Evaluation of New York School Funding

Report Brief 3: Using Cost Modeling to Inform School Funding Policies

Bruce Baker
University of Miami

Jesse Levin, Drew Atchison, Arun Kolar, and Adam Hearn
American Institutes for Research®

November 2024

Advancing Evidence.
Improving Lives.

Contents

Introduction 1
Addressing Endogeneity in the Relationship Between Outcomes and Spending 4
Relative Efficiency 4
Properties of a Strong Education Cost Model 6
Using the Education Cost Model to Generate Cost Estimates 7
Setting a Target Outcome Level 7
Setting the Levels of Inefficiency Variables 8
Predicting Costs 8
Using the Cost Estimates to Model a Funding Formula 8
Conclusion 9
References 10

Exhibits

Exhibit 1. Education Cost Model Components 3

Introduction

This third report brief in our series provides an overview of how cost modeling can be used to estimate the cost of achieving adequacy and inform school funding policies. Our previous two report briefs in this series addressed *what is* with respect to school funding and student outcomes (i.e., the current levels of funding and outcomes and how these vary across public school districts in the state). The first report described New York's funding formula and examined whether it successfully provides more resources to districts serving higher-need student populations. In the second report, we examined whether New York's children are meeting the outcome goals set by the state and whether students have equal opportunity to meet those goals regardless of their background and where they attend school. The two previous reports find that (a) existing funding for New York schools and districts is not equitably distributed and (b) students are not provided with equal opportunity to achieve the state's outcome goals. These findings suggest that the education funding system should be recalibrated to ensure that more resources are provided to high-need districts.

Beyond suggesting that change is needed, however, our prior two report briefs do not provide insights into either the level of funding needed to achieve more adequate outcomes for all students or the differential funding needed to provide equal educational opportunity for students with different needs or learning in different contexts. In other words, although the evaluation of existing distributions of funding and student outcomes can identify issues the state currently faces, the methods used in our prior reports do little to inform *what should be* with respect to funding. Cost function modeling is a useful approach to gain a better understanding of how much funding is needed to provide an equal opportunity for all students to achieve at a common adequate level of outcomes and how such funding must be distributed toward this end.

The goal of education cost modeling, whether for evaluating equal educational opportunity or producing adequacy cost estimates, is to empirically establish reasonable guideposts for developing more rational school finance systems. Historically, funding levels for state school finance systems have been determined more by political will and economic capacity than any empirical measures of the true cost of producing educational outcomes. 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 be limited in terms of the amount of revenues they can collect and distribute for public schools. But reasonable estimates of the cost of producing desired outcomes may influence the appetite for additional taxes or the redistribution of revenue by revealing the misalignment between costs and actual spending levels.

Reasonable estimates of cost may inform policy by assisting legislators in setting spending levels consistent with outcome demands or determining whether outcome goals are realistically attainable under existing spending levels. Reasonable estimates of cost also may assist courts in determining whether current funding levels and distributions are reasonable, sufficient, and aligned with constitutional or other legal requirements.

The following describes the methodological approach of education cost modeling and how this approach can be used to obtain reasonable estimates of the cost of meeting desired outcomes and providing equal opportunity to achieve those outcomes and how those cost estimates can be used to inform policy.

Estimating Cost Models

Education cost modeling is a statistical modeling approach that uses regression to estimate what must be spent to achieve the desired outcomes given the set of other factors that can affect the cost of achieving those outcomes. Salient cost factors include scale of operations (i.e., the existence of diseconomies of scale where costs are higher for very small schools or districts), geographic variation in the price of resources (particularly the salaries necessary to hire and retain staff), and the characteristics of the student populations served with respect to their needs. Typically, economically disadvantaged students, ELLs, and SWDs are the student groups recognized as requiring additional resources to achieve educational success.

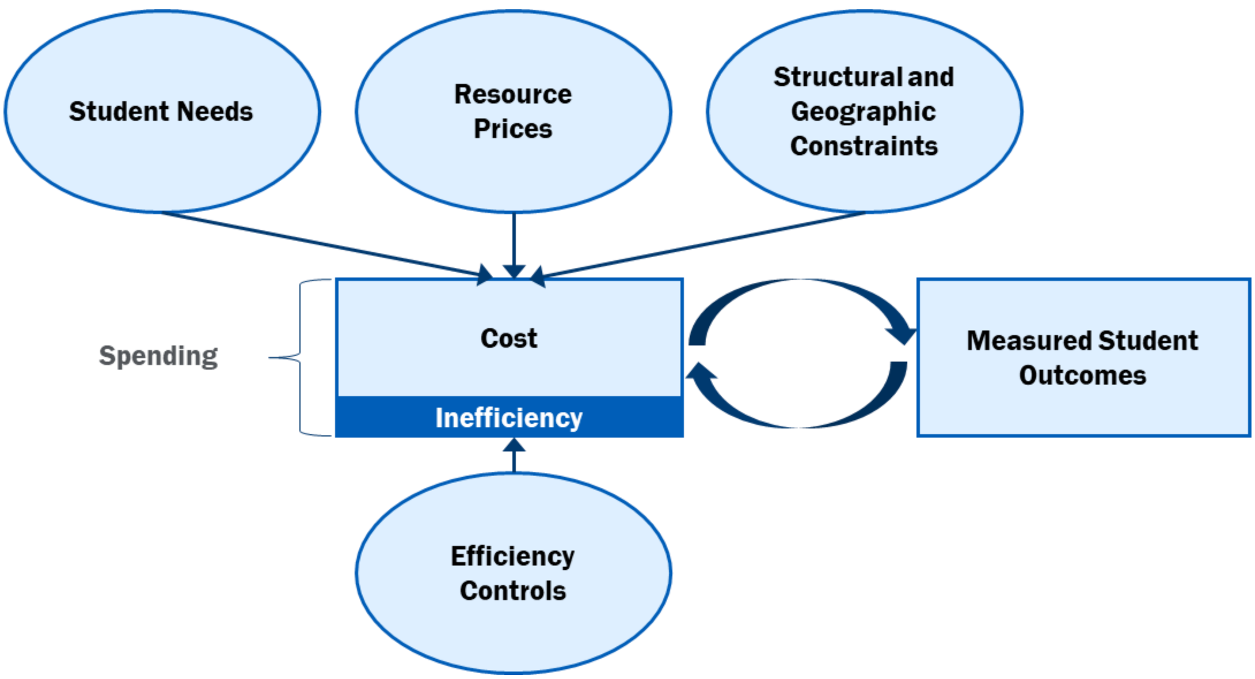
The dominant education cost modeling approach in recent peer-reviewed literature is one in which:

- The dependent measure is a measure of current operating expenditures per pupil;[1]
- Student outcome measures are treated as endogenous and instrumented using measures of the competitive context within which local public school districts operate; and
- Attempts are made to control for "inefficient" spending (i.e., spending that does not contribute to the production of the outcomes included in the model) by including measures of variations in fiscal capacity and local public monitoring.

[1] Current operating expenditures excludes spending on building construction and large capital improvements as well as debt service, which may be used to finance construction and capital expenditures.

Exhibit 1 illustrates the key components of an education cost model as well as the estimation issues that must be accounted for. The goal of the model is to determine the relationship between spending and student outcomes (such as student achievement on standardized tests of English language arts or mathematics and graduation rates) across schools or districts while accounting for the various cost factors. To do so, a cost-function model is set up as a model of spending levels that are predicted as a function of educational outcomes and other factors, rather than predicting outcomes from spending levels (a production-function model). Therefore, the dependent measure in the education cost model is a measure of per-pupil spending. The model must necessarily include measured student outcomes. Also included are factors that affect the differential cost of achieving any given level of outcome and that are assumed to be outside the control of districts (*cost factors*) that include (a) variation in student needs, (b) geographic variation in the price levels of educational inputs (e.g., teacher salaries), and (c) structural or geographic factors such as district size and population density.

Exhibit 1. Education Cost Model Components



Note. Student needs usually include measures of economic disadvantage, ELs, and students with disabilities. Resource prices refer to the exogenously determined geographic variation in the price of resources (e.g., teacher salaries). Structural and geographic constraints often include the size of districts or schools (economies of scale) and population density (to measure rurality). Efficiency controls often include measures of fiscal capacity, degree of competition (e.g., from neighboring districts), and public monitoring of public spending.

Addressing Endogeneity in the Relationship Between Outcomes and Spending

The first complexity is that the relationship between spending and student outcomes is potentially circular or endogenous (i.e., considered to be determined simultaneously), meaning that increased spending can drive better student outcomes through the purchase of additional education resources. But higher outcomes also may drive increased spending (e.g., by making the district more attractive, leading to increased property values and locally raised revenue. Thus, we must take statistical steps to correct for the fact that spending is influenced by outcomes, whereas simultaneously, outcomes also are affected by spending (the circular/feedback loop relationship in Exhibit 1).

The relevant statistical approach to isolate the effect of outcomes on spending (distinct from the effect of spending on outcomes) is to use a two-stage *instrumental variables* 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. The instrumental variables approach uses two-stage estimation where in the first-stage outcomes are estimated using *instrumental variables*, which should have an effect on student outcomes but have no effect on education spending. The second-stage model then replaces the observed outcomes with the predicted outcomes from the first-stage model, where any variation in predicted outcomes is due to the relationship between the instrumental variables and the outcome, thereby disrupting the circular relationship between spending and student outcomes.

Identifying instrumental variables that statistically influence outcomes of the observed district (are *relevant*) but, at the same time, are *valid* in that they can legitimately be excluded from the second-stage model involves both conceptual and statistical considerations. Conceptually, a long line of similar studies by Duncombe and Yinger (e.g., 2004, 2011) and Baker (2011) have used characteristics of surrounding districts, including demographic, economic, and even outcome characteristics of these districts as instrumental variables. The idea is that the outcomes of neighboring districts may place competitive pressure on the observed district.[2] To be used as instruments these "over the fence" variables must influence outcomes beyond other measures of the characteristics of the district itself (such as student demographic variables) that are included in the main (second-stage) model.

Relative Efficiency

A second complexity that must be addressed in education cost models is that education spending includes both expenditures that contribute to student outcomes included in the

[2] Note that although education cost models have traditionally been run on data with districts as the unit of observation. The AIR team has also estimated models using schools as the unit of observation. For school-level models, a similar approach can be used with average characteristics of neighboring schools used as instrumental variables.

model (represented by the cost portion of spending) and expenditures not related to these student outcomes (termed inefficiency). Specifically, districts may make investments that do not contribute to the available quantifiable outcomes included in the model. For example, significant investments in music or arts programming, drama, or extracurricular activities may not affect the student outcomes under consideration, and the model should account for this potential inefficiency. It is not necessarily the case that these expenditures are undesirable, but rather that they do not contribute directly to the measured outcomes included in the model.

The education cost model accounts for this by including efficiency controls that predict increased spending behavior but do not contribute to higher outcomes (Duncombe et al., 1997; Grosskopf et al., 2014). These could include measures of local district competition and measures influencing local public monitoring of public expenditures (share of funding coming from nonlocal sources and proportions of the local population that are school aged). 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, so that we can set these factors to a constant level (average) when projecting cost estimates.

However, there will always likely remain some variation in spending in relation to outcomes that is either random (a function of unexplained variation in either the spending or outcome measures) or nonrandom but not captured by the measures available that were included in the model. This variation can encompass a number of factors and should not be overinterpreted. Unexplained variation in our model can be parsed into three potential sources:

- **Omitted variables**. The AIR team prefers to estimate education cost models that are relatively simple in terms of the number of variables and interactions included. We find that simpler models are more easily interpreted, making them more useful for policymakers. Our models are also limited to using data that is collected consistently over a period of time. However, estimating simple models based on the available data may mean that there are certain variables that are not accounted for that affect the cost of achieving a given level of outcome. For example, the measures of student need that states collect are often coarse and are imperfect measures of student need. There are certainly dimensions of need such as food security, housing security, parental education, and student health that could affect student outcomes and the cost of education are not fully reflected in the limited measures of student need that are collected and available.
- **Measurement error in inputs or outcomes (systematic or random)**. Outcome measures, like state assessment scores, even when aggregated up to schools or districts, contain measurement error. There also may be differences in the measurement of relevant

expenditures across districts either because of reporting irregularities or different relationships between district or school organizational structure and the provision of services to students. When this measurement error or irregularities in the data are random, explanatory variables will not capture that variation.

- **Real Differences in Inefficiency**. It is reasonable that any two districts serving otherwise similar student populations and facing similar external cost pressures may 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 these measured outcomes. Ideally, we would have complete models with sufficiently accurate and precise measures of inputs and outcomes to isolate these real differences in inefficiency. But even in this case, we must be careful to understand what we mean by differences in efficiency. As we mentioned earlier, some districts may spend more to achieve the same measured outcomes because they are electing to spend their funds on services or programs that are valued by their communities or constituents but that may not translate directly to shifts in reading and mathematics scores or other outcomes reflected in the data. This spending, although valued and potentially contributing to unmeasured student outcomes, would be "inefficient" per the model specifications herein.

In short, education cost models may be imperfect and/or incomplete but can still provide reasonable broad policy guidance regarding the relative adequacy of school spending toward achieving common outcomes and can provide evidence on the magnitude of disparities in school funding.

Properties of a Strong Education Cost Model

Estimating an education cost model is an iterative process. Not all instrumental variables end up being strong predictors of outcomes and not all inefficiency controls end up being related to differences in spending. Usually multiple models are estimated using different options for instrumental variables and controls for inefficiency before a model with strong properties is estimated. Ultimately, the model selected should exhibit the following properties:

- The main regression (second-stage) model describing spending yields estimated coefficients of the major cost factors that are (a) in the expected direction and (b) of reasonable magnitude.
- The selected collection of instruments are of sufficient strength and are valid/not overidentified.
  - Sufficient strength is indicated by an *F* test of the instrumental variables included in the first-stage model, where a rule of thumb suggests the *F* statistic should be greater than 10.

  – A common test of overidentification is the *Hansen J* statistic. An insignificant Hansen J ($p > .10$) indicates that the model is not overidentified.

- At least one of the variables included in the model intending to capture inefficiency (e.g., measures related to fiscal capacity, local public monitoring, and/or competition density) is statistically significant.

Using the Education Cost Model to Generate Cost Estimates

After estimating an education cost model, the model can be used to generate predictions of the cost of achieving a target outcome level for each school or district included in the data. Generating these cost predictions requires selecting a target outcome level for the outcome variable included in the model and determining what level to set the inefficiency variables.

Setting a Target Outcome Level

The setting of a target outcome level should be informed by an analysis of the existing outcomes in the state and whether the outcomes in the state already meet the state's outcome goals. As noted in our report brief on student outcomes and student needs, New York State's average outcomes on reading and math assessments generally fall below NAEP proficiency standards and the state's own proficiency standards (on average) and is relatively low among other neighboring states (Atchison et al., 2024b). New York's 8^{th} graders perform somewhat better than the state's 4^{th} graders relative to benchmarks and other states. In our prior brief, we also compared New York's actual performance to the state's educational goals defined in its state plan under the Every Student Succeeds Act (ESSA; New York State Education Department, 2024), leading to the conclusion that performance in the state must be improved to meet the state's educational goals.

Given that current outcomes in the state do not seem sufficient, we recommend predicting costs at two outcome targets: (a) the current average outcome level and (b) a high outcome target that better aligns with the state's goals. Using the average outcome target shows how funding would be distributed to achieve equal opportunity assuming no statewide change in outcome levels (and therefore little change in statewide funding levels). Predicted costs at a high outcome target will reflect both the increased statewide cost needed to achieve the higher outcome target as well as how that amount of funding should be distributed to achieve equal opportunity to achieve the higher outcome target.

Setting the Levels of Inefficiency Variables

We recommend predicting spending at the averages for the inefficiency control measures, which produces results that can be interpreted as representing average school or district spending that is unrelated to the measured outcomes included in the model. That is, in our cost predictions, we do not want to predict the bare minimum that must be spent for students to achieve only those measured outcomes included in the model. Rather, we prefer to estimate the spending associated with achieving the measured outcomes while assuming an average mix of other programming to which spending is directed that may not contribute directly to those outcomes. It is our assumption that all children should have equal opportunity to access a similar mix of programs and resources beyond those that contribute only to commonly measured academic outcomes.

Predicting Costs

After setting the outcome at a target outcome level and setting the inefficiency controls at a fixed level, costs can be predicted for each school or district that reflect the differences in student needs or other contextual factors. For example, if the education cost model indicates that districts with higher poverty rates have a higher cost, the predicted cost estimates for higher-poverty districts will be higher than for otherwise similar lower-poverty districts. In other words, the predicted costs can be used to demonstrate how costs required to achieve a target outcome level vary across schools or districts in the state given the variation in other cost factors included in the education cost model.

Using the Cost Estimates to Model a Funding Formula

In our prior work, we have also worked to further inform policy by explicitly modeling how the cost estimates can be translated into state funding formulas (Atchison et al., 2023, 2020; Kolbe et al., 2019). Education cost models can be overly complicated with the two-stage estimation, the use of inefficiency controls, and potential use of measures, interactions, or nonlinear terms that would not typically be included as part of a state funding formula. Therefore, we also often estimate a secondary “weights estimation model,” which can be used to directly model the funding parameters that might be included in a state funding formula (e.g., a base funding amount and weights for student needs and other characteristics such as small districts/schools). That additional weight estimation step also provides additional flexibility to explore alternative options for the structure of the funding formula (e.g., whether to keep the current formula’s structure and funding parameters and just update them or whether to include new/different funding parameters).

Conclusion

The design or updating of state funding formulas should be informed by evidence regarding the cost of achieving adequate student outcomes that meet the state's educational goals. Education cost modeling is one method for generating reasonable estimates of the cost of achieving a target level of student outcomes. These cost estimates can then be used by state policymakers, the courts, and other education advocates in evaluating whether the current funding system or new proposals to changing the education funding system achieve the goals of adequacy and equal opportunity

References

Atchison, D., Levin, J., Fatima, S., Trauth, A., Srikanth, A., Heberle, C., Gannon-Slater, N., Junk, K., Wallace, L., & Baker, B. (2023). *Assessment of Delaware Public School Funding*. American Institutes for Research.

Atchison, D., Levin, J., Kolar, A., & Hearn, A. (2024a). *Evaluation of New York school funding—Report brief 1: Equity for students*. American Institutes for Research.

Atchison, D., Levin, J., Kolar, A., & Hearn, A. (2024b). *Evaluation of New York school funding—Report brief 2: Student outcomes and student needs*. American Institutes for Research.

Atchison, D., Levin, J., Baker, B., & Kolbe, T. (2020). *Equity and adequacy of New Hampshire school funding: A cost modelling approach*. American Institutes for Research. https://carsey.unh.edu/sites/default/files/media/2020/09/20-12685_nh_final_report_v10.pdf

Atchison, D., Levin, J., Fatima, S., Trauth, A., Srikanth, A., Heberle, C., Gannon-Slater, N., Junk, K., Wallace, L., & Baker, B. (2023). *Assessment of Delaware public school funding*. American Institutes for Research.

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.

Baker, B. D. (2013). What does the New York City Charter School Study from CREDO really tell us? School Finance 101. https://schoolfinance101.com/2013/02/25/what-does-the-new-york-city-charter-school-study-from-credo-really-tell-us/

Baker, B. D. (2024). *How and why racial isolation affects education costs & the provision of equal educational opportunity*. (EdWorkingPaper 4-1047). Annenberg Institute, Brown University.

Baker, B., Levin, J., Atchison, D., & Kearns, C. (2020). *Costing out an adequate education: A primer*. American Institutes for Research. https://carsey.unh.edu/sites/default/files/media/2020/06/20-11882_1._primer_costestimation_formatted_air_v4.pdf

Cornman, S.Q., Nixon, L.C., Spence, M.J., Taylor, L.L., and 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, National Center for Education Statistics.

Duncombe, W. D. (2002). *Estimating the cost of an adequate education in New York*. (Center for Policy Research Working Paper 114). Maxwell School of Citizenship and Public Affairs, Syracuse University. https://surface.syr.edu/cgi/viewcontent.cgi?article=1113&context=cpr

Duncombe, W., Lukemeyer, A., & Yinger, J. (2003). Financing an adequate education: A case study of New York. In W. Fowler (Ed.), *Developments in school finance: 2001–02* (pp. 127–154). U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics.

Duncombe, W., Miner, J., & Ruggiero, J. (1997). Empirical evaluation of bureaucratic models of inefficiency. *Public Choice*, 93(1), 1-18.

Duncombe, W., & Yinger, J. (2004). *How much more does a disadvantaged student cost?* (Center for Policy Research Working Paper 60). Syracuse University.

Duncombe, W., & 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.

Grosskopf, S., Hayes, K. J., & Taylor, L. L. (2014). Efficiency in education: Research and implications. *Applied Economic Perspectives and Policy*, 36(2), 175-210.

Kolbe, T., Baker, B., Atchison, D., & Levin, J. (2019). *Pupil weighting factors report*. University of Vermont. https://legislature.vermont.gov/assets/Legislative-Reports/edu-legislative-report-pupil-weighting-factors-2019.pdf

New York State Education Department. (2024). *Revised state template for the Consolidated State Plan (New York, Draft Amendments 2024)*. https://www.nysed.gov/sites/default/files/programs/accountability/reimagine-essa-plan-redline_public-comment.pdf

About the American Institutes for Research®

Established in 1946, the American Institutes for Research® (AIR®) is a nonpartisan, not-for-profit institution that conducts behavioral and social science research and delivers technical assistance both domestically and internationally in the areas of education, health, and the workforce. AIR's work is driven by its mission to generate and use rigorous evidence that contributes to a better, more equitable world. With headquarters in Arlington, Virginia, AIR has offices across the U.S. and abroad. For more information, visit AIR.ORG.

AIR® Headquarters
1400 Crystal Drive, 10th Floor
Arlington, VA 22202-3289
+1.202.403.5000 | **AIR.ORG**

26599_11/24