fiscal implications of intervening and concerns over separation of legislative and judicial powers. These courts may be more willing to address unequal opportunities to achieve outcomes, where remedies may be achieved by redistribution of existing resources. Along similar lines, the state's ability to support a specific level of adequacy may be subject to the economic fluctuations that impact the state's ability to collect revenues.[17] Importantly, at those times when revenues fall short of supporting high (or even average) outcome standards, equal opportunity should still be preserved. That is, equal opportunity can be achieved even when the adequacy standard is lower than, equal to, or higher than a level necessary to meet targeted outcomes.[18]

Understanding Cost Variation

Providing equal educational opportunity requires that each child has opportunity to gain access to a given set of outcomes. It also requires a recognition that achieving those outcomes varies in cost from child to child, location to location, and setting to setting for a variety of reasons. It is critical to consider all factors that influence costs in an integrated manner; failing to account for these factors will lead to specious comparisons between states, school districts, and schools.

The *education cost function* is the most appropriate tool for understanding cost variation across diverse settings and student populations. Education cost function modeling has been used extensively in peer-reviewed studies of education costs and cost variation.[19] As Downes (2004) notes, "Given the econometric advances of the last decade, the cost-function approach is the most likely to give accurate estimates of the within-state variation in the spending needed to attain the state's chosen standard, if the data are available and of a high quality."[20] In particular, significant advances in data quality, statistical computing and econometric techniques since 2004 have improved education cost modeling.[21]

In this paper, we have applied education cost modeling to generate reasonable, empirically grounded estimates for the extent to which the costs of achieving current national average outcomes (by district type) vary from one school district to another, and from one state to another. Our model allows us to address the question: How much more or less does it cost to achieve national average outcomes in a district with high poverty levels than in more affluent (and predominantly white) middle-class communities? These estimates of cost variation can then be used to adjust or correct for cost differences in the value of current operating expenditures. Thus, education cost modeling—based on actual data on schools, outcomes, and student characteristics—is the most reasonable approach for determining and comparing the costs of educating students across school districts and states.

The Purpose of Cost Model Estimates

The modeling of education spending generally takes two forms: a cost perspective or a *production perspective.*[22] At their most basic levels, each answers a different but related question:

- Cost perspective: Holding all else equal, including educational outcomes, how much does a school, school district, or state spend?

- Production perspective: Holding all else equal, including spending, what educational outcomes does a school, school district, or state achieve?

For our purposes here, the cost perspective is the more relevant one. We are interested in ascertaining the cost of achieving a certain level of educational outcomes, and how that cost changes as factors such as student characteristics, geographic region, and others change. We discuss this choice further in Appendix B.

The goal of education cost modeling, whether for evaluating equal educational opportunity or for producing adequacy cost estimates, is to establish reasonable guideposts for developing more rational state school finance systems. Historically, funding levels for state school finance systems have largely been determined by taking the total revenue generated for schooling as a function of statewide tastes for taxation and dividing that funding by the number of students in the system. In this limited approach, the budget constraint—or total available revenue—and total student enrollment have been the key determinants of the foundation level or basic allotment. To some degree, this will always be true: states and localities will always have some limit on the amount of revenues they can collect and distribute for public schools. But reasonable estimates of the "cost" of producing desired outcomes, given current technologies of production, may influence the appetite for additional taxes by revealing whether the preferences regarding taxation and the desired student outcomes in public education are misaligned, and that therefore one or the other should be adjusted.

By way of analogy: Let's say an individual asserts he wants to buy a Cadillac Escalade but wishes only to spend about $25,000. After a little research, he finds that he can either buy a Ford F-150 for $25,000 or an Escalade for $65,000. The buyer may then decide to go with the Ford, or increase his spending to enable the Escalade, or choose a different car in the middle. But he can only make an informed choice after determining the true costs of his options.

This is where the empirical research we present becomes useful—by identifying the gap between uninformed assumptions and reasonably informed ones, albeit with greater precision (i.e., actual car prices, in our example above). Reasonable estimates of cost may assist legislators in setting spending levels consistent with outcome demands and in setting outcome goals that are attainable at desired spending levels. Reasonable estimates of cost may also assist courts in determining whether current funding levels and distributions (or the minimum educational achievement goals, for that matter) are unreasonable, insufficient, or otherwise substantially misaligned with constitutional or other legal requirements.

Limitations and Critiques of Cost Model Estimates

There are limits to cost model estimates. First, they provide guidance regarding the general levels of funding increases that would be required to produce measured outcomes at a certain level, assuming that districts are able to absorb the additional resources without efficiency loss—in other words, assuming that efficiency of outcome production remains constant. This is not always the case: districts may use additional revenues for all sorts of programs or services. This additional spending is "inefficient" only in the sense that it does not contribute to improving the educational outcomes we measure. That is not to say this spending does not help districts achieve other goals important to the community or society in general: spending on sports programs, for example, may be desirable, but do not necessarily increase statewide accountability test scores. Cost models, therefore, are limited by the outcome measures employed within them.

Moreover, cost model estimates are not well suited to measuring the impact on short-term measures. For example, they cannot predict student outcomes *next* year if we adopt a state school finance system based on them *this* year. Studies of school finance reform suggest that school finance reforms must be both substantive and sustained in order to be successful.[23] Moreover, the immediacy of outcome changes due to funding increases depends on what is being funded. If additional dollars to high-need districts are leveraged toward high-quality preschool programs and/or class size reductions in the early grades, we are unlikely to see changes to college readiness outcomes in the following year (or even in the following five years). Similarly, if the additional dollars are leveraged toward increasing salaries of teachers in the years of employment in which they are most effective, thereby allowing districts to recruit and retain more skilled teachers over time, we are also unlikely to see immediate returns in student test scores.

Some critics of education cost analysis in general, and cost function modeling in particular, assert that these practices accept inefficient school policies as a given and fail to take into account cost-saving policy changes. For example, they point to the fact that local public school districts (inefficiently, in their opinion) pay their personnel based on parameters not associated with improved student outcomes.[24] Therefore, the critics assert, it is useless to consider the current spending practices of school districts when trying to determine how much needs to be spent to achieve desired outcomes in the future. If instead, they argue, school districts paid teachers based on the test scores their students produce, and if school districts systematically dismissed ineffective teachers based on those test scores, then productivity would increase dramatically and spending would decline. Educational adequacy, they assert, could be achieved at much lower cost; therefore, estimating costs based on current conditions or practices is a meaningless endeavor.[25]

The most significant problem with this logic is that there is no empirical evidence to support it. It is entirely speculative, based on the assertion that teacher workforce quality or effectiveness can be improved, with no increase to average wages, simply by firing the poorest performing (say, the bottom 5 percent) teachers each year and paying the rest based on the student test scores they—or, more accurately, their students—produce. To return to the car purchasing analogy above, this is like assuming that somewhere out there is a vehicle with all the features of the Escalade but the price of the F-150—specifically, a version of the Escalade produced by a new, yet-to-be-discovered technology with materials not yet invented, that allow that vehicle to be sold at less than half its original price. This is, to put it bluntly, no more than wishful thinking. And so, while some may criticize cost modeling as being constrained by current realities, they fail to provide a sound, alternative basis for making a judicial determination regarding constitutionality of existing funding or for informing statewide mandates or legislation.[26] Whatever their limitations, cost model estimates, as well as the recommendations of professionals and expert panels, can still serve to provide useful, meaningful information to guide the formulation of more rational, equitable, and adequate state school finance systems.

Applying the Education Cost Function

The dominant modeling approach in recent peer-reviewed literature for the district level education cost function is one in which:

a) the dependent measure is a measure of current operating expenditures per pupil;

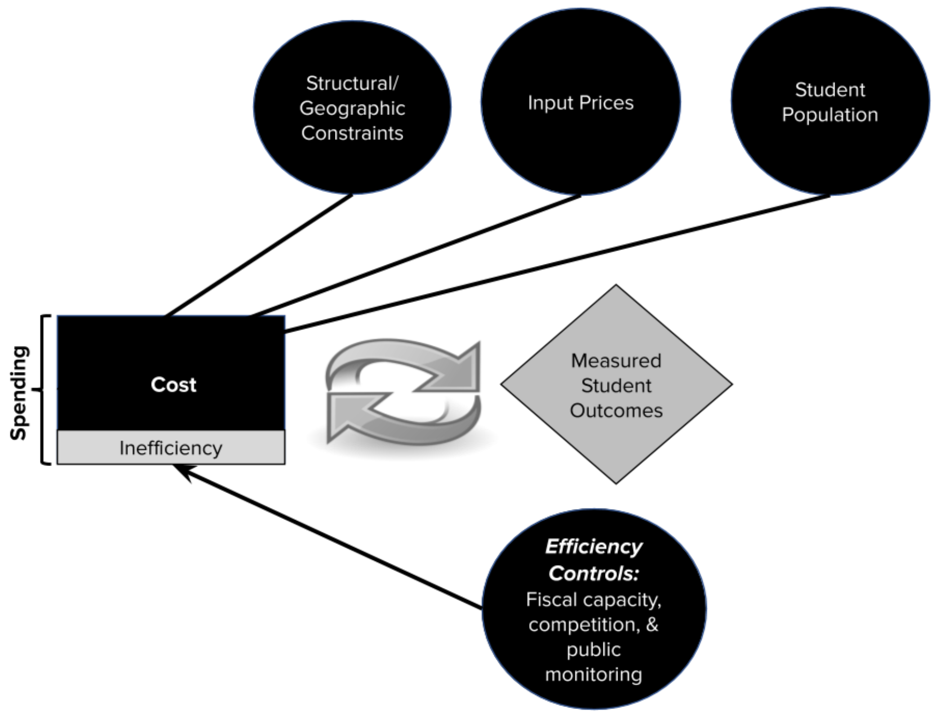
b) student outcome measures are treated as "endogenous" and instrumented using measures of the competitive context within which local public school districts operate; and

c) attempts are made to control for inefficiencies in the spending measure by including measures of variations in fiscal capacity and local public monitoring.

This approach is largely the product of years of peer-reviewed cost function estimation by William Duncombe, John Yinger and colleagues of the Maxwell School at Syracuse University. Here, we provide the rationale for this approach.

These issues are statistically complicated but necessary for teasing out the relationship between school district spending and measured student outcomes. Figure 1 provides an overview of the issues listed above. Our goal is to elicit from district spending data the "cost" of achieving specific outcome levels. We are setting up a model in which we predict spending levels from educational outcomes (narrowly measured as student achievement in Math and Language Arts), and other factors, rather than predicting outcomes from spending levels. As such, we must take statistical steps to correct for the fact that spending is influenced by outcomes, while, simultaneously, outcomes are also affected by spending (the circular/feedback loop relationship in the picture). More spending can lead to better student outcomes, as increased funding can be used to

FIGURE 1



reduce class sizes, recruit better-qualified personnel, provide support services, and so on. However, higher outcomes in a community may drive increased spending, as homeowners desire to have their schools continue to be perceived as high-performing, thus keeping their property values relatively high. In this case, there is no clear causal direction: the two factors affect each other simultaneously. The relevant statistical approach to isolate the causal effect of outcomes on spending (distinct from the effect of spending on outcomes) is to use a two-stage model in which we use exogenous (outside the loop) measures of each district's competitive context to correct for endogeneity (inside the loop feedback) in the outcome measure. A more extensive, technical explanation is provided in Appendix A.

In general, the main (second stage) equation of the education cost function is one in which a measure of current operating expenditures is expressed as a function of the outcomes achieved at those expenditure levels, the students served by school districts, a measure of variation in competitive wages (Input Prices) for teachers, structural characteristics of the school district such as grade ranges served, the size of the school district (perhaps coupled with other location factors such as sparsity or remoteness), and any factors that might produce inefficiencies in the spending measure. The equation may be expressed as follows:

$$\textbf{Spending}_{dj} = \textbf{f(Outcomes}_{dj}\textbf{*, Students}_{dj}\textbf{, Input Prices}_{dj}\textbf{, Structure}_{dj}\textbf{, Scale}_{dj}\textbf{, Inefficiency}_{dj}\textbf{)}$$

*endogenous

Where *Spending* is a measure of current per pupil operating expenses in district "d" in year "j"; Outcomes are the outcome measure(s) of interest; *Students* is a matrix of student need and demographic characteristics for district "d" in year "j"; *Input Prices* is a measure of geographic variation in the prices of key inputs to schooling such as teacher wages; *Structure* is a matrix of district structural characteristics such as grade ranges served; *Scale* is a measure of economies of scale usually expressed in terms of student enrollments and, in some cases, also addressing population sparsity; and *Inefficiency* is a matrix of variables which predict variation in spending but are not related to commensurate shifts in outcomes.

Another issue we must deal with is the fact that not all school district spending is efficient spending, or by statistical definition here, spending which contributes directly to the measured outcomes. In any given school district, some part of current spending contributes directly to the measured student outcomes used in the model, given the students served, salaries of teachers, and the structure, size, and location of the school district. The objective of the cost function is to identify the levels of spending associated with achieving specific outcome levels under different circumstances and across varied student populations, holding factors associated with inefficiency constant.

In the modeling approach used here, we include measures which research literature identifies as predictors of differences in district spending not directly associated with outcomes (i.e., inefficiencies). These include measures of local district competition density and measures influencing local public monitoring of public expenditures (share of aid coming from non-local sources and proportions of local population that is school-aged). A more extensive discussion of controlling for efficiency is included in Appendix B.

From Model Estimates to a National Cost Simulation

The goal of this project is to generate district, state and national level cost estimates through school year 2021–22 for raising the floor of educational opportunity in U.S. schools. Specifically, raising that floor to national average levels in the most recent year of equated outcome data from the Stanford Education Data Archive—2016. This involves a three-step process.

- First, we estimate education cost models per the specifications laid out in the previous section, using data from 2009 to 2016 on education spending, outcomes and a variety of factors influencing the cost of achieving those outcomes. These cost models allow us to estimate predicted costs per pupil for all districts with complete data for the years of data in the model (2009 to 2016). We can use these district level cost predictions in the next step of the process.

- Second, we take the district level predicted costs and identify a simplified set of "cost factors" that can be used in a simulated funding formula. We fit a model relating these factors to the predicted costs, with the purpose of generating a set of weights for use in predicting per pupil costs for all districts in future years. Here, because part of our concern is to estimate year over year change (inflation) to predict future years, we included only data from 2012 to 2016 (to remove lagged and negative growth during the recession).

- Third, we use the weights estimated in the second stage, to build a simulation to generate per pupil cost estimates for all districts, nationally, for 2019–20, 2020–21 and 2021–22 using forecast enrollment data (linear trend). We compare these cost estimates to the most recent available current spending per pupil data (2017) to determine spending gaps.

Through these steps, some data elements change. Estimation of the cost model requires that we meet certain statistical requirements and requires a sufficiently thorough model which may be unnecessarily complex for simulating later costs. Further, some data collections or measures have been discontinued and/or replaced in recent years. Thus, it is important to make the transition from the previous version to the new version when moving from the cost modeling stage to the forecast, simulation stage.

Step 1: Model Estimation

Model estimation involves data elements from the following three data sets:

- School Finance Indicators Data System (SFID)[27]

- Stanford Education Data Archive[28]
- NCES EDGE System, School Neighborhood Poverty Index[29]

TABLE 1

	Aggressive Estimates[1]		Conservative Estimates[2]	
	Estimate	R.S.E.	Estimate	R.S.E.
Outcome Index	1.619***	0.083	1.103***	0.044
Education Comparable Wage Index	0.446***	0.033	0.514***	0.028
Student Needs				
Adjusted Poverty Rate	3.106***	0.172	2.126***	0.092
State Mean Centered SWD Rate	2.363***	0.123	2.040***	0.096
% ELL	0.976***	0.085	0.618***	0.059
Grade Ranges Served				
% Enrollment in Pre-k	0.371***	0.131	0.316***	0.103
% Enrollment in Secondary Grades	0.549***	0.038	0.492***	0.030
Economies of Scale				
Less than 100 Students	0.601***	0.096	0.609***	0.076
101 to 300 Students	0.370***	0.018	0.348***	0.014
301 to 600 Students	0.213***	0.014	0.208***	0.011
601 to 1200 Students	0.130***	0.011	0.126***	0.009
1201 to 1500 Students	0.094***	0.013	0.089***	0.011
1501 to 2000 Students	0.086***	0.012	0.082***	0.010
Log of Population per Square Mile	-0.032***	0.005	-0.020***	0.004
Efficiency Factors				
% Population between 5 and 17 yrs of age	-0.084	0.090	-0.038	0.070
Ratio of Housing Values to Surrounding Districts	-0.300***	0.023	-0.178***	0.015
Herfindahl Index	-0.017	0.033	-0.067**	0.029
Year	-0.004***	0.001	-0.004***	0.001
Constant	17.110***	2.283	15.512***	1.845
Number of observations	92,039		92,039	
R2	-1.051		-0.306	

Note: *** p<0.01, ** p<0.05, * p<0.1
R.S.E. = Robust Standard Errors (clustered on district I.D.)
[1] Excluded instruments: School Neighborhood Poverty Index (mean of surrounding districts), percent of surrounding district enrollment that is black or Hispanic
Partial F of Instruments = 256.97 (R^2 = 0.0453)
Hansen J = 0.097 (p-value = 0.7552)
[2] Excluded instruments: School Neighborhood Poverty Index (mean for district's own schools), percent of surrounding district enrollment that is black or Hispanic
Partial F of Instruments = 708.51 (R^2 = 0.0923)
Hansen J = 22.754 (p-value = 0.0000)

Per the specifications laid out in the previous section, we estimate a 2 stage least squares (2SLS, or instrumental variables) model using data from 2009 to 2016. The panel includes 11,000 to 12,000 local public-school districts per year (of about 13,000). We generate an outcome index by collapsing standardized assessments to district averages (grades 3 to 8 reading and math) using data from the Stanford Education Data Archive. Data on school district spending and other district characteristics are from the SFID, which combines data from a variety of sources. Our spending measure is the district level current operating spending per pupil (PPCSTOT in the Census fiscal survey).

As one of our "exogenous" instruments, we take advantage of the new, School Neighborhood Poverty Index, developed by researchers at the National Center for Education Statistics. This measure uses census data on characteristics of resident populations near schools to generate a poverty index value for all schools in the country. We use these resident population characteristics as a predictor, in our first stage models, of our outcome index. In one version (the conservative model) we use the outcome index for all schools in the observed district itself. This shifts some of the poverty influence onto the outcome index (which is highly associated with poverty) and reduces our poverty weight in the simulation. In the alternative version, we use

TABLE 2

MODEL WEIGHTS ESTIMATE

	Simulation Weights Aggressive		Simulation Weights Conservative	
	Estimate	S.E.	Estimate	S.E.
Comparable Wage Index for Teachers (CWIFT)[33]	5,912.284***	174.220	7,798.815***	44.065
Student Needs				
Adjusted Poverty Rate	40,948.753***	196.062	26,293.087***	49.590
State Mean Centered SWD Rate	32,630.489***	578.737	28,446.256***	146.379
% ELL	15,793.171***	206.136	8,127.892***	52.138
Grade Ranges Served				
% Enrollment in Pre-k	1,895.790***	697.217	4,531.004***	176.346
% Enrollment in Secondary Grades	6,937.937***	130.735	6,177.455***	33.067
Economies of Scale				
Less than 100 Students	10,549.981***	550.084	9,155.322***	139.132
101 to 300 Students	5,630.401***	188.187	4,533.382***	47.598
301 to 600 Students	3,078.293***	124.666	2,556.467***	31.532
601 to 1200 Students	1,856.980***	80.110	1,513.616***	20.262
1201 to 1500 Students	1,322.727***	106.288	1,051.193***	26.883
1501 to 2000 Students	1,305.024***	84.663	1,006.608***	21.414
Population Density				
Less than 30/ sqmile	384.030***	81.762	5.908	20.680
30 to 100/ sqmile	187.474***	52.917	-27.219**	13.384
100 to 150/ sqmile	306.941***	64.466	79.806***	16.305
year	180.109***	11.062	235.930***	2.798
Constant	-367,560.949***	22,286.267	-478,617.384***	5,636.837
Number of observations	65,377		65,377	
R2	0.644		0.925	

note: *** p<0.01, ** p<0.05, * p<0.1

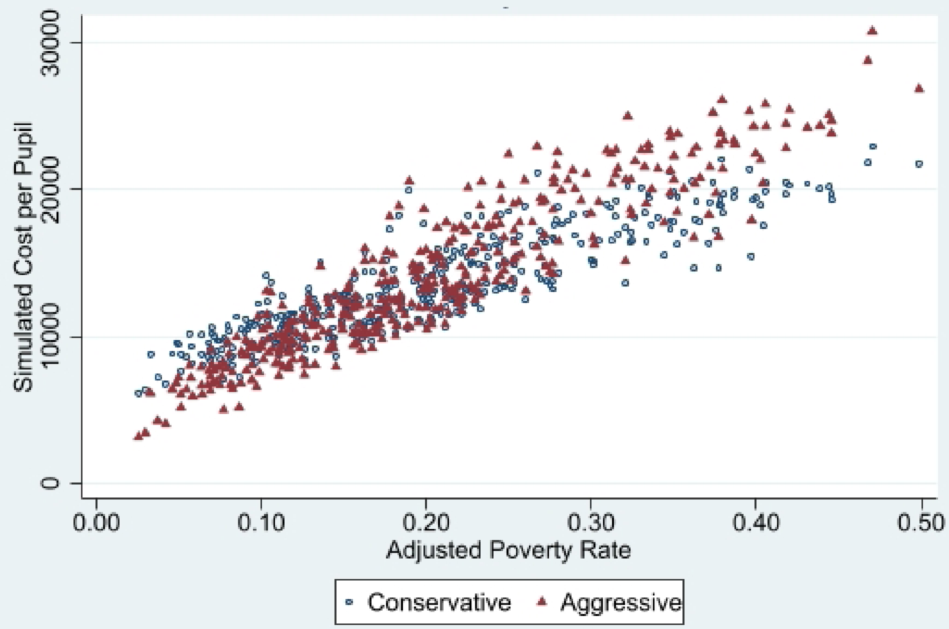
the poverty index of schools in all other districts (other than the observed) in the labor market. This is less predictive of the outcome measure, and leads to a larger second stage poverty weight in our cost model. This version of the poverty index instrument is also more purely exogenous (and passes the relevant statistical tests). As such, this model is preferred.

Table 1 provides the cost model estimates for our two alternative models. First and foremost, we find that higher outcomes are associated with higher per pupil costs. That is, it costs more to achieve higher outcomes. As such, to move districts that are below current average outcomes to those outcomes will require higher spending, holding constant the efficiency factors in the model.

It also costs more to achieve common outcome goals where teacher wages are expected to be higher. Costs are higher in districts serving higher poverty student populations. In our models, we adjust poverty rates per the methods laid out by Baker and colleagues, to account for the fact that Census poverty rates apply the same income thresholds from place to place, despite vast differences in the quality of life attainable at any given income threshold.[30] Because of large differences in average disability classification rates across states (some having classification rates that are depressed by policy pressures)[31] we adjusted special education rates for all districts around their state's average rate. Thus, our special education measure doesn't capture differences in special education costs across states, but does capture differences across districts within states, which are large and positive. How each of these factors plays out across districts will be easier to understand as we translate these model coefficients to dollar value differences, and simulate funding district by district.

FIGURE 2

PER PUPIL COST ESTIMATES CONSERVATIVE AND AGGRESSIVE COST MODELS, BY POVERTY RATE



Step 2: Simulation Weights Estimation

Next, we take the predicted per pupil costs for our panel of about 11,000 districts and fit a new regression model to those predicted costs, in an attempt to identify more usable weights for a funding formula simulation. Because we also want to identify the change over time—inflation effect—we use data from 2012 to 2016 (removing recession years and focusing on the most recent five years). Here, because we want the simulations to be annually updatable into future years, as additional data become available, we use the new Comparable Wage Index for Teachers (CWIFT),[32] which should be a similar predictor of cost variation to the earlier version (given that it is based on the same conceptual approach as the previous wage index). To avoid having a simulation using a complicated measure like the "natural log of population density," we create density categories which result in weights/adjustments for each category, similar to our enrollment size categories.

Because our predicted costs per pupil are based on a common outcome goal (holding outcomes for all districts at the national average) and at common efficiency expectations (holding our efficiency measure at national averages), these factors can be removed from this model (that is, they are held constant/same for all districts). Here, the goal is to focus on the cost factors that vary across districts which can be translated into formula simulation weights.

Table 2 summarizes our regression models predicting the per pupil cost estimates from the conservative and aggressive cost models. The main differences are in the magnitude of the poverty effect, which are easiest to understand in Figure 2. Table 2 indicates that in the aggressive model, a district with 100% children in poverty would require about $41,000 more per pupil than a district with 0% children in poverty, and in the conservative model that difference would be about $26,000. Those numbers certainly seem large, but Figure 2 (excluding small districts) shows us that the practical range of child poverty is from near 0% to between 40 and 50%, so the differences in costs per pupil from the actual lowest to highest poverty districts are only about half the estimated range. And, the two models are not strikingly different. For high poverty districts, the more aggressive model (which has more desirable statistical properties) leads to per pupil cost estimates that are about $5,000 per pupil higher in the highest poverty districts (or about 20% higher).

FIGURE 3

PER PUPIL COST ESTIMATES CONSERVATIVE AND AGGRESSIVE COST MODELS,

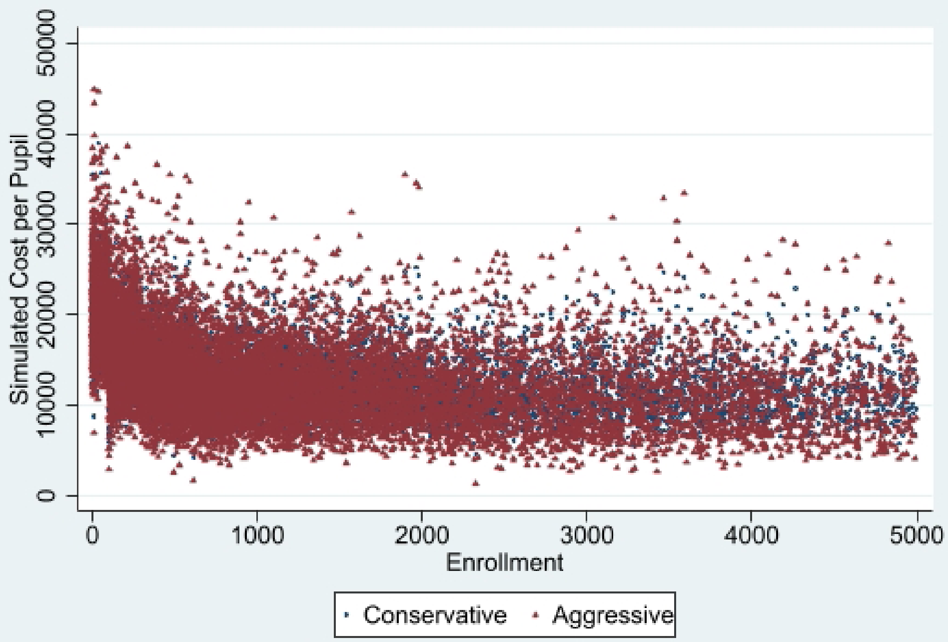


Figure 3 shows the "economies of scale" effect of the two models. The step-down per pupil cost adjustments for both models are quite similar, with the smallest districts (<100 enrollment) having per pupil costs that are about $10,000 more per pupil than the "base" cost of around $10,000, or about double the per pupil costs of larger districts. Scale related costs drop sharply and level off for districts with over 2,000 pupils, consistent with prior studies.[34]

Overview of Simulation and ost Model Findings

Here I provide a more detailed review of the simulated cost estimates for years 2019–2021 and comparisons of those estimates with actual current spending per pupil for FY2017 (the most recent available year of federally reported data).

Simulate Weighted Formula

Using the weights derived in the previous step, we construct a formula simulation which we apply to 13,107 local public school districts for years 2019 to 2021. Note that there are a total of 14,280 local public school districts reporting fiscal data in 2017. SEDA includes 10,240 districts in 2016. We have sufficiently complete data on other attributes of local public school districts to get our cost prediction count back up over 13,000 but not yet to the full 14,280, some of which are fiscally independent charter schools and other special schools and service centers. This requires making some assumptions about the enrollments and demographics of districts in future years. We apply the following simplified assumptions:

- Demographics held at average from 2012 to 2017
- Enrollments linear forecast based on trend from 2012 to 2017

Demographics includes maintaining the same population density group. Enrollment change may affect which enrollment size group into which a district falls.

FIGURE 4

OUTCOME GAP FOR AGGRESSIVE COST MODEL, BY SPENDING GAP PER PUPIL

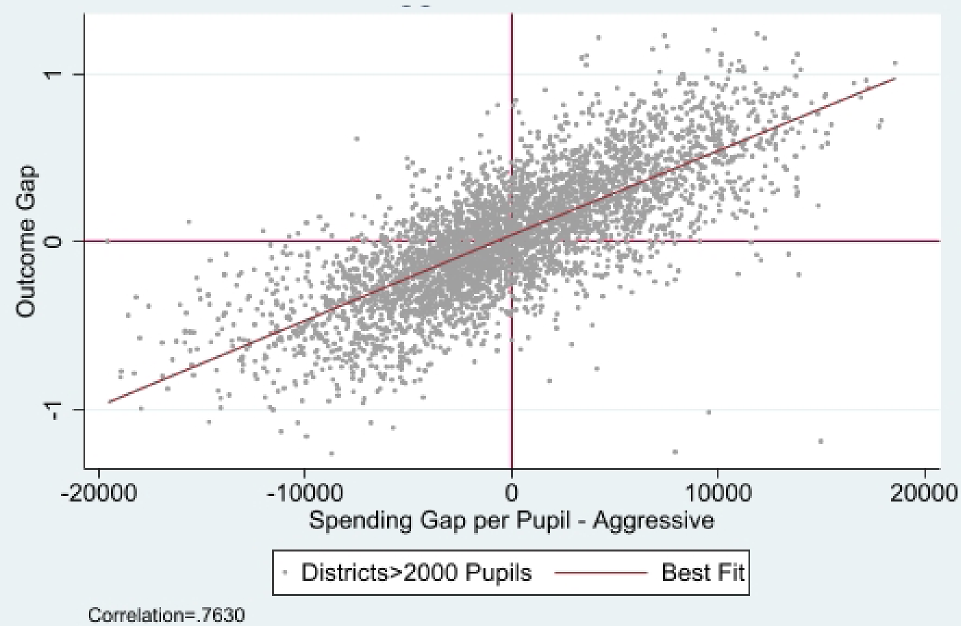


FIGURE 5

OUTCOME GAP FOR CONSERVATIVE COST MODEL, BY SPENDING GAP PER PUPIL

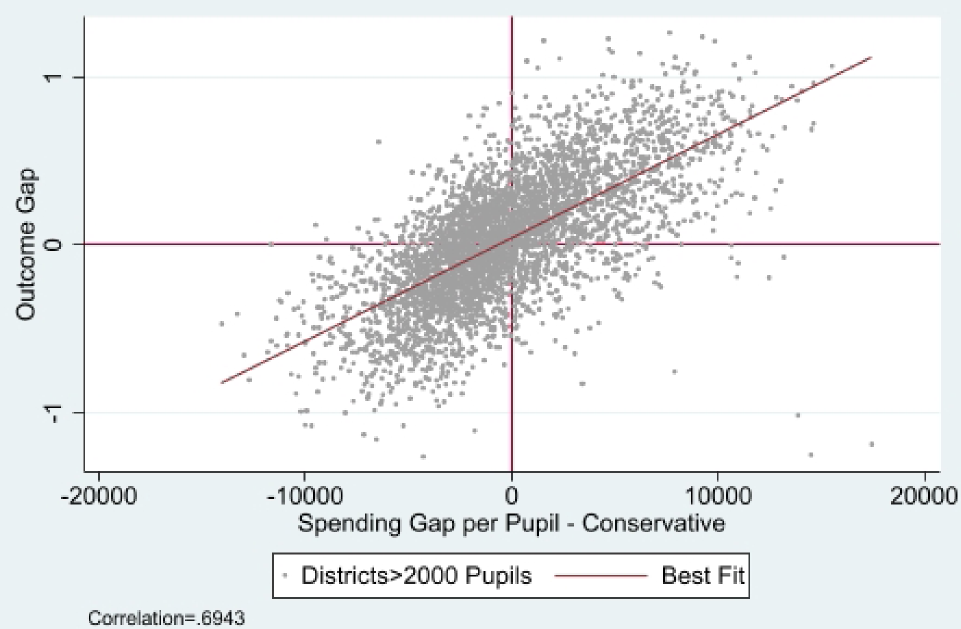


FIGURE 6

SIMULATED FUNDING GAPS NATIONWIDE, AGGRESSIVE MODEL

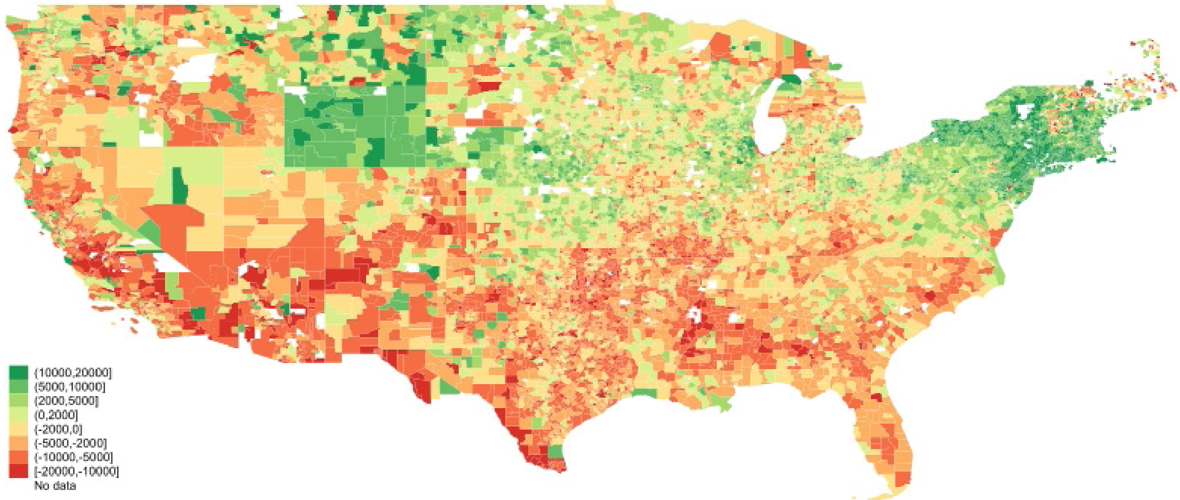


FIGURE 7

SIMULATED FUNDING GAPS NATIONWIDE, CONSERVATIVE MODEL

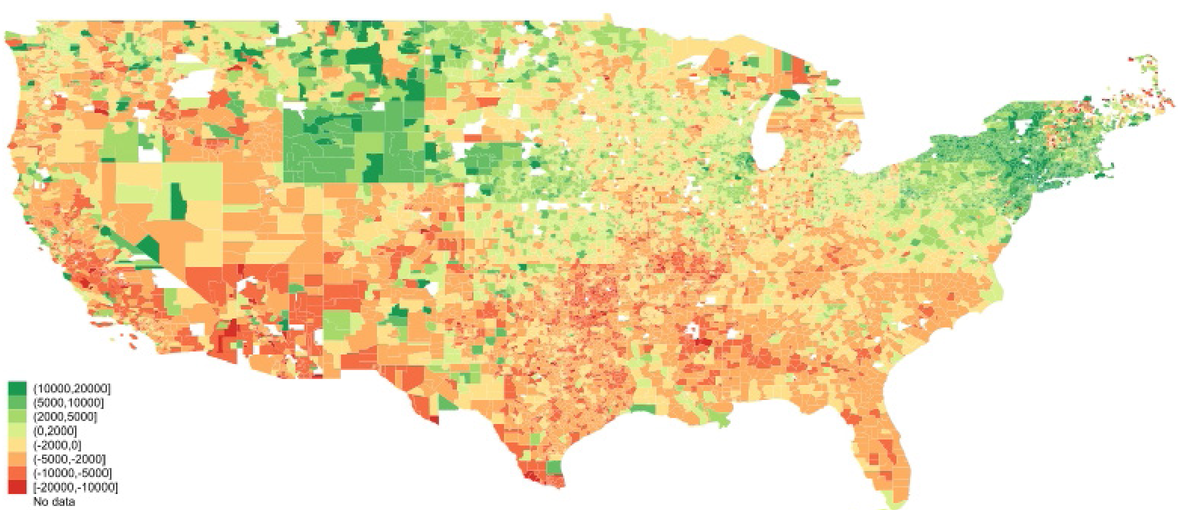


FIGURE 8

SIMULATED FUNDING GAPS NATIONWIDE, AGGRESSIVE MODEL, SPOTLIGHT ON PHILADELPHIA

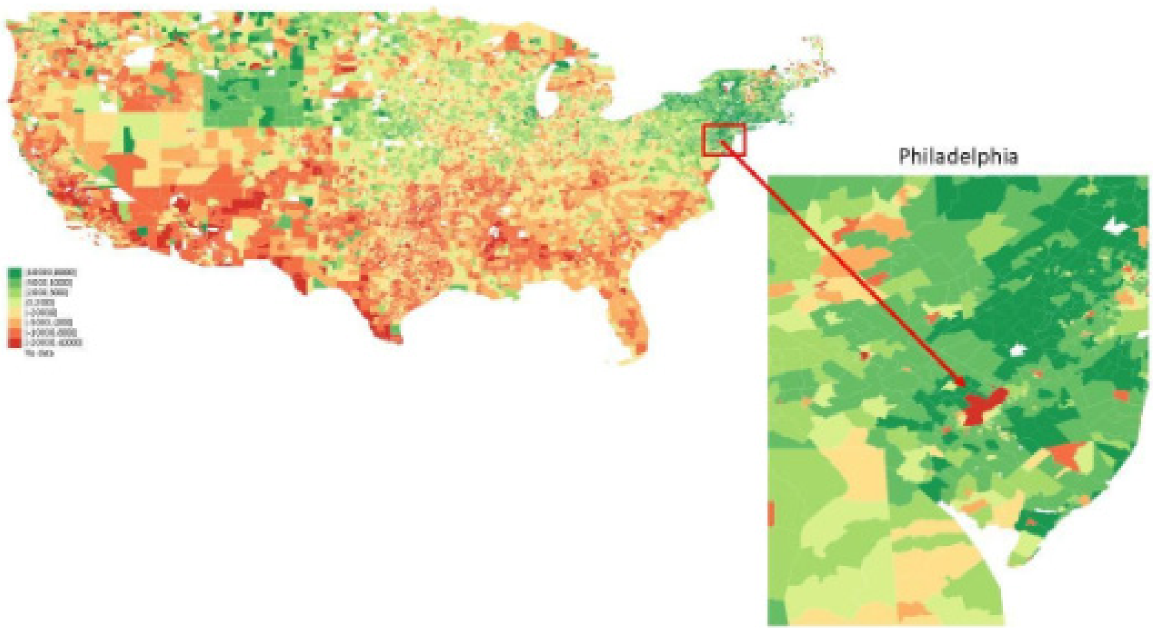


FIGURE 9

OUTCOME GAP FOR AGGRESSIVE COST MODEL IN PENNSYLVANIA, BY SPENDING GAP PER PUPIL

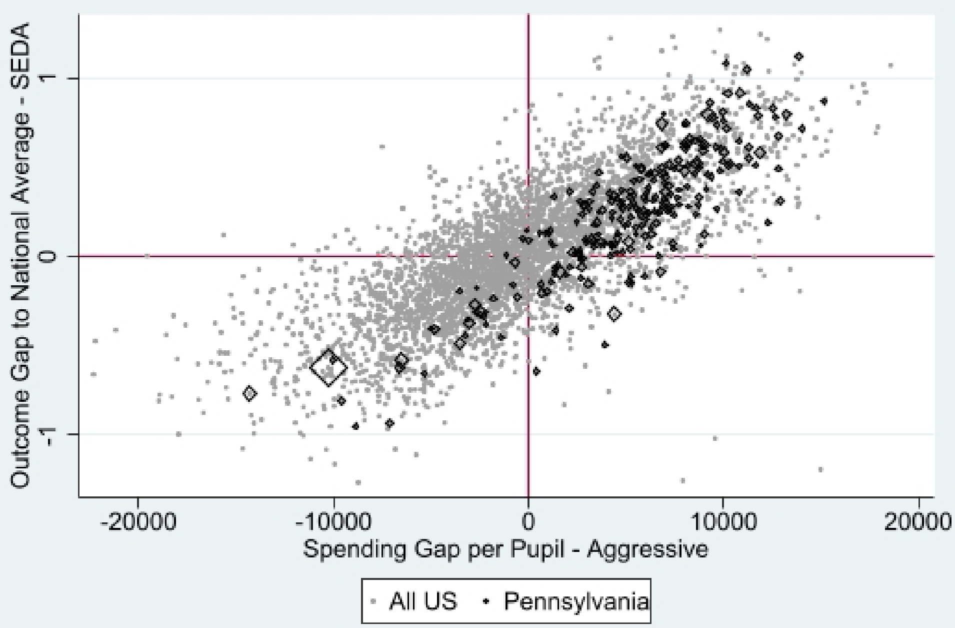


FIGURE 10

OUTCOME GAP FOR AGGRESSIVE COST MODEL FOR NEW JERSEY, BY SPENDING GAP PER PUPIL

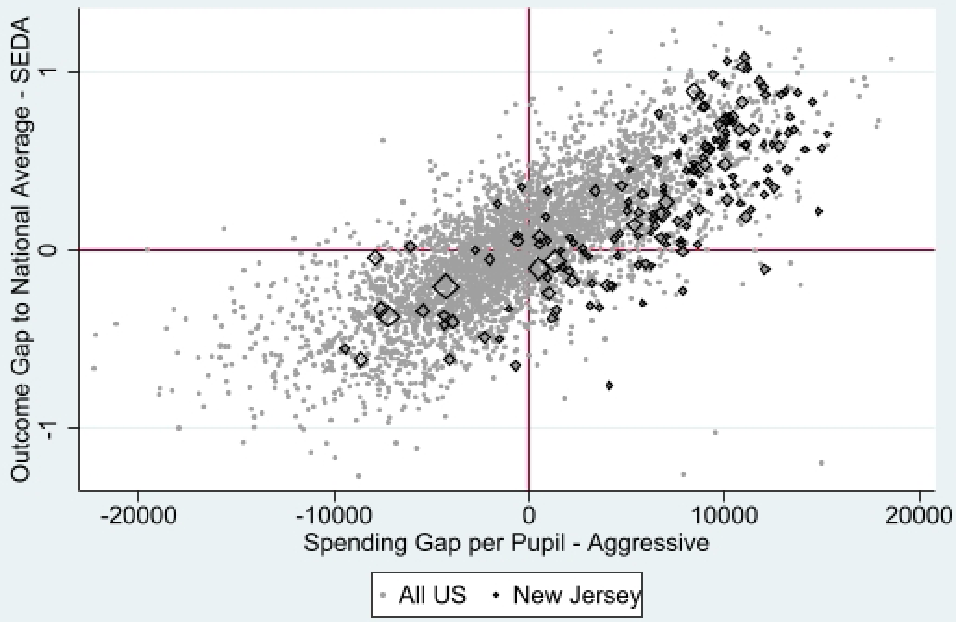


FIGURE 11

OUTCOME GAP FOR AGGRESSIVE COST MODEL IN MASSACHUSETTS, CONNECTICUT, CALIFORNIA, ARIZONA, COLORADO, AND KANSAS, BY SPENDING GAP PER PUPIL

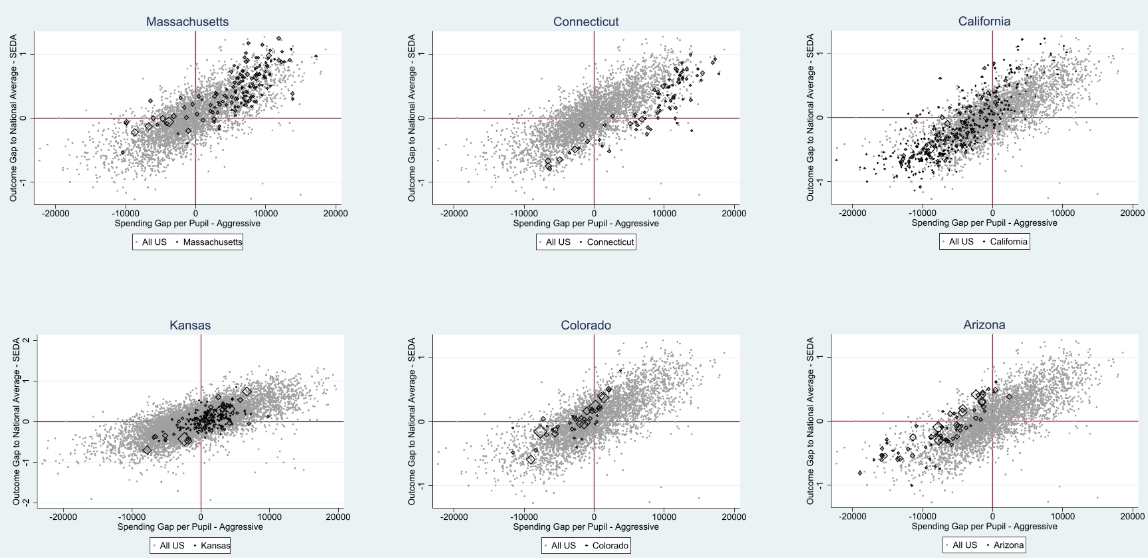


FIGURE 12

OUTCOME GAP FOR AGGRESSIVE COST MODEL FOR MICHIGAN, OHIO, TEXAS, MARYLAND, AND LARGE DISTRICTS, BY SPENDING GAP PER PUPIL

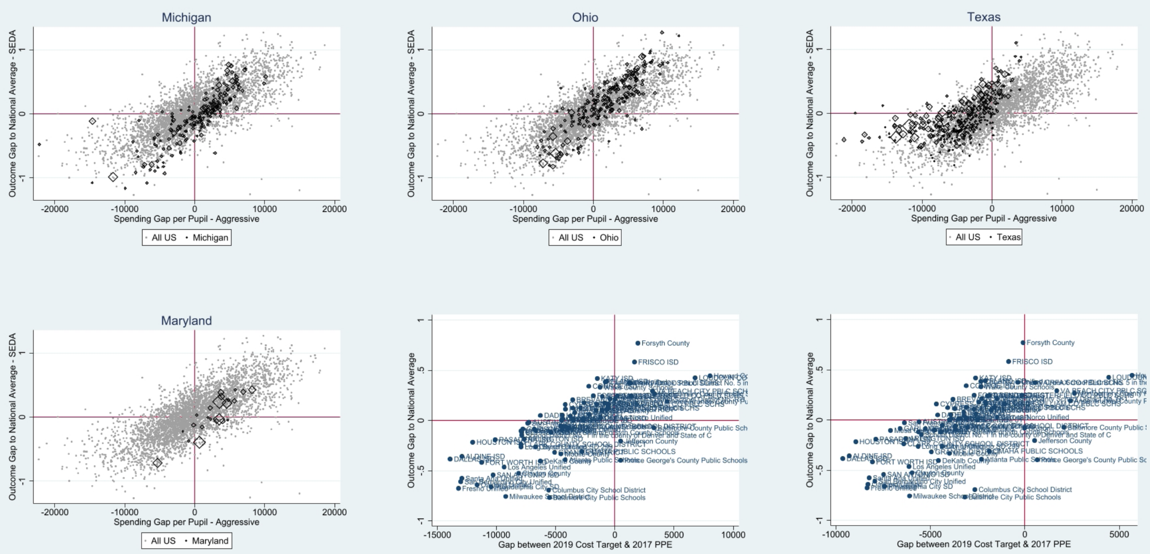


FIGURE 13

SCHOOL STAFFING RATIOS FOR AGGRESSIVE COST MODEL, BY SPENDING GAP PER PUPIL

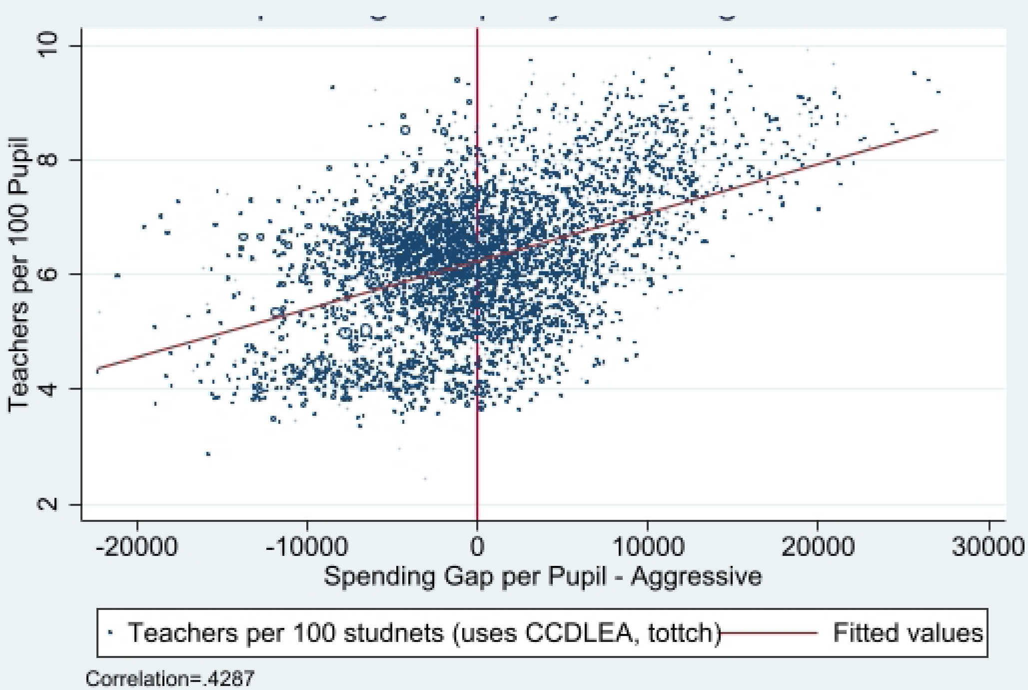
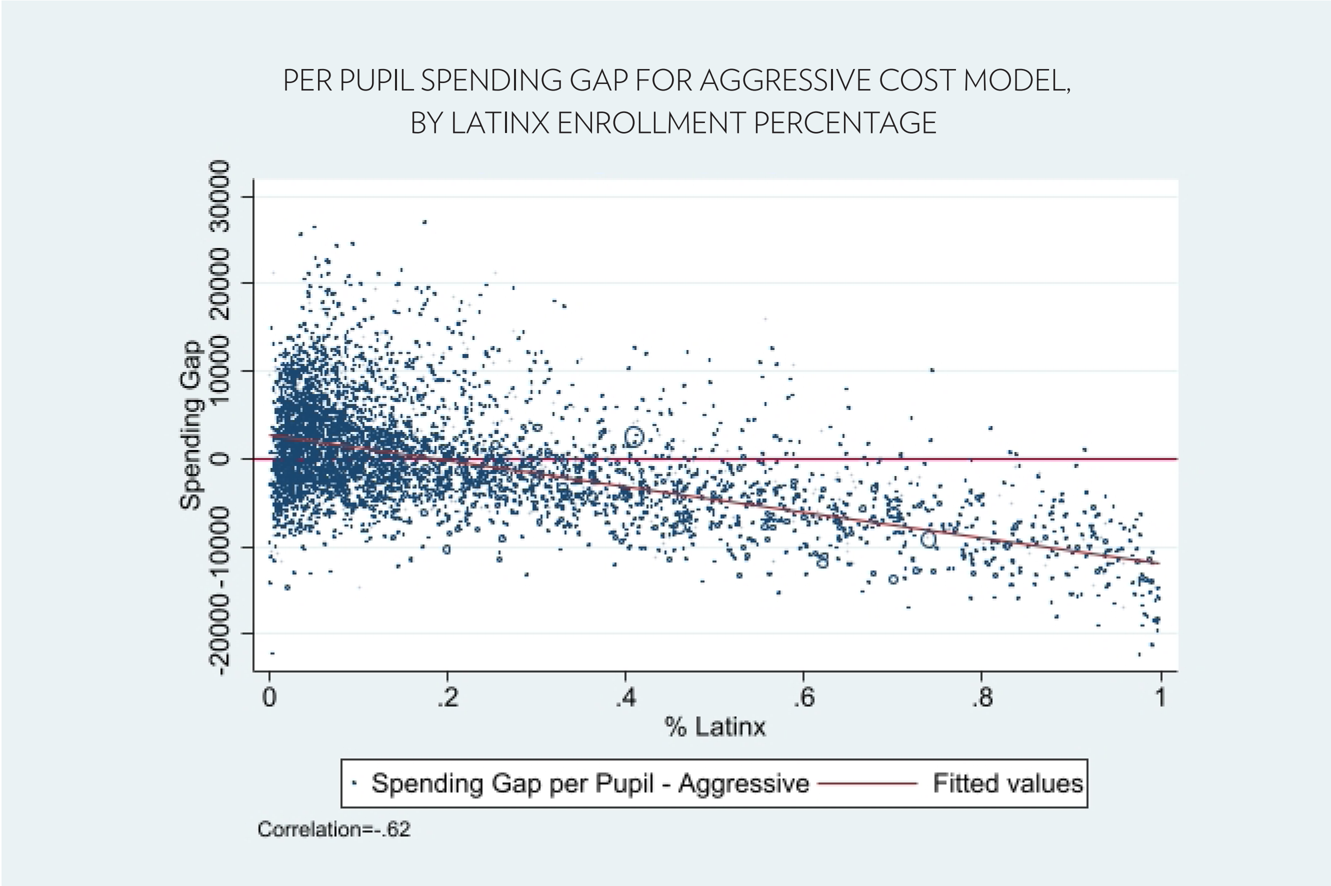


FIGURE 14



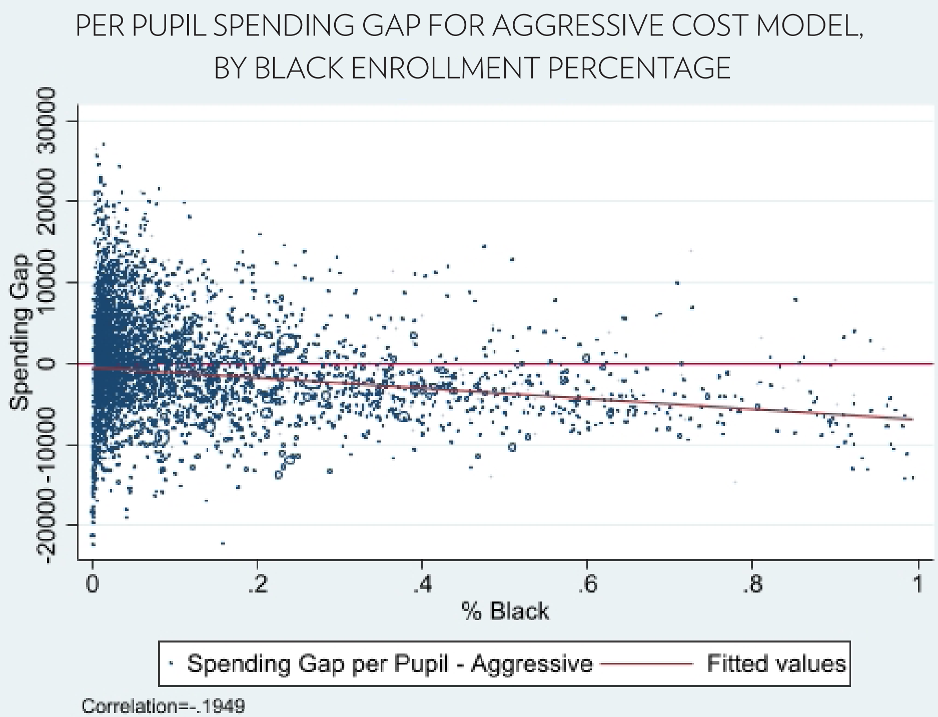
Face Validity Test

Figure 4 and Figure 5 provide a crude validity check on the cost estimates and spending gap estimates from our models. At the most basic level, for districts that spend more than needed to achieve a given level of outcomes, we should expect that on average, those districts exceed national average outcomes. That is, that there is some positive correlation between spending gap to average, and outcome gaps. Both the aggressive and conservative models conform to this expectation, with a slightly stronger positive correlation for the aggressive model. As a result, the majority of districts, and enrolled children fall either in the upper right (spending more than needed to achieve average outcomes, and exceeding average outcomes) or lower left (spending less and achieving less) quadrants.

Certainly, the pattern is not a perfect diagonal line intersecting at 0/0. There are districts in the upper left and lower right quadrants and there is variation across districts in all quadrants. That is, even at the same estimated spending gap (more or less than needed, there are differences in outcomes). This variation can encompass a number of things and should not be over-interpreted as meaning any one of the following. This variation should especially not be overinterpreted as indicating real differences in the relative efficiency of public school districts in one state versus another. This may in part be the case, but we are unsure how much this is the case, since there are at least three significant categories of factors that may influence these estimates.

1. **Omitted Variables Bias:** First and foremost, cases where districts, or entire states, have spending lower than needed to achieve average outcomes, but higher than average outcomes (upper left quadrant), or vice versa, might be a result of unobserved (unmeasured, not included in model) important differences in costs, either in terms of student characteristics or other exogenous environmental factors. Our models herein are relatively simple

FIGURE 15



and clearly do not capture everything that might affect cost differences, say, between schooling in New York and schooling in New Mexico. It would be implausible to determine the perfect, complete model for all districts nationally. Nonetheless the models seem to do a reasonable job at predicting cost variation in relation to outcomes and offer a huge advancement for guiding the distribution of federal aid.

2. **Measurement Error in Inputs or Outcomes** (systematic or random): The Stanford Education Data Archive takes methodologically groundbreaking steps to equate school assessments across varied state testing regimes. Our cursory review of the spatial patterns of differences between adjacent districts along state borders, however suggests that their methods and/or the underlying data, are imperfect in achieving this goal. Similar concerns exist with equating current spending measures, despite attempts by the U.S. Census Bureau and National Center for Education Statistics to provide guidance to state officials regarding specific chart of accounts codes to be included in this measure. If outcomes of a group of districts in a state are systematically underestimated and/or spending is systematically overestimated, these districts may be misplaced in the overall distribution of districts, nationally. We have specific concerns regarding spending levels reported for New York State school districts and outcome levels of western and upstate New York districts.

3. **Differences in Inefficiency:** It is reasonable that for any two districts serving otherwise similar student populations and facing similar external cost pressures, they might achieve different outcomes even while spending the same amount. Spending the same, but achieving more (on the measured outcomes) would indicate greater efficiency in producing those measured outcomes. Ideally, we would have sufficiently complete models with sufficiently accurate and precise measures of inputs

FIGURE 16

STATE SPENDING GAPS, BY SHARE OF AGGREGATE INCOME

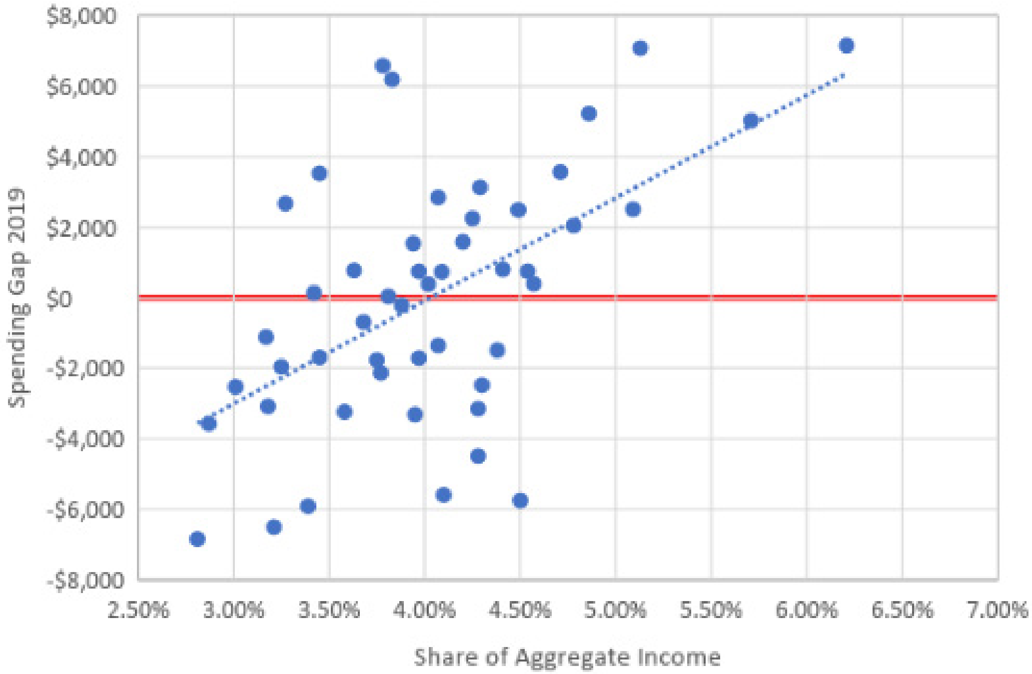
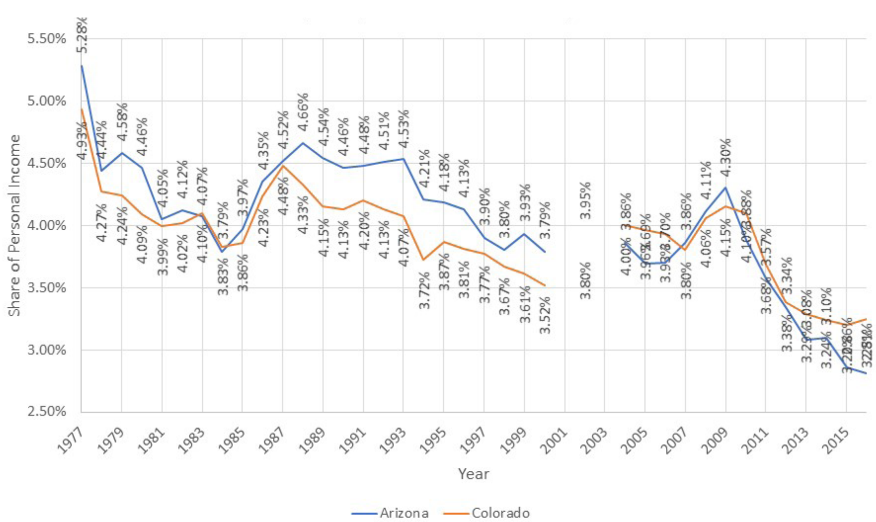


FIGURE 17

EXPENDITURES ON EDUCATION AS A PERCENTAGE OF PERSONAL INCOME, ARIZONA AND COLORADO, 1977–2015



Suggested Citation: State & Local Government Finance Data Query System. http://www.taxpolicycenter.org/slf-dqs/pages.cfm. The Urban Institute-Brookings Institution Tax Policy Center. Data from U.S. Census Bureau, Annual Survey of State and Local Government Finances, Government Finances, Volume 4, and Census of Governments (Years). Date of Access: (05-Jul-19 08:37 PM) and outcomes to isolate these real differences in inefficiency. But even in this case, we have to be careful to understand what we mean by differences in efficiency. Some districts may spend more to achieve the same measured outcomes (reading and math scores grades 3 to 8) because they are spending on other things valued by their communities/constituents, such as a strong orchestra or theater program, chess, or lacrosse team. These expenditures may not translate directly to shifts in reading and math scores and thus would be "inefficient" per the model specifications herein.

While there may be legitimate differences in relative efficiency of school districts, or entire states, picked up in these models, we suspect that much of the variation seen in these scatterplots, for example, districts in the upper left (more efficient?) and lower right (less efficient), is attributable to the first two issues noted here—omitted variables bias and measurement error.

Indeed, these models are imperfect and incomplete. But, these models can still provide reasonable broad policy guidance regarding the relative adequacy of school spending toward achieving common outcomes, a perspective on interstate disparities in school funding not previously available.

Figure 6 and Figure 7 present national heat maps of the aggressive and conservative spending gaps. The only difference between the two are the depths of the green (spending more than needed) and red (spending less than needed) shades. Otherwise, districts estimated to have larger gaps in one model tend to have larger gaps in the other. Maps like this can be somewhat deceptive in that the largest areas often have the fewest people attached to them. Wyoming stands out as having significantly higher funding (and no red shades) than other states around it. This is largely true, as aggressive Wyoming school finance reforms of the 1990s have been supported by robust natural resource revenues. But Wyoming has just over 90,000 kids, which statewide is smaller than many of the nation's larger individual public school districts (similar in total to Vermont). Philadelphia, including children enrolled in charter schools has more than double the enrollment of Wyoming but is barely visible in Figure 6 or Figure 7, unless you know exactly where to look. Figure 8 zooms in on Philadelphia, showing that the city has very large funding gaps to achieve national average outcomes. Notably, Philadelphia does not even have nominal per pupil spending equal to the average of surrounding districts, nor has it for decades, despite having child poverty rates more than double its surroundings. We can also see in this figure, other Pennsylvania districts that appear in deeper shades of red, but seem relatively small geographically. These include the relatively large districts of Allentown and Reading.

Figure 9 shows the position of Pennsylvania school districts in the scatterplot of the relationship between spending gaps and outcome gaps. Pennsylvania is a large, diverse state, and one with vast disparities in school funding which have gone unresolved for decades. Philadelphia's spending gap per pupil is just over $10,000. Philadelphia is the largest of the hollow diamonds in the lower left quadrant. But out to the left of Philadelphia, with an even larger gap is Reading and out near Philadelphia in the figure are Lebanon, York, Harrisburg, Allentown and Chester Upland, all relatively large enrollment districts serving high need student populations.

In Figure 8, New Jersey lies to the east and Northeast of Philadelphia. Most of New Jersey appears in deep shades of green, spending more than enough to achieve national average outcomes (and largely achieving well above national average outcomes). But even in New Jersey, a state which has over time supported one of the most progressively funded, high-performing school systems, a handful of districts fall short of the funding they need to achieve even national average outcomes. To an extent, these disparities have reemerged as that progressive funding has waned. But some smaller districts that were not parties to decades of school funding litigation were also left out of the gains of that litigation. Furthest in the bottom left corner in Figure 10 are districts including Lakewood, alongside Trenton (so, in both Pennsylvania and New Jersey, the state capital is far in the lower left corner). Still, most New Jersey children attend

TABLE 3

	High Funding and High Outcomes (Upper Right)	Low Funding and Low Outcomes (Lower Left)
Teachers per 100 Pupils	6.68	5.89
Percent Black	7.75	20.22
Percent Latinx	13.22	38.29

districts in the upper right quadrant (65.85%). By contrast over half of children in Arizona attend districts in the lower left quadrant in 2019. In California, 67.59% of students are in districts in the lower left quadrant, while in Massachusetts, 67.08% are in the upper right!

Figure 11 presents illustrations of six additional states and Figure 12 presents illustrations of 4 more states and estimates for large districts, both aggressive estimates and conservative estimates. Some large, relatively affluent county districts such as Loudoun County, Virginia, spend more than needed to achieve national average outcomes and far exceed national average outcomes. However, several large city school systems serving low income and minority children sit well into the lower left of the bottom two figures in Figure 12, including Fresno, Dallas, Baltimore, Milwaukee, and Los Angeles.

Figure 13 shows that on average, districts that spend more than enough to achieve national average outcomes also tend to have more teachers per 100 pupils (excluding districts with fewer than 2,000 pupils, which necessarily have lower staffing ratios).

The next two figures parse the racial disparities in spending gaps. Figure 14 shows a striking pattern of racial disparity by Latinx enrollment share. The greater the Latinx enrollment share the greater likelihood of a spending gap and the greater the spending gap. The correlation here is −0.62. Visually, we can see that few if any very high Latinx share districts spend more than enough to achieve national average outcomes. This pattern is a result of both within and between state disparities that fall disproportionately on Latinx children and families. States in the southwestern United States with the highest concentrations of these children tend to have the least well funded overall school systems. Further, high Latinx share districts in other states like Pennsylvania, Connecticut, New Jersey and Illinois tend to have significant spending gaps.

Figure 15 shows the disparities by black enrollment share. These disparities also exist and few very high percent black districts have sufficient spending to achieve national average outcomes. But, the patterns are somewhat less striking than for Latinx populations.

Table 3 provides a summary of Latinx and Black population shares for districts in the upper right and lower left of Figure 4. We note that there is disproportionate representation of predominantly black districts in the lower right quadrant—those estimated as spending enough or more to achieve national average outcomes, but still falling below national average outcomes. It may be that black population concentration here is simply an omitted cost variable. That is, that it actually costs more to achieve common outcome goals where policy has constructed over time, concentrated, segregated, racially isolated poor black neighborhoods. Prior empirical work has failed to find a sufficient race-neutral alternative to capture the cost difference associated with black racial isolation.[35] We chose not to include race as a cost factor herein because of the legal complexities that adds to translating the cost model into federal aid policy.[36]

Table 3 shows that while only 7.75% of children in well funded high performing districts are black and 13.22% are Latinx, over 20% of children in poorly funded low performing districts are black and nearly 40% are Latinx.

Differences in State Effort Matter

Finally, we point out that differences in the amount of effort states put forth to fund their schools are largely correlated with whether or not those states generate sufficient funding to achieve national average outcomes. That is, the gaps are not entirely a rich state, poor state problem. To some extent, they are also an indicator of how much a state is or is not even trying. The School Finance Indicators Database includes two measures of state "effort." First is a measure of per pupil spending on K–12 education as a share of aggregate personal income and second is a measure of per pupil spending on K–12 education as a share of gross domestic product–state. The latter includes the revenue generating value of natural resources, which are significant in states like Alaska and Wyoming. In Figure 16, where we use the aggregate personal income measure, Wyoming appears as a relatively high effort state, because incomes in Wyoming on average are not particularly high. But when measured as a share of GDP–state, Wyoming's effort is much lower. Still, Wyoming spends more than needed to achieve national average outcomes.

Figure 16 shows us that some states like Massachusetts and Connecticut can put up relatively low effort (<4% API) and still spend more than needed to achieve national average outcomes. Other states like New Mexico and Mississippi have higher effort and still have large spending gaps. But, states like Arizona and Nevada, along with Colorado have low effort and significant spending gaps. Figure 17 shows that, for example, Arizona and Colorado have significantly reduced their effort to fund K–12 education over time. This is a policy choice and one that appropriate federal leverage may mitigate and/or reverse.

Appendix B

Controlling for Inefficiency

It would be difficult, if not impossible, to observe a single school district in isolation to determine the inefficient share of spending—that is, the share of spending that does not contribute to improvement of measured outcomes. However, when looking across many school districts of both similar and different characteristics, it is possible to detect variation in spending that is not explained by differences in outcomes or cost factors. Among similar sets of school districts based on observed characteristics, some spend more or less than others to achieve any given outcome level. The higher levels of spending may be considered less efficient spending and the lower levels more efficient spending for comparable outcomes, assuming one has fully captured factors outside of a district's control that affect the cost of outcomes.

This assumption is also influenced by the particular outcomes measured in the model. If a school or district is spending on physical education, sports, and/or music and arts for its children; if those expenditures do not have as strong a direct effect on reading and math test scores; and if the model is based on reading and math test score outcomes alone, then those expenditures might be considered less efficient with respect to the tested outcomes. In short, efficiency is a highly circumscribed measurement: Some districts are more or less efficient than others at producing *specific* outcomes and can only be evaluated and/or controlled for in education cost functions to the extent that the efficiency, as measured by the impact on discrete outcomes, varies from one district to the next.

It is important to acknowledge that the response to inefficiency can also raise equity concerns. In the context of educational adequacy claims or adequacy-oriented school finance policies, one might argue that districts whose children fall below adequacy standards on specific assessments should be required to allocate all resources toward the direct improvement of those outcomes and those outcomes alone. That is, higher-need districts that are more likely to be underperforming should be required to operate at maximized efficiency (on measured outcomes only) and the state should fund those districts at the level necessary to achieve adequate outcomes assuming maximized efficiency. But lower-need districts that already have sufficient resources to exceed adequate outcomes are exempt from such requirements. Such differential efficiency

State by State Gaps						
Per pupil Gaps						
	2019–20		*2020–21*		*2021–22*	
State	Conservative	Aggressive	Conservative	Aggressive	Conservative	Aggressive
Arizona	-6,089	-6,853	-6,322	-7,022	-6,556	-7,191
Nevada	-5,190	-6,511	-5,427	-6,693	-5,660	-6,869
Texas	-4,661	-5,605	-4,871	-5,738	-5,079	-5,869
California	-4,279	-5,924	-4,517	-6,100	-4,753	-6,273
New Mexico	-4,055	-5,755	-4,288	-5,924	-4,527	-6,103
Mississippi	-3,615	-4,496	-3,834	-4,642	-4,048	-4,783
Oklahoma	-3,294	-3,244	-3,514	-3,388	-3,733	-3,532
Florida	-3,096	-3,583	-3,330	-3,758	-3,564	-3,934
North Carolina	-2,934	-3,088	-3,168	-3,261	-3,403	-3,434
Alabama	-2,883	-3,314	-3,120	-3,489	-3,351	-3,656
Idaho	-2,848	-2,533	-3,085	-2,710	-3,306	-2,866
Utah	-2,761	-1,771	-2,989	-1,936	-3,218	-2,102
Arkansas	-2,593	-3,156	-2,844	-3,349	-3,082	-3,522
Colorado	-2,190	-1,964	-2,423	-2,140	-2,660	-2,321
Georgia	-2,048	-2,485	-2,276	-2,649	-2,505	-2,815
Oregon	-1,817	-2,140	-2,047	-2,311	-2,282	-2,489
Indiana	-1,685	-1,697	-1,911	-1,857	-2,135	-2,013
Tennessee	-1,439	-1,122	-1,668	-1,288	-1,897	-1,454
Louisiana	-1,284	-1,715	-1,521	-1,896	-1,753	-2,071
Kentucky	-1,208	-1,357	-1,437	-1,525	-1,670	-1,698
South Carolina	-1,192	-1,497	-1,424	-1,665	-1,654	-1,831
Washington	-768	-693	-997	-858	-1,223	-1,020
Missouri	-720	-215	-945	-375	-1,170	-534
Michigan	-420	35	-657	-144	-898	-328
South Dakota	-393	134	-625	-33	-828	-165
Iowa	31	747	-205	572	-428	413
Virginia	204	773	-21	606	-245	441
Montana	226	384	-8	212	-239	42
Wisconsin	249	745	8	562	-233	377
West Virginia	254	391	20	218	-230	24
Kansas	304	732	70	564	-169	390

	2019–20		2020–21		2021–22	
State	Conservative	Aggressive	Conservative	Aggressive	Conservative	Aggressive
Ohio	448	803	216	633	-18	461
Minnesota	787	1,582	563	1,425	343	1,272
Nebraska	1,368	2,043	1,134	1,872	908	1,710
District of Columbia	1,406	-471	1,170	-651	934	-831
Illinois	1,678	1,540	1,479	1,412	1,277	1,280
Vermont	1,936	2,510	1,689	2,319	1,396	2,076
Maryland	1,995	2,672	1,770	2,509	1,545	2,345
Delaware	2,209	2,255	1,935	2,038	1,666	1,827
Maine	2,464	2,846	2,245	2,689	1,974	2,469
Rhode Island	2,544	2,490	2,301	2,297	2,058	2,105
Pennsylvania	2,661	3,131	2,430	2,963	2,192	2,784
North Dakota	2,694	3,569	2,447	3,381	2,236	3,237
Massachusetts	3,045	3,528	2,780	3,305	2,520	3,091
New Jersey	4,722	5,222	4,459	5,016	4,200	4,813
New Hampshire	4,795	6,195	4,519	5,972	4,227	5,728
Alaska	5,152	5,030	4,895	4,824	4,637	4,615
Connecticut	5,951	6,583	5,682	6,358	5,409	6,126
Wyoming	6,441	7,156	6,204	6,976	5,955	6,780
New York	7,706	7,089	7,446	6,875	7,185	6,660

Total Gaps (Sum of Negatives Only)

	2019–20		2020–21		2021–22	
State	Conservative	Aggressive	Conservative	Aggressive	Conservative	Aggressive
California	-25.99	-36.94	-27.25	-37.80	-28.62	-38.67
Texas	-23.79	-29.60	-24.96	-30.42	-26.10	-31.25
Florida	-8.82	-10.33	-9.54	-10.91	-10.27	-11.49
Arizona	-5.65	-6.43	-5.86	-6.58	-6.07	-6.74
North Carolina	-4.25	-4.55	-4.56	-4.77	-4.93	-5.00
Georgia	-3.78	-4.94	-4.14	-5.20	-4.49	-5.47
Illinois	-2.49	-3.90	-2.64	-3.98	-2.79	-4.08
Nevada	-2.33	-2.92	-2.44	-3.01	-2.55	-3.10

	2019–20		2020–21		2021–22	
Alabama	-2.20	-2.65	-2.36	-2.77	-2.51	-2.88
Oklahoma	-2.11	-2.34	-2.25	-2.41	-2.36	-2.47
Indiana	-1.98	-2.54	-2.12	-2.63	-2.29	-2.73
Colorado	-1.90	-2.34	-2.03	-2.45	-2.32	-2.57
Michigan	-1.68	-2.24	-1.83	-2.34	-1.97	-2.45
Mississippi	-1.67	-2.13	-1.75	-2.17	-1.82	-2.21
Pennsylvania	-1.58	-2.41	-1.67	-2.48	-1.76	-2.55
Ohio	-1.47	-2.29	-1.64	-2.40	-1.82	-2.51
Utah	-1.44	-1.07	-1.56	-1.17	-1.73	-1.26
Missouri	-1.32	-1.57	-1.43	-1.64	-1.53	-1.70
Washington	-1.32	-1.97	-1.47	-2.09	-1.65	-2.21
New Mexico	-1.30	-1.85	-1.38	-1.90	-1.45	-1.96
Tennessee	-1.27	-1.33	-1.43	-1.45	-1.58	-1.56
Arkansas	-1.20	-1.56	-1.29	-1.62	-1.40	-1.69
Oregon	-1.13	-1.43	-1.25	-1.51	-1.37	-1.60
South Carolina	-1.12	-1.46	-1.26	-1.56	-1.41	-1.67
Louisiana	-1.01	-1.38	-1.11	-1.46	-1.21	-1.53
Kentucky	-0.99	-1.25	-1.08	-1.31	-1.18	-1.38
Virginia	-0.94	-1.16	-1.05	-1.24	-1.19	-1.36
Idaho	-0.84	-0.75	-0.92	-0.81	-0.99	-0.87
Wisconsin	-0.77	-1.12	-0.84	-1.18	-0.93	-1.23
Massachusetts	-0.58	-1.04	-0.63	-1.30	-0.70	-1.36
New Jersey	-0.51	-1.19	-0.57	-1.27	-0.63	-1.32
Iowa	-0.41	-0.50	-0.46	-0.54	-0.52	-0.59
Minnesota	-0.35	-0.64	-0.41	-0.68	-0.46	-0.71
Kansas	-0.34	-0.58	-0.38	-0.61	-0.43	-0.64
Maryland	-0.24	-0.43	-0.26	-0.44	-0.28	-0.45
Connecticut	-0.22	-0.46	-0.24	-0.47	-0.26	-0.56
Rhode Island	-0.15	-0.29	-0.16	-0.30	-0.17	-0.30
West Virginia	-0.13	-0.18	-0.15	-0.20	-0.19	-0.22
Montana	-0.13	-0.17	-0.15	-0.18	-0.17	-0.19
Vermont	-0.12	-0.13	-0.13	-0.14	-0.14	-0.15

2019–20			2020–21		2021–22	
Nebraska	-0.10	-0.15	-0.12	-0.17	-0.14	-0.18
South Dakota	-0.10	-0.11	-0.12	-0.12	-0.14	-0.13
Maine	-0.07	-0.09	-0.08	-0.10	-0.09	-0.10
New Hampshire	-0.05	-0.06	-0.06	-0.06	-0.06	-0.07
New York	-0.04	-0.09	-0.05	-0.10	-0.06	-0.28
North Dakota	-0.02	-0.03	-0.02	-0.03	-0.03	-0.03
Alaska	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03
Delaware	-0.01	-0.02	-0.01	-0.02	-0.02	-0.03

Appendix A

Data and Measures

Measure	*Source Data*	*Source Measure(s)*	*Variable (derived)*
Main Cost Model (Second State Equation)			
Per Pupil Spending	Secondary Source: http://schoolfinancedata.org/download-data/ Primary source: https://www.census.gov/programs-surveys/school-finances/data/tables.html	PPCSTOT	Natural log of PPCSTOT
Outcome Index	Stanford Education Data Archive seda_geodist_long_CS_v30 https://edopportunity.org/get-the-data/seda-archive-downloads/	mn_all	Collapsed to district mean by year across all grade cohorts
Adjusted Poverty Rate	U.S. Census Small Area Income and Poverty Rate https://www.census.gov/programs-surveys/saipe/data/datasets.html	Percent of 5 to 17 Year Olds in Poverty multiplied by “Poverty Adjustment Factor” (PAF)	SAIPE estimate multiplied by PAF to adjust poverty income thresholds for regional variation[1]
State Mean Centered Students with Disabilities Rate	NCES Common Core of Data, Public Education Agency Universe Survey	IDEA Count as a share of Membership	District IDEA shares divided by state mean IDEA share
ELL Share		ELL Count as a share of Membership	ELL Count as a share of Membership
% Enrollment in Pre-k		Pre-K enrollment divided by Mmbership	Pre-K enrollment by Membership
% Enrollment in Secondary Grades		Grades 9 through 12 Enrollment divded by membership	Grades 9 through 12 Enrollment divded by membership
Enrollment		Membership of LEA	Assigned to categories

Measure	*Source Data*	*Source Measure(s)*	*Variable (derived)*
Log of Population per Square Mile	Secondary Source: http://schoolfinancedata.org/download-data/ (see: http://schoolfinancedata.org/wp-content/uploads/2019/03/DID_Codebook_2019.pdf) Primary Source: http://factfinder.census.gov	densitypop_ucsb	Natural log of densitypop_ucsb
% Population between 5 and 17 yrs of age	Secondary Source: http://schoolfinancedata.org/download-data/ (see: http://schoolfinancedata.org/wp-content/uploads/2019/03/DID_Codebook_2019.pdf) Primary source: https://www.census.gov/data/datasets/2017/demo/saipe/2017-school-districts.html	Population 5 to 17 divided by Total Population	Population 5 to 17 divided by Total Population
Ratio of Median Housing Values to Surrounding Labor Market	Secondary Source: http://schoolfinancedata.org/download-data/ (see: http://schoolfinancedata.org/wp-content/uploads/2019/03/DID_Codebook_2019.pdf) Primary source: NCES Education Demographic and Geographic Estimates (EDGE) URL: https://nces.ed.gov/programs/edge/	mhu_value2000_edge (secondary source variable name)	District MHU divided by average MHU for others in labor market (excluding district)
Herfindhal Index - Enrollment	Based on Enrollment data from NCES CCD LEA Universe and Labor Market Definitions from original Taylor ECWI (source: https://bush.tamu.edu/research/faculty/Taylor_CWI/)		Stata function HHI5 by Labor Market and State
ECWI	Education Comparable Wage Index (Original) source: https://bush.tamu.edu/research/faculty/Taylor_CWI/ Imputations in secondary source (linear extrapolation within LEA over time (year) Secondary Source: http://schoolfinancedata.org/download-data/ (see: http://schoolfinancedata.org/wp-content/uploads/2019/03/DID_Codebook_2019.pdf)	ECWI	Linear imputation within district over time
	First Stage Instruments		
NEI_BlackHisp	Based on Enrollment data from NCES CCD LEA Universe and Labor Market Definitions from original Taylor ECWI (source: https://bush.tamu.edu/research/faculty/Taylor_CWI/)	-Total black enrollment -Total Hispanic enrollment -Membership -Labor market delineation	Average black or Hispanic share of enrollment of all other districts in labor market
Neighborhood Poverty Index	Source: https://nces.ed.gov/programs/edge/Economic/NeighborhoodPoverty	ipr_est	School neighborhood poverty index rolled up to LEA Mean

Measure	Source Data	Source Measure(s)	Variable (derived)
Weights estimation			
Comparable Wage Index for Teachers	Updated EDGE System Comparable Wage Index for Teachers (CWIFT) Source: https://nces.ed.gov/programs/edge/Economic/TeacherWage	LEA_CWIFTEST	
[1] Baker, B. D., Taylor, L., Levin, J., Chambers, J., and Blankenship, C. (2013). Adjusted Poverty Measures and the Distribution of Title I Aid: Does Title I Really Make the Rich States Richer?. Education Finance and Policy, 8(3), 394–417.			

expectations are plainly and obviously inequitable.

Such differences in efficiency requirements placed on higher- versus lower-need districts can also lead to dramatic inequities in the breadth of educational opportunities available to children. What might be characterized as inefficient frills include not only instrumental jazz or ceramics classes, but also include advanced course offerings in math, social sciences, foreign language, and science, which are critical prerequisites for students competing for limited slots in competitive colleges or universities.

A common approach for accounting for inefficiency in peer-reviewed education cost function literature is to identify factors that vary across school districts that might explain some of the differences in spending that are not directly associated with the measured outcomes. These indirect inefficiency factors are typically organized into two groups: fiscal capacity factors and public monitoring factors. Fiscal capacity factors may include the median income of communities, taxable property wealth, or other factors that may allow local homeowner voters to more easily raise revenue for schools with potentially less consideration for the extent to which each additional dollar translates to improved measured outcomes. It is also conceivable that higher fiscal capacity communities are more likely to support spending on unmeasured outcomes and may place equal or even greater value on those outcomes than on the measured outcomes. Public monitoring factors include characteristics of school districts that may lead local homeowner voters to be more or less critical of the extent to which each additional dollar translates into improved measured outcomes. For example, local school districts receiving larger shares of funding from the state rather than local property tax sources may have reduced local public monitoring, although state accountability monitoring may offset this reduction.

$$\textbf{Inefficiency}_d = f(\textbf{Fiscal Capacity}_d, \textbf{Public Monitoring}_d)$$

"Inefficiency" as Missing/Omitted Variables Bias

It is important to understand that, in statistical terms, correcting for inefficiency in a cost model is an *omitted variables bias* problem. That is, we are simply trying to identify factors that explain differences in spending that are neither associated with legitimate cost differences nor with differences in outcomes. Other approaches for addressing *inefficiency*, such as stochastic frontier models, fail to address this omitted variables bias problem. Rather, these other approaches simply assume that districts on the edge of the distribution (of a pre-determined shape) are most efficient and that deviations from that frontier (based on a pre-determined error distribution) indicate inefficiency. We have come to believe over time that the approach of including indirect *inefficiency* corrections for variations in spending is more thorough and likely more accurate, especially when used for the purposes herein.

Further, the understanding that these inefficiency controls address omitted variables bias clarifies important differences between education cost functions and education production functions, and validates why the cost function is the appropriate tool for the task at hand. In an education production function, the goal is to estimate the extent to which spending, as an independent variable, affects the dependent outcome measure. While the cost model evaluates the extent of spending variation (dependent measure) associated with outcome variation (independent measure), controlling for cost factors and correcting for inefficiency, the production model attempts to evaluate the extent of *outcome* variation that results from *spending* variation, controlling for other factors. Some have asserted that a viable validity check on the education cost model is to see if it produces the same results – the same predictions – as an education production function estimated with the same data.[37] But, in a production function, measured outcomes are the dependent variable and spending is one of the independent variables, and there is no comparable, statistically reasonable way to correct for inefficiency in the spending measure when the spending measure is among the independent variables.

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Notes

1 Downes (2004) What is Adequate? Operationalizing the Concept of Adequacy for New York State, 9, http://www.albany.edu/edfin/Downes%20EFRC%20Symp%2004%20Single.pdf.

2 Duncombe, W., and Yinger, J. (2011). Are education cost functions ready for prime time? An examination of their validity and reliability. Peabody Journal of Education, 86(1), 28–57.

3 Cornman, S.Q., Nixon, L.C., Spence, M.J., and Taylor, L.L., Geverdt, D.E. (2019). Education Demographic and Geographic Estimates (EDGE) Program: American Community Survey Comparable Wage Index for Teachers (ACS-CWIFT) (NCES 2018-130). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved [date] from http://nces.ed.gov/pubsearch/

4 Berne, R., and Stiefel, L. (1979). The equity of school finance systems over time: the value judgments inherent in evaluation. Educational Administration Quarterly, 15(2), 14–34.

5 Berne, R., and Stiefel, L. (1984). The measurement of equity in school finance: Conceptual, methodological and empirical dimensions. Johns Hopkins University Press; Berne, R., and Stiefel, L. (1999). Concepts of school finance equity: 1970 to the present. Equity and adequacy in education finance: Issues and perspectives, 7–33.

6 Regarding children with disabilities, see: ENDREW F. v. DOUGLAS COUNTY SCHOOL DISTRICT RE-1, 137 S. Ct. 29 (U.S. 2016); regarding children with limited English language proficiency, see: Issa v. SCHOOL DISTRICT OF LANCASTER, No. 16-3528 (3d Cir. Jan. 30, 2017).

7 Baker, B., and Green, P. (2008). Conceptions of equity and adequacy in school finance. Handbook of research in education finance and policy, 203–221; Baker, B. D., and Green, P. C. (2009); Conceptions, measurement and application of educational adequacy standards. AERA handbook on education policy. New York: Routledge, 311–337.

8 See for example: Rose v. Council for Better Educ., Inc., 790 S.W.2d 186, 60 Ky. 1289 (1989).

9 See, for example: Debra P. v. Turlington, 644 F.2d 397 (5th Cir. 1981).

10 Clune, W. H. (1994). The shift from equity to adequacy in school finance. Educational Policy, 8(4), 376–394.

11 Koski, W. S., and Reich, R. (2006). When Adequate Isn't: The Retreat from Equity in Educational Law and Policy and Why It Matters. Emory LJ, 56, 545.

12 Hollis, M. (1987). Education as a positional good. In Philosophers on education (pp. 43–58). Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-1-349-08106-6_4.

13 Koski, W. S., and Reich, R. (2006). When Adequate Isn't: The Retreat from Equity in Educational Law and Policy and Why It Matters. Emory LJ, 56, 545

14 For example, the Kansas Constitution requires that the legislature "shall make suitable provision for finance of the educational interests of the state." Those educational interests are articulated in standards adopted by the state board of education (which holds independent constitutional authority for the "general supervision of public schools"). Kansas courts have repeatedly held that the legislature's obligation is to provide financing which grants all children equal opportunity to achieve those standards. Gannon v. State, 368 P.3d 1024, 303 Kan. 682 (2016); Gannon v. State, No. 113,267 (Kan. June 28, 2016); Montoy v. State, 279 Kan. 817, 112 P.3d 923 (2005); USD NO. 229 v. State, 256 Kan. 232, 885 P.2d 1170 (1994).

15 Cover, A. Y. (2001). Is Adequacy a More Political Question Than Equality: The Effect of Standards-Based Education on Judicial Standards for Education Finance. Cornell JL and Pub. Pol'y, 11, 403.

16 Fiscal Equity v. State of NY, 801 N.E.2d 326, 100 N.Y.2d 893, 769 N.Y.S.2d 106 (2003). As we further explained, many of the more detailed standards established by the Board of Regents and Commissioner of Education "exceed notions of a minimally adequate or sound basic education," so that proof that schools do not comply with such standards "may not, standing alone, establish a violation of the Education Article" (id.). The trial court, accordingly, declined to fix the most recent, and ambitious, statement of educational goals—the Regents Learning Standards, adopted in 1996—as the definition of a sound basic education (187 Misc 2d at 12). As the trial court observed, so to enshrine the Learning Standards would be to cede to a state agency the power to define a constitutional right.

17 Rebell, M. A. (2011). Safeguarding the right to a sound basic education in times of fiscal constraint. Alb. L. Rev., 75, 1855.

18 Baker, B., and Green, P. (2008). Conceptions of equity and adequacy in school finance. Handbook of research in education finance and policy, 203–221; Baker, B. D., and Green, P. C. (2009). Conceptions, measurement and application of educational adequacy standards. AERA handbook on education policy. New York: Routledge, 311–337.

19 Duncombe, W., Yinger, J. (2008) Measurement of Cost Differentials In H.F. Ladd and E. Fiske (eds) pp. 203–221. Handbook of Research in Education Finance and Policy. New York: Routledge; Duncombe, W., Yinger, J. (2005) How Much more Does a Disadvantaged Student Cost? Economics of Education Review 24 (5) 513–532; Duncombe, W.D. and Yinger, J.M. (2000). Financing Higher Performance Standards: The Case of New York State. Economics of Education Review, 19 (3), 363–86; Duncombe, W., Yinger, J. (1999). Performance Standards and Education Cost Indexes: You Can't Have One Without the Other. In H.F. Ladd, R. Chalk, and J.S. Hansen (Eds.), Equity and Adequacy in Education Finance: Issues and Perspectives (pp.260–97). Washington, DC: National Academy Press; Duncombe, W., Yinger, J. (1998) "School Finance Reforms: Aid Formulas and Equity Objectives." National Tax Journal 51, (2): 239–63; Duncombe, W., Yinger, J. (1997). Why Is It So Hard to Help Central City Schools? Journal of Policy Analysis and Management, 16, (1), 85–113; Imazeki, J., Reschovsky, A. (2004b) Is No Child Left Beyond an Un (or under)funded Federal Mandate? Evidence from Texas. National Tax Journal 57 (3) 571–588.

20 Downes (2004) What is Adequate? Operationalizing the Concept of Adequacy for New York State, 9, http://www.albany.edu/edfin/Downes%20EFRC%20Symp%2004%20Single.pdf.

21 Duncombe, W., and Yinger, J. (2011). Are education cost functions ready for prime time? An examination of their validity and reliability. Peabody Journal of Education, 86(1), 28–57.

22 Baker, B. D., and Weber, M. (2016). Deconstructing the Myth of American Public Schooling Inefficiency. Washington, D.C.: Albert Shanker Institute. Retrieved from http://www.shankerinstitute.org/resource/publicschoolinginefficiency

23 See: Baker, B.D., Welner, K. (2011) School Finance and Courts: Does Reform Matter, and How Can We Tell? Teachers College Record 113 (11).

24 Hanushek, E. (2005, October). The alchemy of 'costing out' and adequate education. Paper presented at the Adequacy Lawsuits: Their Growing Impact on American Education conference, Cambridge, MA. Costrell, R., Hanushek, E., and Loeb, S. (2008). What do cost functions tell us about the cost of an adequate education? Peabody Journal of Education, 83, 198–223.

25 For elaboration on this argument, see: Costrell, R., Hanushek, E., and Loeb, S. (2008). What do cost functions tell us about the cost of an adequate education? Peabody Journal of Education, 83, 198–223. An alternative version of this argument is presented by the "efficiency" intervenors in Fort Bend ISD v. Scott, a Texas school funding case (https://www.tasb.org/Legislative/Issue-Based-Resources/School-Finance/documents/treeintervention.aspx). Intervenors' brief explains: "Therefore, it is literally impossible for the legislature or other current managers of the school system in Texas to take the position, in cost-effective economic terms, that any particular level of funding is necessary for efficiency. Even the question of allocation of funding among districts cannot be determined in an efficient manner without a more substantive and comprehensive system of financial accountability." This comment would appear to be a backhanded attempt to undermine any use of analysis of existing spending data for addressing either the overall adequacy of funding to Texas school districts or the equitable distribution of that funding. But this argument suffers the same lack of substantiation that there actually exists some hypothetically more efficient system out there somewhere, and that the current system is necessarily so inefficient as to be irrelevant. The only reasonable basis for the court to determine education costs in Texas, and how they vary across children and settings, is to evaluate those costs in the context of policies as they currently exist, given the actual production of outcomes and average efficiency of schools and districts in producing those outcomes. Reducing regulations may be a rational alternative, and re-estimating costs after such policy change is also reasonable. If costs of desired outcomes go down after such policy change, then great! But one cannot simply assume that regulatory change (or charter expansion as an approach to regulatory reduction—see Section 5.0) will result in dramatic efficiency gains.

26 In fact, the logical way to test these very assertions would be to permit or encourage some schools/districts to experiment with alternative compensation strategies, and other "reforms," and to include these schools and districts among those employing other strategies (production technologies) in a cost function model, and see where they land along the curve. That is, do schools/districts that adopt these strategies land in a different location along the curve? Do they get the same outcomes with the same kids at much lower spending?

27 Available at http://schoolfinancedata.org/download-data/.

28 Available at https://exhibits.stanford.edu/data/catalog/db586ns4974.

29 Available at https://nces.ed.gov/programs/edge/Economic/NeighborhoodPoverty.

30 Baker, B. D., Taylor, L., Levin, J., Chambers, J., and Blankenship, C. (2013). Adjusted Poverty Measures and the Distribution of Title I Aid: Does Title I Really Make the Rich States Richer? Education Finance and Policy, 8(3), 394–417.

31 DeMatthews, D. E., and Knight, D. S. (2019). The Texas special education cap: Exploration into the statewide delay and denial of support to students with disabilities. education policy analysis archives, 27, 2.

32 Available at https://nces.ed.gov/programs/edge/Economic/TeacherWage.

33 Available at https://nces.ed.gov/programs/edge/Economic/TeacherWage.

34 Andrews, M., Duncombe, W., and Yinger, J. (2002). Revisiting economies of size in American education: are we any closer to a consensus?. Economics of education review, 21(3), 245–262.

35 Baker, B. D. (2011). Exploring the sensitivity of education costs to racial composition of schools and race-neutral alternative measures: A cost function application to Missouri. Peabody Journal of Education, 86(1), 58–83

36 Baker, B. D., and Green III, P. C. (2009). Equal educational opportunity and the distribution of state aid to schools: Can or should school racial composition be a factor?. Journal of Education Finance, 289–323; Green III, P. C., Baker, B. D., and Oluwole, J. O. (2008). Achieving racial equal educational opportunity through school finance litigation. Stan. JCR and CL, 4, 283.

37 Costrell, R., Hanushek, E., and Loeb, S. (2008). What do cost functions tell us about the cost of an adequate education? Peabody Journal of Education, 83, 198–223.