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A Study of Cost Adequacy, Distribution, and Alignment of Funding for North Carolina's K–12 Public Education System

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Introduction

This finance and resource allocation study focused on an examination of three major components of an effective resource allocation system in North Carolina: (1) the equitable distribution of funding across school districts; (2) the alignment of funding to student needs; and (3) the adequacy of education funding. Each of these components are cited in the *Leandro* rulings as areas of need that should be addressed by the state. Furthermore, these components must work in congruence with one another in order to progress toward the standard set by the Supreme Court of North Carolina (the Court) in the *Leandro* rulings. That is, one component alone is insufficient to either achieve the standard of the rulings or to remain consistent with the research and evidence on this topic.

Equitable Distribution: The third tenet of the *Leandro* ruling states that the system should ensure that "the educational needs of all children, including at-risk children, have the equal opportunity to obtain a sound basic education, can be met" (*Hoke County Board of Education v. State*, 2002). Although the ruling allows for local communities to supplement funding beyond what the state provides, the ability of local communities to provide supplemental funding varies. As such, the third tenet relates to how the education finance system distributes funding to support educational opportunities for historically underserved student populations.

This may require distributing more resources to higher-need student populations. For example, research suggests that to reach the same performance target, a low-income student may require twice as much — or more — funding than a student who is not low income (Duncombe & Yinger, 2005).

Equitable education systems provide significant social and economic benefits for all citizens. This includes expanding the pool of skilled workers, promoting economic growth by driving upward mobility (OECD, 2015), reducing crime by increasing human capital (Meghir, Palme, & Schnabel, 2012), and reducing dependency on public aid by reducing poverty (OECD, 2012).

Alignment: The *Leandro* ruling also states that "the resources necessary to support the effective instructional program" should be provided in "the most cost-effective manner" (*Hoke County Board of Education v. State*, 2002). This indicates that the state should support, and not hinder, efforts to strategically allocate resources in alignment with local student need. Aligning funding to student needs requires sufficient funding stability and flexibility. Without funding stability, districts struggle to engage in multiyear budget planning — an important component not only for improving student outcomes, but also for maintaining the district's fiscal health (Williams & Kersten, 2013). Funding flexibility is important to enable schools to invest funds in proven, effective strategies and programs to serve their specific student populations and to uncover new promising practices (Hill, Roza, &

Harvey, 2008). Moreover, too many restrictions on funding may result in inefficient spending by limiting the extent to which districts are able or compelled to make strategic trade-offs. This component also addresses strategic implementation of changes to the state's finance system, including the gradual phasing-in of investments and accountability measures.

Adequacy: In calling for the provision of "the resources necessary to support the effective instructional program" to meet the educational needs of all students (*Hoke County Board of Education v. State,* 2002), the third tenet of the *Leandro* ruling directly requires the need for adequate funding. *Leandro*'s other two tenets, which call for access to effective teachers and principals, also depend upon adequate funding.

The attention to the fiscal adequacy of public education reaches beyond North Carolina and includes many other states where courts have played an important role. Typically, these lawsuits argue that the formula by which a state funds education results in insufficient funding, often for particular school districts. In fact, the prevalence of such lawsuits has grown over the past three decades, with litigation in 45 of 50 states. And in the majority of these cases, the plaintiffs won (Rebell, 2016). Between 2003 and 2014, independent researchers conducted studies in at least 26 states to review state funding and estimate the level of funding required to meet the obligation established by the state courts (Aportela, Picus, Odden, & Fermanich, 2014).

Context

Education Funding Models

North Carolina's current school finance system is an allotment system, based on a resource allocation model of funding. In a resource allocation model, the state determines which components are necessary for public education and provides resources specifically for each component. North Carolina is one of only seven states in the country that still utilize a resource allocation model (Program Evaluation Division, North Carolina General Assembly, 2016). Furthermore, North Carolina's resource allocation system reflects one of the most traditional versions of this model among the seven states. Delaware and Idaho, for example, have adapted their resource allocation models to include approaches more commonly found in other states.

The most common finance model is the foundation model,[1] in which the state determines the minimum amount of funding per pupil, estimates each district's ability to contribute local funds, and fills in the gap (Chingos & Blagg, 2017). In most states, districts are allowed to raise additional local funds to spend beyond the minimum level. Most foundation models determine the minimum amount of funding needed based on a weighted student formula, which provides additional funds for students with greater needs, such as economically disadvantaged students, English learners, students with disabilities, and certain grade levels (Chingos & Blagg, 2017). Although districts may have substantial flexibility in how to use these foundation funds, some states also provide a smaller proportion of their funds via categorical grants, which must be used for specific purposes, similar to North Carolina's allotment system.

The State's Allotment System

North Carolina's allotment system funds schools with three basic types of allotments:

Position allotments provide funding for a set number of staff positions in various categories, including teachers, school building administrators, and instructional support. Staff salaries are determined by statewide salary schedules, though districts may choose to supplement salaries with local funding. Position allotments accounted for approximately 54% of 2018–19 allotment funding, based on North Carolina Department of Public Instruction (NCDPI) data.

1 Used by between 35 and 37 states, depending on how strictly one defines the term.

Dollar allotments provide a set number of dollars to pay for specific resources, including some staff positions, such as central office administration and teacher assistants, as well as physical resources like textbooks and classroom materials. Dollar allotments provide a flat amount of funding based on district enrollment, or the average daily membership (ADM).

Categorical allotments provide a set number of dollars to pay for specific programs, such as transportation and driver education, or for programs serving specific populations, such as at-risk students, English learners, students with disabilities, and exceptional children. Similar to dollar allotments, categorical allotments provide a flat amount of funding based on district enrollment.

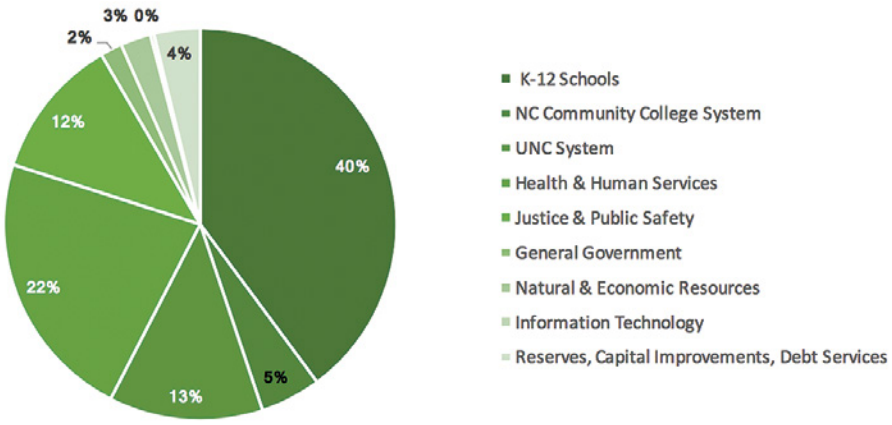
A few small categorical grants also exist for specific initiatives, such as school safety; these are often one-time funds.

Although only some of North Carolina's allotments and grants are "categorical" in name, the state's entire resource allocation system prescribes specific purposes for each funding allowance. As will be discussed in the Findings section, the system previously provided substantial flexibility — allowing for funds to be transferred from one purpose to another, in accordance with local district needs — but much of this flexibility has been withdrawn in recent years. Notably, this contrasts with national trends, as other states have increasingly moved away from prescriptive funding systems and have increased local flexibility (Smith, Gasparian, Perry, & Capinpin, 2013).

Sources of Funding

In 2019, North Carolina allocated approximately 40% of its total General Fund appropriation to K–12 education (North Carolina General Assembly, 2018a, p. A2). Exhibit 1 displays the overall distribution of appropriations in 2018–19.

Exhibit 1. General Fund Appropriations by Spending Category — 2018–19



Source: North Carolina General Assembly — 2018 Appropriations Act

State funds comprised about 65% of all K–12 education spending in the 2017–18 school year.

Compared with the nationwide average and with neighboring states, North Carolina's public education system receives a significantly higher proportion of its funding from the state (see Exhibit 2). Consequently, the state's significant role in determining the level and distribution of funding for K–12 education puts it in a pivotal role to create funding structures that attend to adequacy, equity, and alignment.[2]

Exhibit 2: Public Education Funding by Source, FY 2016

	Federal	State	Local
North Carolina	12%	62%	26%
South Carolina	10%	48%	43%
Tennessee	12%	46%	42%
Georgia	10%	46%	45%
U.S. Average	8%	47%	45%

Source: National Center for Education Statistics data, FY 2016

For example, local funding levels tend to reflect the local community's wealth, with affluent communities providing more supplemental funding. However, state funding can address inequities in local funding by directing additional state resources toward less affluent districts, which also tend to serve higher-need student populations (Baker, Farrie, & Sciarra, 2018).

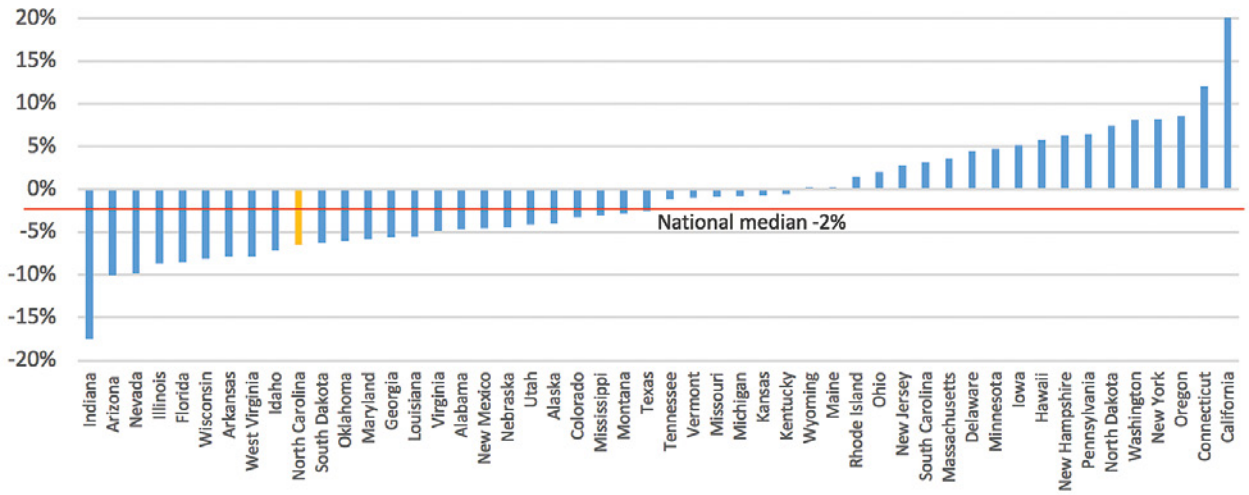
In North Carolina, this need and opportunity to address inequity is particularly significant, as the state has an above-average proportion of high-need students. As of fiscal year (FY) 2017, the most recent year for which national data are available, 53.1% of North Carolina's enrolled K–12 students were eligible for free lunch, a federal definition for the most economically disadvantaged student population. Compared with other states, North Carolina has the ninth-highest proportion of this student population, among those states with data reported.[3] Moreover, these students are concentrated in communities with less ability to provide local supplemental funding (Public School Forum of North Carolina, 2018).

Also notable is the decline in North Carolina's inflation-adjusted education spending compared with that of other states. Between FY 2010 and FY 2016, North Carolina's adjusted per-pupil revenue declined by 6%, three times more than the national median decline of 2%.

2 In an effort to increase fiscal transparency, in April 2019, North Carolina launched the new North Carolina School Finances website — an interactive, accessible online dashboard displaying fiscal data for all 115 local education agencies across the state.

3 This is based on National Center for Education Statistics data, FY 2017. Eight states did not have required data reported due to not meeting relevant data quality standards.

Exhibit 3: Percent Change in Real Inflation-Adjusted Dollar-per-Pupil Total Revenue, 2009–10 to 2015–16

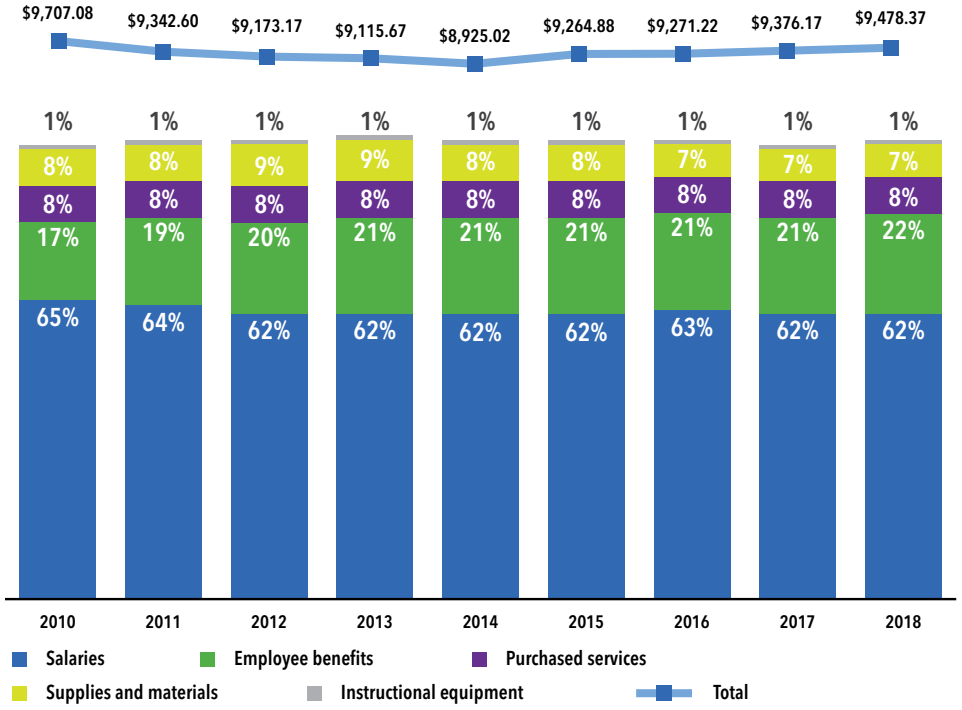


Source: National Center for Education Statistics data, FY 2016

As of FY 2017, the most recent year for which national rankings are available, North Carolina's total per-pupil spending was the sixth-lowest in the nation (U.S. Census Bureau, 2019).

Considering per-pupil spending within North Carolina between 2010 and 2018 (see Exhibit 4), the allocation of resources by category remained fairly stable, with the main exception of salaries and benefits. Although the proportion of spending on labor overall increased 2 percentage points, the share of this spending allocated to salaries went down 3 percentage points while the share of spending on employee benefits increased 5 percentage points. Thus, although a greater proportion of expenditures is going toward labor costs, this does not translate into proportionately higher teacher salaries, due to the increasing cost of benefits — a trend seen nationwide (Aldeman, 2016). Proportion of funds allocated to other categories of spending remained relatively consistent over time.

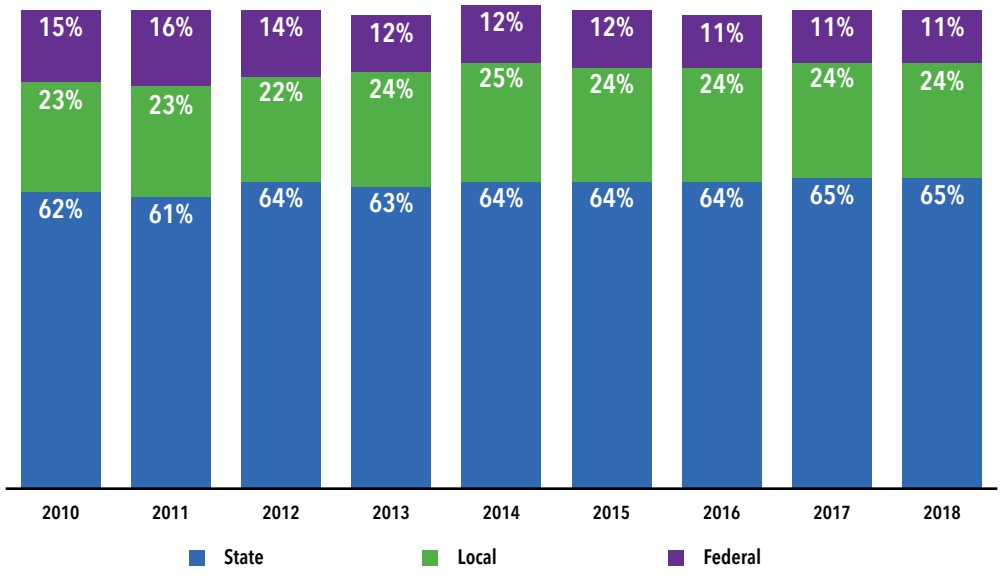
Exhibit 4: Total per-Pupil Spending by Category and Overall — 2010–2018



Source: NCDPI Statistical Profile data. Values adjusted for inflation to 2018 dollars.

Furthermore, over this same period, state and local dollars have grown as a proportion of spending by 4 percentage points, from 85% to 89% (see Exhibit 5).

Exhibit 5. Distribution of Spending by Source of Funding — 2010–2018



Source: NCDPI Statistical Profile data. Values adjusted for inflation to 2018 dollars.

Growth of Charter School Enrollment

Exhibit 6: Charter School Growth from FY 1998 to FY 2018

	# charters	Planned allotted ADM	% state ADM	Allotted state $
1997–98	33	4,106	0.3%	$16.6 million
2007–08	98	30,892	2.1%	$169.9 million
2017–18	173	101,689	6.6%	$580.8 million

Source: Highlights of the North Carolina Public School Budget, February 2018

As shown in Exhibit 6, over the past two decades, the number of students enrolled in charter schools in North Carolina has increased dramatically, similar to the rate of growth in charter enrollment nationally (National Center for Education Statistics, 2018). When a student exits a traditional public school district to enroll in a charter school, the per-pupil funding follows the student. As indicated in Exhibit 6, the proportion of North Carolina public school students (with enrollment measured by the ADM) attending charter schools has risen from 0.3% in FY 1998 to 6.6% in FY 2018.

Charter schools are exempt from the state's allotment system requirements and are afforded a great deal of financial and educational flexibility. For example, each charter school receives a single allotment of flexible funds, is not required to use statewide salary schedules to determine staff compensation, and is not subject to the class size maximums for grades K–3 (North Carolina State Board of Education & Department of Public Instruction, 2018a).

Approach

Research Questions

This study's research questions focused on the three critical components of effective finance systems.

1. **Distribution:** What is the current distribution of funding across schools and districts? What factors (statutory or distribution of funds) create inequities in the allocation of resources, if any?
2. **Alignment:** Is funding flexible enough to ensure effective use of funds? Is funding stable enough to ensure effective use of funds?
3. **Adequacy**: How much funding is necessary to achieve North Carolina's goals for student outcomes?

Methods

The research design included three methods: a needs assessment, professional judgment panels, and a cost function analysis.[4] Drawing on the study's findings, the research team developed a set of recommendations for the education finance system to support achievement of the state's goals for student performance.

Needs Assessment

The needs assessment included the collection of qualitative and quantitative data on North Carolina's current education finance system, its evolution over time, and its strengths and weaknesses.

The needs assessment focused largely on Research Questions #1 and #2: whether resources are distributed equitably and whether they allow for alignment with student needs by providing sufficient flexibility and stability. Research Question #3, adequacy, was addressed to a more limited extent. From the data collected, several priorities were identified as requiring additional funding; however, unlike the costing-out studies, the needs assessment did not attempt to address the question of how much funding is necessary to meet student needs.

Discussion and interview protocols (see Technical Appendix A) were developed for the focus groups and interviews. Data were collected from the following sources:

4 For the detailed methodology and protocols used for each part of this research study, please see Technical Appendices A–D.

» Two in-person focus groups of 12 North Carolina school district chief financial officers (CFOs) representing a diverse range of districts

» Individual follow-up phone interviews with 7 district CFOs

» Individual phone interviews with 2 former NCDPI business officials

» Online survey responses from more than 700 North Carolina public school principals

» Manuals published by the NCDPI, including annual Allotment Policy Manuals

» Reports published by the NCDPI, including annual Budget Highlight reports

» Publicly available multiyear data from the NCDPI website on district allotments, expenditures, student demographics, and school characteristics

» North Carolina legislation

In addition, the needs assessment involved a review of prior research, including North Carolina education finance reports and research studies, as well as national school finance studies.

North Carolina Professional Judgment Panels

Drawing on the expertise of a diverse pool of panelists representing a variety of practitioner roles, the purpose of a typical professional judgment panel is to generate estimates of the minimum spending associated with a set of desired outcomes.[5] The WestEd research team conducted a series of three professional judgment panels in different areas of the state. Panelists were selected to reflect a mixture of perspectives, with representatives from various groups (Chambers, Levin, & DeLancey, 2006).

Moreover, panelists were selected because they were exemplary representatives of their respective roles and brought a diversity of experiences and characteristics. See Technical Appendix B for more details on the panel selection process.

» **Panelist identification** — To identify prospective panelists, the research team invited education leaders to serve as "key messengers" and provide a list of prospective panelists meeting the selection criteria.[6] Based on their referrals, 143 individuals were invited to join the pool of prospective panelists, 88 of those invited expressed interest, 55 were identified as finalists, and 19 ultimately participated in the panels. These individuals were split into groups of 8, 6, and 5 for each of the three panels, respectively.

5 This usually includes teachers, principals, instructional support staff, school counselors, district business officers, and district leadership.

6 This included both state-level education leaders and local leaders identified by project staff through direct stakeholder engagement. Ultimately, out of 54 people contacted, 11 people agreed to serve in this role of key messenger and recommend prospective panelists. For a full list of key messengers, see Technical Appendix B.

» **Panelist quality and best fit** — A variety of measures were considered in the panelist selection process to identify panelists best able to contribute to the panel discussions. This included number of years of experience, independent recognition of quality, direct referral by an education leader, experience working with special populations and in a diversity of settings, and a current assignment in a low-wealth district. These measures were used to provide a score for each prospective panelist. Finalists were identified as only those receiving average or above-average scores.[7]

» **Panelist diversity** — This study's emphasis on innovative thinking led the research team to conclude that diversity of characteristics and experiences would be particularly important for these panels. As such, an effort was made to select as diverse groups of panelists as possible.[8]

Each group of panelists was presented with a data profile of the "typical" school environment at each schooling level: elementary, middle, and high school. Panelists were then asked to deliberate on the resources required in the specified environment to achieve a desired set of student outcomes. Based on the qualitative recommendations made by the panels, the research team estimated a total per-pupil dollar amount using a set of assumptions about prevailing costs. For some resource categories, panelists provided estimated costs as part of their recommendations. The primary purpose of creating these estimates was to prompt a discussion among panelists about how best to make necessary trade-offs when the scope of desired outcomes is narrowed and the budget is constrained. (See Technical Appendix B for further details.) Due to the imprecise nature of the cost estimates generated by the professional judgment panels, these estimates did not affect this study's cost adequacy calculations as provided by the cost function analysis. Rather, findings from the panels were used to establish a list of resource allocation priorities.

Panel Structure

The research team drew on best practices from prior research to design the structure of the two-day panel meetings (Levin, Brodziak de los Reyes, Atchison, Manship, Arellanes, & Hu, 2018). The panel process included an icebreaker, pre-reading activity, base and special setting recommendation deliberations, cost estimate review, and implementation discussion. For additional details on the panel structure, see Technical Appendix B.

Although the professional judgment panels implemented for the current study follow the typical panel method in general, there are a few key differences between the goals and structure of the typical method and those of the panels for this study. These differences include:

» **Emphasized allocation over estimated costs** — Unlike a traditional panel, the primary goal of the panels in this study was to provide recommendations on the ideal allocation of resources, as opposed to providing an estimate of the adequate level of funding.

7 Particularly due to the emphasis of this study and the ongoing *Leandro* litigation, we sought panelists with experience serving high-need groups and students in low-wealth environments.

8 For additional details on the final composition of panelists, see Technical Appendix B.

» **Investigation of trade-offs** — To mitigate the concern that panels do not take into account budget constraints, panelists also engaged in an activity to establish resource allocation recommendations under a narrower set of desired outcomes for students.[9]

» **Implementation discussion** — To address the challenge that new investments must be made over time and within a complex political environment, panels discussed and made recommendations related to the timing, sequence, flexibility, and accountability of new investments.

Education Cost Function Method

A cost function analysis was the primary method used to address Research Question #3, about funding adequacy. Using the same approach as a 2018 cost adequacy study conducted for the state of Kansas (Taylor, Willis, Berg-Jacobson, Jaquet, & Caparas, 2018), the research team used a stochastic frontier analysis to estimate an education cost function for North Carolina. A cost function estimates the minimum funding necessary to achieve certain outcomes, given input prices and environmental factors. Using the model, it is possible to estimate the marginal effect of specific factors, holding all other factors constant. Put simply, if a given set of schools are identical in every way except for their poverty rates, this model estimates how the minimum spending required for each school to achieve the same student outcomes differs across these schools. For example, must the high-poverty schools spend more relative to the low-poverty schools? The cost function model provides evidence regarding these marginal effects.

The data used in this analysis came from NCDPI administrative and public files, including data housed and maintained by the Duke University North Carolina Education Research Data Center. Publicly available data from the National Center for Education Statistics, the U.S. Bureau of Labor Statistics, the U.S. Department of Housing and Urban Development, and the U.S. Census Bureau were also used in the analysis. The analysis covered the five-year period from 2012–13 through 2016–17.

It should be noted that the analysis uses a constructed measure of "operating expenditures," which excludes some categories of expenditures not considered to be operating expenditures. These excluded categories include debt service; construction expenditures; fund transfers; food services; judgments and settlements against the district; transportation services; tuition- or fee-funded programs (e.g., before- and after-school care, preschool); ancillary services; payments to other government units except indirect costs; and nonprogrammed charges. Furthermore, preschool expenditures were excluded due to inaccessibility of complete financial data for these grades. Finally, charter schools were excluded because they may have different cost structures than other buildings, as were a handful of special schools for which no spending data was provided. These exclusions amounted to approximately 425 schools across all years of data. Therefore, the expenditures reported represent K–12 operating expenditures in traditional school buildings.[10] This definition should be noted as one reviews the cost estimates reported in this summary.

9 This sort of introduction and examination of potential trade-offs is becoming more common in more recent iterations of this method (e.g., Levin, Brodziak de los Reyes, Atchison, Manship, Arellanes, & Hu (2018)). However, as far as we are aware, our study is the first time that results from a cost function analysis have been included in a panel discussion.

10 Due to missing data, the analysis sample excluded approximately 50 additional schools.

Components of the education cost function analysis included:

- Unit of analysis (traditional public schools)
- Dependent variable (per-pupil expenditures)
- Outputs (student outcomes) — specifically, graduation rates and growth measures of student performance in English language arts and math on the North Carolina state assessments
- Input prices (a hedonic wage index for modeling teacher salaries)
- Environmental factors (district enrollment, schooling level, and proportion of students with higher needs, such as English learners, exceptional children, and students eligible for free lunch)
- Efficiency factors (a combination of five factors that might influence spending efficiency)[11]

A more detailed description of the stochastic frontier analysis and the teacher cost index used in this study can be found in Technical Appendices C and D.

11 Specifically, these efficiency factors included a measure of market competitiveness, relevant community characteristics, measures of local wealth and poverty, an indicator of schools that received Race-to-the-Top funds through the TALAS program, an indicator of schools serving only pre-K grades, and interaction terms to account for how the effect of these factors may depend on other relevant factors. A complete discussion of efficiency factors included in the model is found in Technical Appendix C.

Findings

The findings that follow are organized based on the three components of effective finance systems: equitable distribution, alignment with student needs, and adequacy.

Inequitable Distribution of Resources

This study's first research question focuses on the factors that currently influence the distribution of funds and the extent to which this creates inequities in funding. To study the distribution of funding in North Carolina, this study combined a review of the current distribution of funding, the extent to which this current distribution is equitable, and what it might take to improve equity.

Across the three study methods, the statewide distribution of funding was found to be inequitable in two key ways: (1) school districts lack the funding necessary to meet the educational needs of historically underserved student populations, and (2) funding across districts is inequitable due to differences in local funding, differences in state funding received through the Classroom Teacher allotment, and differences in regional costs.

Equity-Focused Allotments Help, But Are Underfunded

As noted earlier, because the state provides a high proportion of North Carolina's overall education funding, policymakers also have a greater ability to ensure that education funds are distributed equitably. This includes the potential to correct for inequities caused by local supplements, as well as providing additional funds for higher-need student populations and/or regional cost differences. Indeed, North Carolina's allotment system does have several allotments that are intended to correct for inequities, as displayed in Exhibit 7.

Exhibit 7. Allotments Intending to Address Inequities

Allotment category	% FY 2019 allotment funds	Additional $ per pupil
Disadvantaged students	0.7%	49.48
At-risk students	2.7%	190.38
English learners	0.8%	57.12
Exceptional children	8.2%	573.35
Low-wealth students	2.2%	154.79
Small county	0.4%	29.41

Source: North Carolina Department of Public Instruction 2018–19 Year-to-Date State Allotment Data

Note: Updated as of May 20, 2019

Nevertheless, during the needs assessment, many district CFOs described inequities in North Carolina's finance system. However, not all CFOs described the funding system as inequitable. Many of those who described the funding system as equitable — or noted that the structure could theoretically be equitable — referred to the allotments that intend to provide additional resources to higher-need students. Several CFOs reported that although these allotments help, they are underfunded.

Furthermore, CFOs identified the system's overall inadequate funding as a contributor to inequity. As one CFO stated, "If the formulas that were in place were adequately funded in the different areas that they have set up, then, yes, it's equitable. Like, everybody gets classroom supplies and materials. Well, everybody knows that you need more than $35 per pupil for a classroom." The same CFO went on to explain that because of insufficient funding for materials, schools frequently ask parents to contribute to the cost of school supplies. Yet some parents, particularly in high-poverty areas, cannot afford to make these contributions. As a result, CFOs reported that these schools are hit hardest by funding inadequacy.

Specific Student Populations Need Higher Levels of Funding

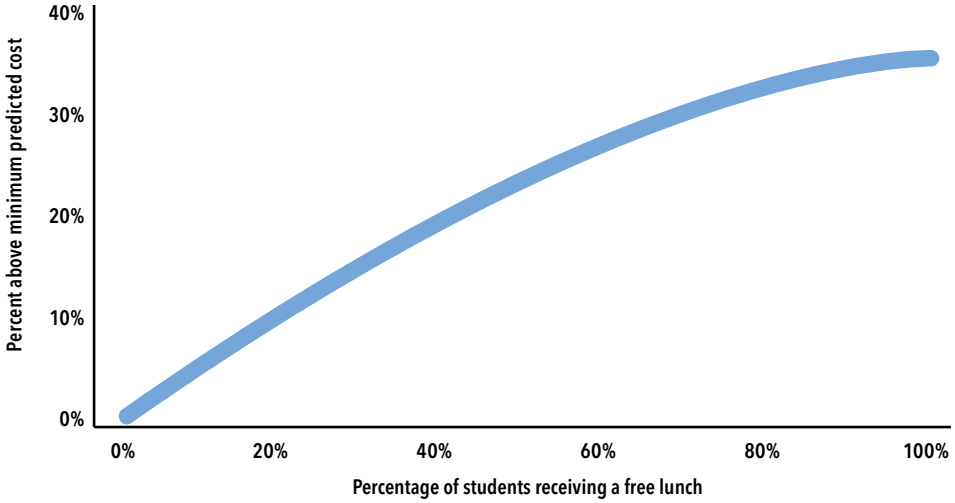
Consistent with prior research (Duncombe & Yinger, 2005; Taylor, Willis, Berg-Jacobson, Jaquet, & Caparas, 2018), the education cost function analysis indicated that more funding is required to produce the same outcomes as the population of students with greater needs (e.g., English learners, economically disadvantaged students, exceptional children) increases. The analysis found that as the school-level percentage of economically disadvantaged students (defined here as those eligible for free lunch)[12] increases, the cost to achieve the same academic growth goes up, holding all other cost factors constant. For example, if we take School A with a population comprised of 60% economically disadvantaged students and compare with to School B with a population of 90% economically disadvantaged students, the predicted cost per pupil to ensure those students reach the same performance level

12 In the professional judgment panels, economically disadvantaged students were defined as those eligible for free or reduced-price lunch (FRPL), whereas in the cost function analysis, economically disadvantaged students were defined only as those eligible for free lunch. This was necessary because the research team views free lunch eligibility as less sensitive to the impact of the Community Eligibility Program and sees the National Center for Education Statistics (NCES) Common Core of Data as the source of data with the most consistently applied rules of aggregation. Based on NCES FY 2017 data, 57% of North Carolina public school students were eligible for FRPL, whereas 53% were eligible for free lunch.

will be greater in School B than in School A. The analysis found that at the highest concentrations of economically disadvantaged students, the per-pupil costs flatten out. Exhibit 8 illustrates these findings.

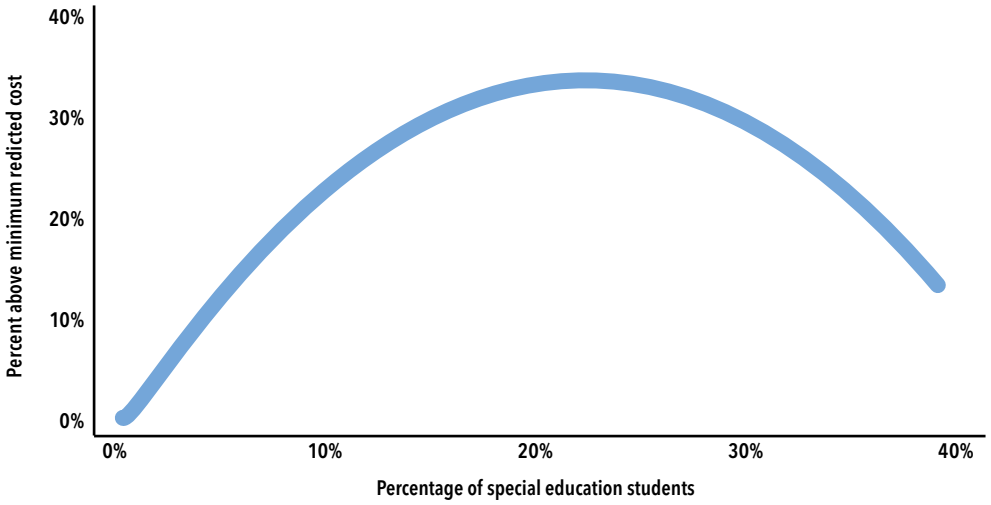
The high per-pupil costs associated with serving high concentrations of economically disadvantaged students affects a substantial proportion of North Carolina schools; approximately 31% of schools in the state are serving student populations in which more than 90% of students are economically disadvantaged.

Exhibit 8: Costs of Educating Students in Poverty



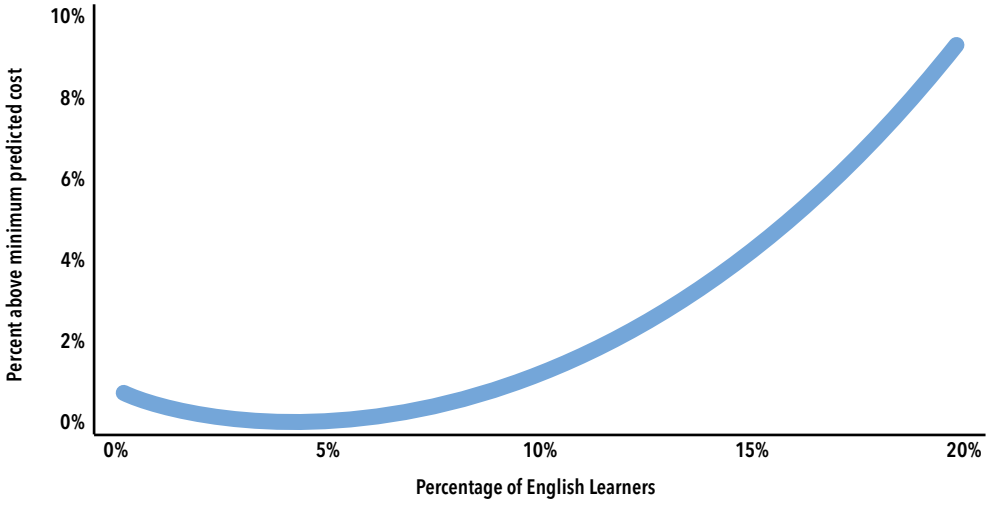
With respect to exceptional children, as the school-level percentage of students in this population increases, the supplemental cost to achieve the same academic growth goes up, but only up to a point. This suggests that schools with high concentrations of exceptional children may have developed an infrastructure for serving these students efficiently, and as a result, each additional student adds less and less to the total cost, and eventually, per-pupil costs go down. Exhibit 9 illustrates this finding, displaying the predicted cost as the percentage of exceptional children increases.

Exhibit 9: Costs of Educating Exceptional Children



Finally, the research team examined the impact on costs of the district-level population of English learners. As the percentage of students in this population goes up, the supplemental cost to achieve the same academic growth also goes up. Unlike economically disadvantaged students and exceptional children, as concentration of students increases, the marginal costs generally get larger. At very low concentrations, there is a dip in costs which likely reflects the impact of the shock of initial investment in new services for the first few English learners. Exhibit 10 illustrates this finding, displaying the predicted cost as the percentage of English learners increases.

Exhibit 10: Costs of Educating English Learners

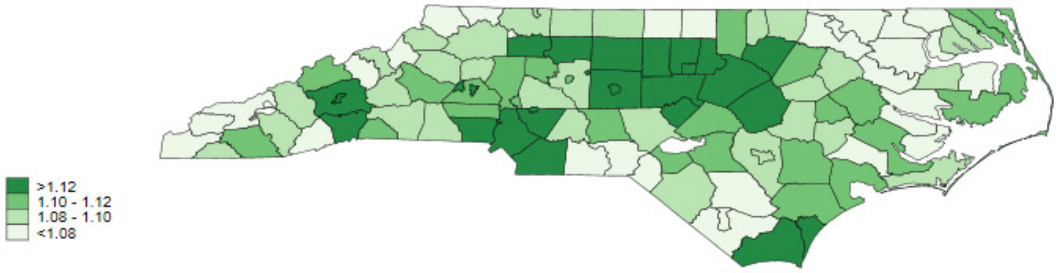


Similarly, the professional judgment panels consistently noted that additional resources are necessary to adequately serve students with greater needs. These included, for example, resources to support additional wraparound services (e.g., counselors, social workers) and interventions (e.g., extended learning time, reading and math interventionist staff) for economically disadvantaged students.

Regional Variations in Costs Impact Funding Needs

The education cost function analysis also found that, all else being equal, the cost of educating students in some regions of the state is higher than in others, primarily due to regional cost factors (e.g., cost of living, local amenities) that impact labor costs. In the model, this was measured by a teacher cost index that captures the regional variation in teacher salaries due to factors beyond district control. The district-level salary indices range from a low of 1.00 to a high of 1.21, indicating that the cost of employing teachers is 21% higher in some parts of North Carolina than it is in others. Exhibit 11 displays the geographic variation in an average district-level salary index.

Exhibit 11. Map of Average District-Level North Carolina Salary Index 2016–17



As displayed in Exhibit 11, the more costly districts are those clustered around the urban centers of the state, including Winston-Salem, Raleigh-Durham, and the interstate corridor between them; the Charlotte metropolitan area; the Asheville metropolitan area in western North Carolina; and along the coast near Wilmington.

In addition to increased labor costs, there is also regional cost variation in nonlabor resources. These costs were found to be higher (1) the closer a school is to a major metropolitan area (primarily urban areas), (2) in very rural areas, and (3) in coastal communities.

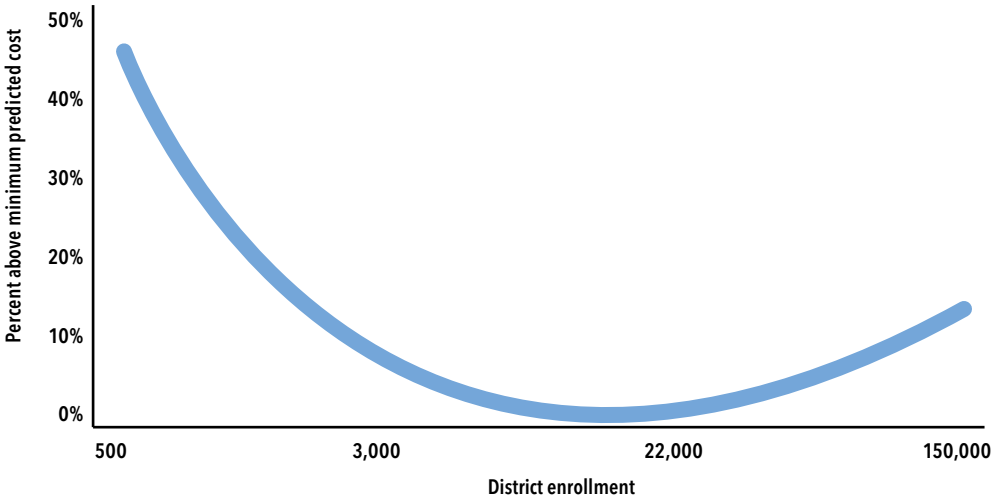
Scale of District Operations Impacts Costs

An observed trend in economic literature is that as organizations produce more units, their marginal costs (i.e., the cost of producing each unit) tend to go down, except at a very large scale of production (Silvestre, 1987; Canback, 1998). This is often described by the concept known as economies of scale, which refers to the notion that as an organization grows in size, it is able to produce more efficiently, and thus its marginal costs to produce each additional unit tend to decline. The exception is once production gets to an extremely large scale. At that point, due to the inherent cost of managing the scale of operation, marginal costs increase again (referred to as diseconomies of scale). Previous research has confirmed that diseconomies of scale occur within very large public school districts (Robertson, 2007).

The cost function results suggest that this concept applies to public school district operations, as does previous research (Augenblick, Myers, & Silverstein, 2001; Andrews, Duncombe, & Yinger, 2002). As the number of

students goes up, the marginal cost to "produce" the same academic growth goes down, except in very large school districts, where the marginal costs begin to creep up again. This finding is illustrated in Exhibit 12.[13]

Exhibit 12. Cost to Achieve Equivalent Outcomes as the District Enrollment Increases



This finding does not suggest a specific policy direction for the state about the organization and appropriate size of school districts. Rather, it indicates that in North Carolina, the relationship between the scale of district operations and per-pupil cost is consistent with previous research findings and should be considered as a factor when funding districts to deliver services for students. For example, the state could align its funding allocations for districts — both small and large — to ensure such economies of scale challenges are offset by the allocations. Another example would be for the state to support districts to achieve economies of scale through building up shared services within regions. There are practices in parts of the state that could serve as a model in areas such as transportation and special education services.

Other Factors, Such as School Level, Affect Required Funding

In addition to the cost function model's finding related to student need, the model finds that certain school settings require additional funding to achieve the same outcomes, holding all other factors constant. Specifically, the model finds that elementary schools generally require less funding than middle and high schools to achieve the same level of academic growth.

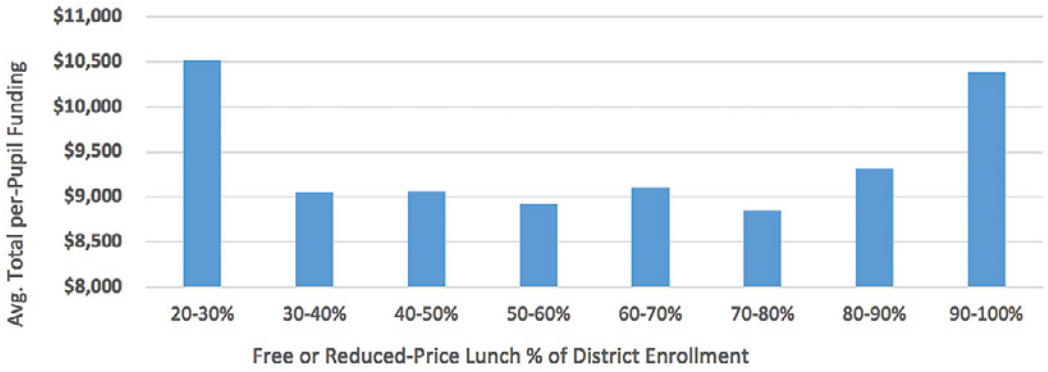
13 It should be noted that the *log* of district enrollment is presented in Exhibit 12, as opposed to enrollment without transformation. This results in the chart illustrating exponential changes in enrollment as equivalent distances on the *x*-axis (e.g., 8 = ~3,000, 9 = ~8,000, 10 = ~22,000, etc.).

No Consistent Relationship Between District Funding Levels and Student Need

The current distribution of state funding indicates little connection between districts' levels of need and their levels of funding. As shown in Exhibit 13, average total per-pupil funding (including federal and local sources) is highest, with an average of $10,522 per pupil, in districts with the lowest proportion of low-income students[14] (20% to 30% of enrollment). Districts receiving the next-highest level of total per-pupil funding ($10,380 on average) are those with the highest proportion of low-income students (90% to 100%), suggesting that the system is designed to some degree to provide additional funding to communities with high proportions of students from low-income families.

However, districts with between 30% and 90% low-income students receive considerably less (with averages ranging from $8,852 to $9,320 in total per-pupil funding, including federal and local funding). Moreover, based on Exhibit 13, there is not an apparent, consistent relationship between per-pupil funding levels and the proportion of students from low-income families.

Exhibit 13: Average Total per-Pupil Funding in Relation to Student Need (District FRPL %)

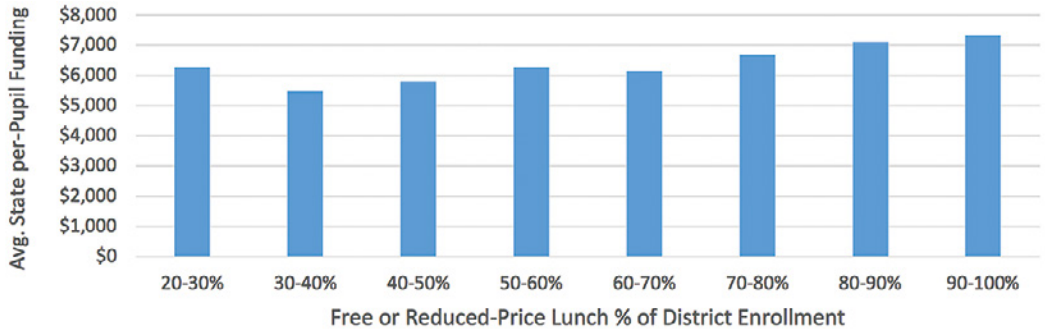


Source: National Center for Education Statistics Data, FY 2016

When examining only the relationship between state per-pupil funding and the proportion of students from low-income families (see Exhibit 14), there appears to be a more consistent relationship, indicating that often, districts with higher levels of need do receive higher levels of state funding. However, this relationship is not always consistent. Most notably, the districts with the lowest levels of need (20% to 30% low-income students) receive an average of $6,289 in per-pupil state funding, which is slightly higher than the average levels of state funding received by districts with 50% to 60% or 60% to 70% low-income students ($6,286 and $6,166, respectively).

14 Defined here as students eligible for free or reduced-price lunch, a federal measure of economic status.

Exhibit 14: Average State per-Pupil Funding in Relation to Student Need (District FRPL %)

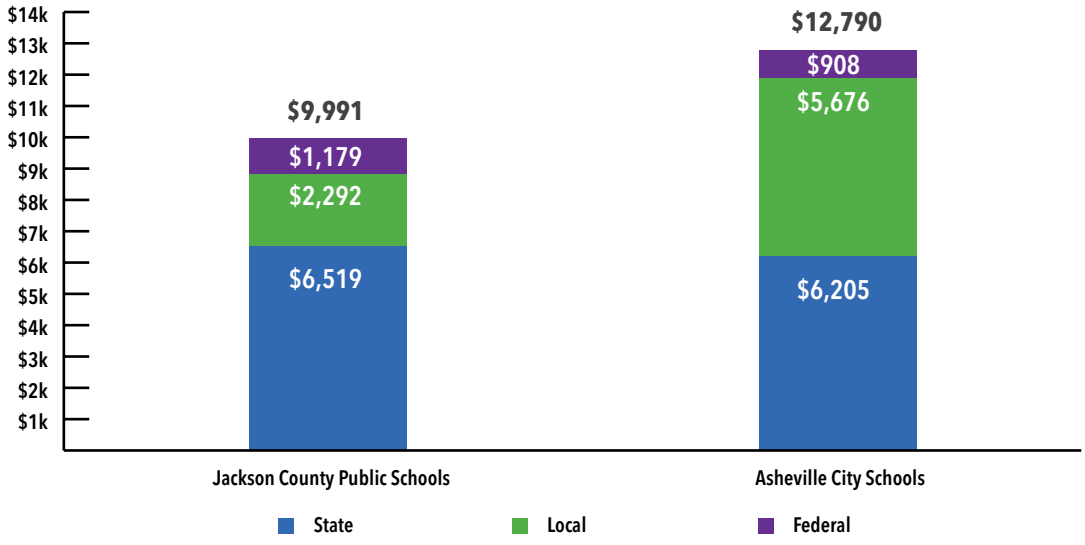


Source: National Center for Education Statistics Data, FY 2016

Inequity From Local Funding Presents Challenges for Lower-Wealth Districts

CFOs noted that inequities based on local wealth also present a challenge for lower-wealth districts. This finding is corroborated by prior research. For example, the Public School Forum found a gap of more than $2,400 per student between the state's 10 counties that spent the most in local contributions per student and the 10 counties that spent the least (Public School Forum of North Carolina, 2019). During our needs assessment, CFOs reported difficulty recruiting teachers and central office administrators due to competition with wealthier districts. One CFO reported that a district just a half-hour drive away could offer teachers a 25% higher salary due to its local supplement. Exhibit 15 illustrates the difference in per-pupil funding between two nearby districts with similar student enrollment: Asheville City Schools and Jackson County Public Schools. Asheville City Schools receives $5,676 in per-pupil local funding, nearly two-and-a-half times as much as Jackson County Public Schools' $2,292 in per-pupil local funding, and it receives approximately 28% more in total per-pupil funding.

Exhibit 15. Disparity in Funding Between Two Nearby Districts of Similar Size



Source: NCDPI Statistical Profile — Table 24 (2018)

Not only does local funding create a major funding disparity between these two districts, but the district receiving fewer funds has greater levels of student need, as indicated in Exhibit 16. Thus, although this district requires higher funding levels to serve its students — as indicated in the cost function analysis results — the state funding system leaves it with less funding than neighboring, wealthier districts with lower levels of student need, with whom the district must compete for qualified teachers and other staff.

Exhibit 16. District With Lower Funding Levels Serving Students With Higher Levels of Need

	Jackson County Public Schools	Asheville City Schools
Total enrollment	3,772	4,558
% economically disadvantaged (eligible for free lunch)	57.4%	36.6%
% English learners	3.6%	1.8%
% exceptional children	14.4%	12.4%

Source: National Center for Education Statistics, Common Core of Data, 2017

Inequity in State Funding Through the Classroom Teacher Allotment

In addition to the funding disparities due to local supplements, the analysis of public year-to-date allotment data shows inequities in North Carolina's allotment system through the Classroom Teacher position allotment. With the position allotments, districts can hire teachers of any experience level — therefore commanding any salary on the state salary schedule — and the state will fund the position. However, prior research suggests higher-qualified, more-experienced teachers may disproportionately choose to work for more affluent districts, a phenomenon known as "teacher sorting," resulting in additional state funding through the Classroom Teacher allotment (Program Evaluation Division, North Carolina General Assembly, 2016).

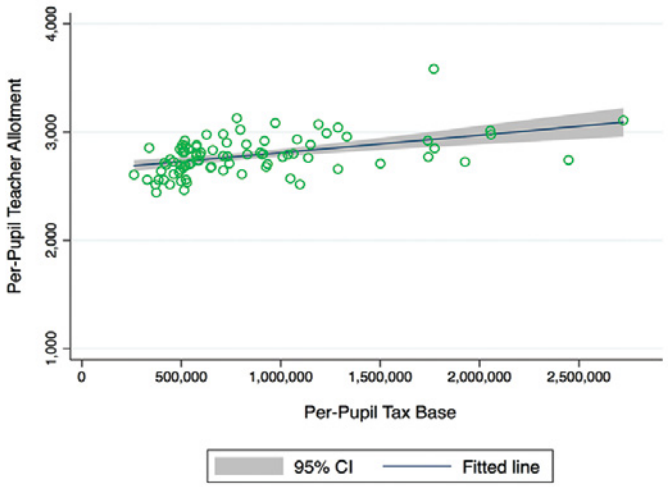
The Classroom Teacher allotment, which covers teacher salaries and benefits, is the largest state allotment to school districts, representing 42% of funding for school districts in the 2017–18 school year (North Carolina Department of Public Instruction, 2017). Thus, inequitable distribution of funding through this allotment can have a major impact on district budgets and reduces the alignment of allocating resources to students of most need.

To verify and build on the findings of previous research, we conducted an analysis examining whether wealthier districts do indeed receive, on average, more funding through the Classroom Teacher allotment than less-wealthy districts.[15] As suggested by prior research, we find a positive and statistically significant correlation between

15 Specifically, this is a replication of a prior analysis conducted by the North Carolina General Assembly (2016), using publicly available FY16 data. As in the original analysis, city school districts could not be included, as the adjusted property tax base is a county measure. We also omit the 11 county districts that have city districts within their borders, as county-adjusted property tax bases may not be an accurate measure of local wealth for these districts. Omission of these additional 11 districts did not significantly change the results.

per-pupil district wealth (as measured by the adjusted property tax base) and per-pupil funding received through the Classroom Teacher allotment (see Exhibit 17).[16]

Exhibit 17: District Wealth and per-Pupil Funding Through the Classroom Teacher Allotment



This study's analysis found a positive and statistically significant correlation between per-pupil district wealth (as measured by the adjusted property tax base) and per-pupil funding received through the Classroom Teacher allotment.[17] This indicates that wealthier districts indeed receive, on average, more funding through the Classroom Teacher allotment than less-wealthy districts. Thus, the Classroom Teacher allotment packs a double punch in reducing the equity of funding distribution, as higher-need students — who are disproportionately served by less-wealthy districts — need more funding than wealthier districts, not less.

Several CFOs reported that this inequity has become particularly pronounced in recent years, due to a new restriction regarding transferring Classroom Teacher allotment funds. Prior to the 2012–13 school year, districts could transfer Classroom Teacher allotment funds to another area. That is, they could choose to hire one fewer classroom teacher through the Classroom Teacher allotment and could instead receive funds, equal to the statewide *average* teacher salary, which could be spent in any other allowable area (North Carolina State Board of Education & Department of Public Instruction, 2016). Districts would then use funding from one of their other allotments to hire a teacher commanding a lower salary. However, districts can now only transfer these funds at a starting teacher salary level,[18] rather than the average salary.

This leaves a wide gap between the funds that districts are technically allotted and the amount that they receive after transferring positions into other funds. In 2017–18, the first step of the salary schedule for teachers with

16 Specifically, we find a Pearson correlation coefficient of r=0.46, n=89, p<.0001 and linear regression also finds a positive relationship, $r^2 = 0.21$, n=89, p<.0001.

17 Our analysis was a replication of a prior analysis conducted by the North Carolina General Assembly (2016), using publicly available FY16 data. As in the original analysis, city school districts could not be included, as the adjusted property tax base is a county measure. We also omit the 11 county districts that have city districts within their borders, as county-adjusted property tax bases may not be an accurate measure of local wealth for these districts. Omission of these additional 11 districts did not significantly change the results.

18 The first step of the "A" teacher salary schedule.

a bachelor's degree was $35,000, whereas the average teacher base salary was $45,861, meaning that this policy change reduced districts' funding by $10,861 for every classroom teacher position transferred. Given the state's teacher shortage, districts cannot always fill all of their position allotments with qualified candidates (North Carolina State Board of Education & Department of Public Instruction, 2018b), let alone candidates at the average salary level. Naturally, this change disproportionately affects districts whose teacher salaries are below the average statewide salary, and, as suggested by the previous analysis, on average, the less affluent the district, the less funding received through this allotment.

Alignment of Funding to Student Needs

Our second research question examines the extent to which funding is aligned to student needs, with a focus on whether funding is flexible and stable enough to ensure the effective use of funds. During the needs assessment, lack of flexibility in how to spend state funds was the most frequently cited obstacle in aligning funding with student needs; in addition, CFOs noted the challenge posed by a lack of finance system stability due to frequent changes in allowed uses of funds.

Practitioners Report Flexibility Is Essential to Meeting the *Leandro* Obligation

Across a variety of resource categories, professional judgment panelists consistently emphasized the importance of flexibility in the specific use of funds, often expressing hesitation to define specific priorities for resource allocation, given the extent of variation in local needs.

For example, two of the three panels recommended allocating a set number of full-time equivalent staff positions for enhancement classes (e.g., health, physical education, art, music, other electives) based on the school level and demographic needs. From there, they recommended providing local leadership with the discretion to determine the specific courses offered. One of the panels recommended a similar approach for funding and allocating support positions such as counselors, social workers, and school nurses. Similarly, when considering instructional support positions, it was common for panelists to recommend a variety of specialists, but all three panels recommended schools be given the flexibility to adapt these positions both to meet students' needs and to leverage existing expertise among instructional staff. For example, one panel suggested that rather than hiring a full-time instructional coach, a school might choose to pay one or more of their high-quality teachers to take on the role of "master teacher" and serve as a coach for their colleagues.

With respect to funding for technology, panelists described wide variation in technological readiness and opportunity, noting, for example, that in some regions, students lack basic Internet access. As a solution, panelists recommended that schools be given the flexibility to invest funds in technology to meet local needs.

Furthermore, even as panelists debated "adequate" class size, all three panels discussed the need for schools to have some amount of flexibility. The extent of this flexibility was a matter of some debate, but overall there was agreement that if local circumstances compel schools to expand class sizes slightly, they should have a reasonable amount of flexibility to do so.

More generally, though conscious of the need for accountability of spending, the panelists nonetheless viewed the current limitations on many allotments as resulting in inefficient resource use. As part of their deliberations, panelists discussed the appropriate balance of flexibility and accountability.[19]

Funding Flexibility Has Declined in Recent Years

North Carolina has historically provided local school districts the ability to make decisions about how to allocate funding based on their unique context. In 1989, North Carolina's General Assembly passed the School Improvement and Accountability Act, which the State Board of Education explained "was designed to give local school systems more flexibility in making decisions in exchange for greater accountability" (North Carolina State Board of Education, 2001). In 1996, the General Assembly continued to focus on flexibility in local decision-making, approving a law to enable the State Board of Education to implement ABC Transfers, which "assign more responsibility at the school building level and allow schools flexibility to use funds as they are most needed at the school" by enabling districts to transfer funds from one allotment to another (North Carolina State Board of Education & Department of Public Instruction, 2016). However, according to school district CFOs and recent reports, the state has changed course in recent years, dramatically increasing restrictions on the allowable uses of many allotments and therefore reducing local flexibility in the use of allotment funds.

Input From District CFOs

During the needs assessment, district CFOs overwhelmingly reported that new restrictions on the allowable uses of allotments hamper their ability to align funding to student needs. For example, CFOs noted the recent restrictions on Textbook allotment funds as an obstacle to effective resource use. Starting in July 2018, Textbook allotment funds can no longer be used for purchases other than physical textbooks or digital resources (e.g., online texts); previously, many schools also used the funds for other learning tools, such as digital learning devices. Several CFOs questioned the wisdom of the state allowing school districts to spend textbook funds on software, but not digital devices, since students need devices in order to access the software.

Allotment Data Analysis

An analysis of allotment data finds that policy changes have led to a dramatic shift in the proportion of funds that allow for local spending flexibility. To demonstrate this decline in allowable funding uses over an eight-year span, Exhibit 18 displays the sum of all initial allotments with and without meaningful flexibility in each year.[20] In this context, "meaningful flexibility" means the ability to transfer funding[21] from one allotment category to another without a substantial reduction in the funding amount. (For example, the Classroom Teacher allotments

19 Note: Although one full panel was able to engage in this discussion, for two of the three panels, only a portion of the full panel was able to contribute due to time constraints, specifically, three of five panelists for one and only one of eight panelists for the other. This is viewed by the study team as a limitation and should be taken into account when considering these findings.

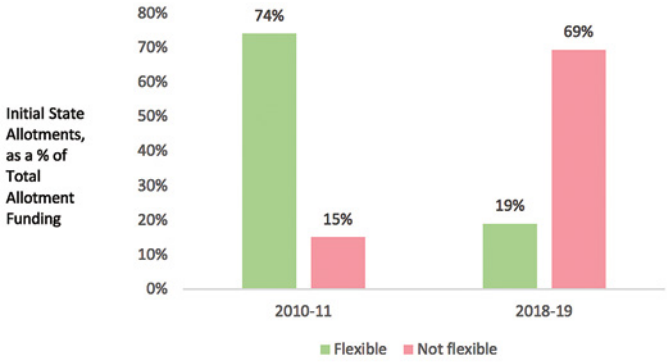
20 A table displaying each initial allotment and their restrictions for 2010–11 compared with 2018–19, as summarized in Exhibit 18, is available upon request.

21 Allotments that allow only a nominal amount of funding to be transferred — for example, the Career Technical Education (Months of Employment) allotment, which limits the amount of funding transfers to the "amount of increase in the state allotment for each fiscal year" — are not considered to have meaningful flexibility.

no longer have "meaningful flexibility" because the funding amount is reduced to the starting salary level when it is transferred.)

Allotments with meaningful flexibility are shown in green, and those without meaningful flexibility are shown in red. In 2010–11, allotments with substantial flexibility represented nearly three quarters of K–12 state funding. By 2018–19, allotments with substantial flexibility represented only about one fifth of K–12 state funding.

Exhibit 18: Flexibility of Allotments in FY 2011 Compared With FY 2019



Source: North Carolina Department of Public Instruction 2018–19 Year-to-Date State Allotment Data

These findings corroborate North Carolina's Program Evaluation Division 2016 report, which found that the system's local flexibility has been drastically reduced in recent years. The report notes the General Assembly's new restrictions on various allotments, including the Teacher Assistant, Exceptional Children, Academically or Intellectually Gifted, and Textbook allotments.

Given the varying needs of different student populations across the state, as well as differences in local context, current restrictions on the allowable use of allotments impose a one-size-fits-all approach on resource allocation. As one CFO asserted, districts need "flexibility to move funds around because there are 115 LEAs [local education agencies] and there are 115 ways of doing things."

Frequent Changes in Funding Regulations Hamper Budget Planning

District CFOs described how the unpredictability of funding regulations from year to year has created instability in the system and limits their ability to do longer-term budget planning. As one CFO explained, "The flexibility that we have in our use of funding varies from year to year depending on what the legislature is trying to prioritize that year, and it can vary wildly." CFOs reported that frequent legislative changes in the allowed use of funds make long-term planning extremely difficult. Another stated, "I think everybody agrees that we spend an enormous amount of time trying to figure out how to implement legislative tinkering with the least amount of harm to our school system."

For example, one district had been leasing the technology for teacher presentation stations using funds from its Textbook and Digital Resources allotment. However, as described earlier in the section on flexibility, starting in

July 2018, these funds could no longer be used for purposes other than textbooks. Without a stable alternative source of funds for technology, the CFO reported uncertainty around whether the districts' classrooms would be able to keep these teaching platforms.

For example, Exhibit 19 outlines the extent of allotment policy changes in recent years for the Teacher Assistant (TA) allotment. Restrictions around the transfer of funds in and out of the TA allotment changed multiple times within three years. Similarly, between FY 2014 and FY 2019, the Driver Training allotment restrictions changed four out of the five years.

Exhibit 19: Change in Funding Transfer Restrictions for TA Allotment Between FY 2013 and FY 2016

Year	Transfer restrictions
2012–13	Funds cannot be transferred out except to the Classroom Teacher allotment. Funds can be transferred in.
2013–14	Fund transfers allowed for any purpose.
2015–16	Funds cannot be transferred out. Funds can be transferred in.

Source: Allotment Policy Manuals for 2012–13, 2013–14, 2014–15, and 2015–16 (North Carolina State Board of Education and Department of Public Instruction, 2016)

According to CFOs, these frequent policy changes complicate their efforts to strategically manage their investments. As one CFO described, "A few years into this role, I find myself questioning, 'Well, what's the value in looking too far out when the standards always change before we get there?'" Yet CFOs reported that a lack of predictability and flexibility in allotment policies was not always the case in North Carolina. As one explained, "Years ago, fiscal accountability, financial-type things were included in our strategic plan … but we've taken that piece out because we've lost so much control, and we can't really budget for the future."

Nationwide, states are making efforts to shift their education systems from a compliance-oriented model to a more performance-oriented model, recognizing the latter's greater potential for improving student outcomes (Murphy & Hill, 2011; Gross, Jochim, & Nafziger, 2013; Honig, 2013). The CFOs' comments suggest local leaders want to plan strategically, but CFOs — constrained by the state's ever-changing regulations — have been forced into a more compliance-focused role.

CFOs Report Year-to-Year Stability in Funding Amount, but State Budget Timeline and Adjustments Create Instability

Because district funding is based on the ADM, most CFOs described their year-to-year funding amount as fairly stable, or at least predictable. In fact, this overall stability is evident when one considers statewide aggregate per-pupil expenditures, adjusted for inflation (see Exhibit 4 in the Context section). Since 2009–10, statewide per-pupil spending (in 2018 dollars) has ranged from $8,925 to $9,707, changing no more than 4% from year to year.

However, CFOs reported that the state's process for finalizing each district's budget, which involves adjustments after the school year begins, presents a substantial challenge. As a focus group of CFOs explained, building the next school year's budget may begin in December or January, and districts must submit their budgets to the county commissioner for review by the spring, or even as early as February. However, the state's timeline begins much later, with the budget passed in summer or, if the legislation is delayed, as late as the fall. Furthermore, districts' budgets are adjusted based on their actual ADM counts from the first month of attendance, as well as the actual ADM from charter schools in their county.

Districts whose ADM is higher than projected must wait until they receive their additional funding to hire the additional teachers necessary to keep class sizes within the state-mandated student-teacher ratios. Conversely, districts whose ADM is lower than projected may not have enough state-allocated funding to support all of the staff that they have hired for the current year, leaving districts with the challenge of finding other funds to fill in the gap.

CFOs also reported that the state's frequently changing, complicated funding system required them to spend a disproportionate amount of time ensuring that their budgets were in compliance with state regulations. Some even reported that the frequent policy changes lead to greater turnover in district finance offices. As one CFO described, "We're seeing a lot of turnover now in the finance office realm. … And a lot of it has to do with the point that there's so much coming down from the state. It changes from year to year. They can't keep up with it." CFOs also identified the transfer of funding from districts to charter schools as a particularly unnecessary administrative burden that obstructs their budget forecasting and planning process. CFOs consistently expressed a desire for the state to fund charter schools directly and "keep us out of the middle of it."

Strategic Implementation of System Changes to Promote Resource Alignment

Professional judgment panelists and CFOs noted that for system adjustments and new state investments to be effective, they should be implemented strategically. Panelists were fairly consistent in their recommendation that investments be phased in over as short a timeline as possible, within three to five years. However, new funding should be announced well in advance; as one panelist noted, it may be unrealistic to expect districts to allocate new funding strategically if they lack sufficient notice.

At the local level, panelists generally identified staffing-related investments as the highest priority, noting that effective use of nonlabor resources largely relied on staff capacity. For example, investments in classroom technology would be most effective when paired with the hiring of a technology specialist and professional development to utilize this technology. Panelists also suggested prioritizing investments for early grades, as the benefits would follow these students as they continue into older grades. However, professional judgment panelists and CFOs overwhelmingly emphasized that given the large variation in local circumstances, districts should be given maximum flexibility to align new funds with local needs.

Regarding accountability, panelists recommended that the state require schools to demonstrate how their spending aligns with data-driven school improvement goals, using locally determined measures. Panelists

emphasized the need for multiple measures that capture the full range of desired outcomes mandated by *Leandro* and asserted that the common measures (e.g., state tests and graduation rates) were insufficient on their own.

Finally, in terms of adjusting the state's finance structure, CFOs voiced concern that consolidating allotments would make it easier for the state to cut funding, undermining any other funding system improvements. As one CFO noted, "I know that there is discussion about going to some kind of block grant, and the fear with that is that tends to lead to cuts to funding. When we speak with other states, whenever [they] get this big consolidated block grant type funding, they've seen cuts." Overall, CFOs expressed cautious ambivalence about changes to the finance system's structure; as one stated,"[It's a] double-edged sword; it could help, but it could also hurt if it's not managed correctly."

Adequacy

Inadequate Funding to Meet Student Needs

In considering the level of funding necessary to achieve the standard of a "sound basic education" as described in the *Leandro* rulings, it is necessary to consider the findings of this report in tandem with the findings and recommendations of the broader investigation of North Carolina's education system by WestEd — particularly those recommendations that may support districts to more effectively use their existing resources. For example, if the state invests additional dollars in the K–12 education system without changing the mechanisms for distributing funding to districts and without providing support and monitoring tools for districts to consider the most effective use of resources, then it is less likely that the desired student outcomes will be achieved. Further, in presenting various scenarios for new short-term and ongoing investments in the K–12 education system, this study intends to provide the state with options to use as they deliberate on the best course of action when considering the distribution, alignment, and adequacy of funding for K–12 operating expenditures.

This adequacy finding indicates that in order for the state to meet the requirements of *Leandro*, it needs to increase funding in two ways: (1) make short-term investments over the next eight years to reduce the achievement gap between lower-performing students and their higher-performing peers and (2) in tandem, provide additional ongoing funding to ensure that once students reach desired performance targets, this growth will be maintained. Accordingly, after the short-term investment period — assuming all students are performing at grade level — the state focus would be on maintaining ongoing funding levels.

To determine the adequacy of education funding, student performance thresholds need to be established — such as statewide graduation rates and statewide percentages of students meeting state standards in English language arts (ELA) and math — as benchmarks for observing the costs associated with students and schools achieving those results. Through the course of this investigation, the state did not identify such thresholds. Therefore, the adequacy component of this study, and thereby this finding, identifies various thresholds of performance linked to figures describing commensurate financial investments. The adequacy results also presume that the state will incorporate findings associated with the distribution and alignment of the financing system in order to maximize the effectiveness of the state's investment in education.

It should be reiterated that the analysis and results presented below use a constructed measure of "operating expenditures," which includes the day-to-day expenses of districts and schools, such as salaries, benefits, purchased services, and supplies and materials. Some categories of expenditures were not considered to be operating expenditures. These excluded categories include debt service; construction expenditures; fund transfers; food services; judgments and settlements against the district; transportation services; tuition- or fee-funded programs (e.g., before- and after-school care, preschool); ancillary services; payments to other government units except indirect costs; and nonprogrammed charges. Furthermore, preschool expenditures were excluded. Finally, charter schools were excluded because they may have different cost structures than other buildings, as were a handful of special schools for which no spending data was provided. Therefore, the expenditures reported represent K–12 operating expenditures in traditional school buildings.[22] These inclusion and exclusion categories are consistent with prior, similar analyses. This definition should be noted as one reviews the cost estimates reported in this summary.

It should also be noted that both scenarios were constructed by estimating the best practice among North Carolina school districts. Our approach allows for the possibility that districts could be spending more than would be strictly necessary to achieve their current levels of measured performance and removes any such district specific "inefficient" spending from the cost projections. In this context, "inefficiency" refers to spending that does not contribute to the measured outcomes in the model (namely, academic growth). As such, inefficiency could include spending that simply contributes to unmeasured outcomes that are uncorrelated with academic growth (e.g., enrichment activities). Because the study's measured outcomes likely do not capture all outcomes relevant to a sound basic education and some amount of "inefficient" spending (e.g., enrichment activities) may in fact be necessary to meet the obligation under *Leandro*, the study adds to the estimates the average percentage of spending identified as inefficient, about 6.3%.

The cost estimates for operating expenditures of K–12 schools and districts were constructed observing that (a) there are students who currently are not performing as well as other students in the state and therefore require *short-term investment* supports to accelerate their growth, (b) an *ongoing investment* is necessary to maintain the level of student performance commensurate with the rulings of *Leandro,* and (c) investments in other areas of public education — namely, early childhood education and state-level investments — are vital in achieving the modeled student outcome results. For example, state-level investments will be needed to ensure sufficient pipelines of effective teachers and principals, revise the state's assessment and accountability system, and create a statewide system of support. The cost estimates presented below do not include associated costs for early childhood education or any of the other suggested state-level investments, which are discussed in the full report, *Sound Basic Education for All: An Action Plan for North Carolina.*

Using the most recent information provided by the state for the 2016–17 fiscal year (FY 2017), Exhibit 20 displays total and per-pupil operating expenditures. The state's traditional public schools had $12.16 billion in operating expenditures, about $8.3 billion of which was provided by state funds. This amounts to $8,346 per pupil, of which $5,690 per pupil was provided by the state, on average. Exhibit 20 provides a further breakdown of operating expenditures, which can be used as a comparison to the cost estimates in the next section.

22 Due to missing data, the analysis sample excluded approximately 50 additional schools.

Exhibit 20. Operating Expenditures, 2016–17

Current operating expenditures	Total spending (in billions)	Per-pupil spending
State	$8.29	$5,690
Local	$2.78	$1,911
Federal and other	$1.09	$745
Total	$12.16	$8,346

Note: Values adjusted for inflation to 2019 dollars using the Bureau of Labor Statistics cost price index (CPI) calculations over the period July 2017 to July 2019.

Short-term and Ongoing Investment Scenarios Based on Performance Threshold Assumptions

In constructing the cost estimates, it is assumed that both types of investments — short-term and ongoing — are coordinated to achieve the desired result of *providing all students with the opportunity of a sound basic education.* Such coordination requires that the state and districts create both monitoring tools and support mechanisms to ensure that current and any future investments are used the most effectively. It also requires that implementation occurs over time, creating an opportunity for districts and schools to plan for the necessary changes in their systems. For purposes of these scenarios, implementation is presumed to span eight years, which coincides with the timeline identified in the North Carolina Every Student Succeeds Act (ESSA) plan.[23]

The short-term cost estimates use specific performance thresholds, i.e., a percentage of students achieving proficiency on the statewide ELA and math assessments, as benchmarks for student performance, recognizing that some students are not currently achieving at grade level and need additional support to achieve those benchmarks. Once students requiring additional support have achieved this standard of performance — in conjunction with all other students already achieving at such a level — the ongoing investment scenarios use student growth thresholds to ensure all students maintain performance at grade level.

Short-term Investment Scenarios

Although the ongoing investment scenarios represent funding levels that would help to **maintain** the average annual growth of students, the short-term investment scenarios represent the support necessary to enable performance **gap reduction** between lower-performing students and their higher-achieving peers. In these investment scenarios, the cost estimates use absolute thresholds of performance to evaluate the necessary, differential growth needed for student populations that are currently not meeting proficiency (or standards) in North Carolina. It is intended, as the name would suggest, that these investments are short-term in nature and are meant to support changes in the public school system that permanently alter structures that will enable all students to meet the standard of the *Leandro* ruling of a sound basic education.

23 State of North Carolina. May 29, 2018. *ESSA Consolidated State Plan*. Submitted to the U.S. Department of Education. http://www.ncpublicschools.org/docs/succeeds/nc-essa-state-plan-final.pdf

In the first (Short-term A) and second (Short-term B) scenarios, all students are projected to achieve average annual, grade-level growth, except for students in schools that are not currently meeting proficiency targets. These students are assigned growth levels that would allow them to achieve proficiency as defined by North Carolina's current Every Student Succeeds Act (ESSA) plan.[24] Under this plan, the state is aiming for proficiency levels of 74.1% in Grades 3–8 Mmath and 73.3% in high school math by the year 2027. For ELA, the targets are 65.8% in Grades 3–8 reading and 71.3% in high school reading by 2027. Notably, this plan and the associated proficiency targets are regarded as not meeting a sufficient level of rigor as reviewed by independent reviewers (Aldeman, Hyslop, Marchitello, Schiess, & Pennington, 2017).

Achieving the ESSA plan goals for 2027 (modeled in Short-term A and Short-term B) would substantially reduce, but would not completely eliminate gaps between students in the highest- versus lowest-poverty schools; therefore, it would not achieve the full standard set out by the *Leandro* rulings. However, Short-term A and Short-term B scenarios do accomplish several things. First, they demonstrate that the state does not fund its education system sufficiently to allow it to reach its own minimal targets identified in ESSA. Second, the scenarios offer a starting point for discussion among decision-makers that uses the state's own documented goals for student performance.

When modeling these scenarios, one decision is to designate how the school will attain overall proficiency. Short-term A and Short-term B use slightly different criteria to reach that bar. In Short-term A, each school currently not achieving proficiency is identified. Then, the students are ranked from nearest to farthest from the standard for proficiency. This scenario applies a growth rate to those students between approximately the 25th and 75th percentile that would enable them to achieve proficiency. All other students currently not meeting proficiency would receive average annual growth. This simulates a practical expectation — and observable past behavior of school improvement implementation — in that most schools will provide support to students in groups, rather than developing individual intervention plans for each student.

Short-term B uses a slightly different approach. First, each school currently not achieving proficiency is identified by comparing the school's current proficiency rates on ELA and math compared with statewide targets. Then, the students are ranked from nearest to farthest from the standard for proficiency. This scenario then applies the necessary growth rate to the lowest-performing student in the school to reach proficiency. This is followed by the second lowest-performing student and so on, until the overall proficiency rate for the school hits the state-identified target. This simulates a different school improvement approach in which students would more likely need more individualized approaches to ensure their performance level increases at the desired rate.

When comparing these first two short-term scenarios, Short-term B is more expensive than Short-term A. This is primarily because a greater amount of support is necessary to bring the lowest-performing student to proficiency, as compared with a student who is closer to the standard of proficiency. This also explains why the overall proficiency rates achieved in Short-term B are very slightly lower than in Short-term A; on average, it costs more for the lowest-performing students to achieve each percentage point of growth, compared with other students.

24 State of North Carolina. May 29, 2018. *ESSA Consolidated State Plan*. Submitted to the U.S. Department of Education. http://www.ncpublicschools.org/docs/succeeds/nc-essa-state-plan-final.pdf

Exhibit 21 presents the performance and cost estimate results from Short-term A and Short-term B and also includes the differences in performance of the highest- and lowest-poverty schools. These cost estimates are assumed to be implemented over an eight-year period.

Exhibit 21. Comparison of Short-term A and Short-term B Phased in Over Eight-Year Period

	Current	Short-term A: 25th–75th Percentile to Proficiency	Short-term B: Lowest-Achieving Students to Proficiency
Estimated State Spending Less Ongoing A	n/a	$1.58	$2.33
Per-Pupil Cost Estimate ($)	n/a	$1,087	$1,599
Statewide ELA Proficiency (%)	58.9	68.3	68.1
Statewide Mathematics Proficiency (%)	52.4	75.3	74.8
High-Poverty Schools ELA Proficiency (%)	43.8	65.6	64.9
High-Poverty Schools Math Proficiency (%)	42.4	74.5	73.7
Low-Poverty Schools ELA Proficiency (%)	79.1	80.6	80.1
Low-Poverty Schools Math Proficiency (%)	81.8	78.6	78.6

Notes: Overall subject-level proficiency data (i.e. math and ELA) includes all grade levels 4–9 (Mathematics) and 4–8, 10 (ELA). High-poverty schools (n=825) are defined as those serving a population of 75% or more students that qualify for free or reduced-price lunch. Low-poverty schools (n=182) are defined as those serving a population of 25% or less students that qualify for free or reduced-price lunch. Dollar values adjusted for inflation to 2019 dollars using the Bureau of Labor Statistics CPI calculations over the period July 2017 to July 2019. These figures would need to be further adjusted for inflation over the next eight years.

The cost associated with Short-term A is an additional $1.58 billion investment, or approximately $1,087 per pupil on average. If this amount were distributed equally over an eight-year period, it would mean an investment of approximately $198 million per year, or $136 per pupil per year. The cost associated with Short-term B is an additional $2.33 billion investment, or approximately $1,599 per pupil on average. If this amount were distributed equally over an eight-year period, it would mean an investment of approximately $291 million per year, or $200 per pupil per year. A large portion of these dollars would be allocated to schools and districts serving students in high-poverty settings.

In the last scenario (Short-term C), the performance threshold is grounded in the Court's *Leandro* ruling: specifically, from the Memorandum of Decision, *Hoke County Board. of Education v. State* (Wake Co. Super. Ct., Oct. 12, 2000), hereafter referred to as the Oct. 12, 2000 Memorandum of Decision. As Judge Manning stated, "North Carolinians should expect no less for their children than an educational goal that seeks to have every child perform at Level III proficiency or above …" (Oct. 12, 2000 Memorandum of Decision, p. 183). Further, the October 12, 2000 Memorandum of Decision (ppg. 187–8) notes the proportion of students that should be achieving proficiency: "Every school in North Carolina is capable of having 90 percent of its students score at proficient levels (i.e., Level III or IV) on the EOG or EOC tests (except for students with disabilities or LEP who are excused from the tests)."

Short-term C replicates the design of Short-term B, in which the lowest-performing students experience targeted growth, but the school-level proficiency benchmarks are increased to 90% of students for all subjects and grade levels. In this scenario, the exact number of lowest-performing nonproficient students is elevated (if necessary) in order for each school to reach 90% of students at proficiency on both subjects at every grade level. Nonproficient students that are not elevated to reach proficiency goals achieve average grade-level growth. Exhibit 22 presents the performance and cost estimate results from Short-term C and includes the differences in performance of the highest- and lowest-poverty schools. These cost estimates are assumed to be implemented over an eight-year period.

Exhibit 22. Short-term C Scenario Phased in Over Eight-Year Period

	Current	Short-term C: *Leandro* Compliant
Estimated State Spending Less Ongoing A	n/a	$3.16
Per-Pupil Cost Estimate ($)	n/a	$2,170
Statewide ELA Proficiency (%)	58.9	91.5
Statewide Mathematics Proficiency (%)	52.4	90.9
High-Poverty Schools ELA Proficiency (%)	43.8	90.0
High-Poverty Schools Math Proficiency (%)	42.4	90.2
Low-Poverty Schools ELA Proficiency (%)	79.1	91.9
Low-Poverty Schools Math Proficiency (%)	81.8	91.7

Note: Overall subject-level proficiency data (i.e. math and ELA) includes all grade levels 4–9 (Mathematics) and 4–8, 10 (ELA). High-poverty schools (n=825) are defined as those serving a population of 75% or more students that qualify for free or reduced-price lunch. Low-poverty schools (n=182) are defined as those serving a population of 25% or less students that qualify for free or reduced-price lunch. Dollar values adjusted for inflation to 2019 dollars using the Bureau of Labor Statistics CPI calculations over the period July 2017 to July 2019. These figures would need to be further adjusted for inflation over the next eight years.

The cost associated with Short-term C is an additional $3.16 billion investment, or approximately $2,170 per pupil on average. If this amount were distributed equally over an eight-year period, it would mean an investment of approximately $395 million per year, or $271 per pupil per year.

Ongoing Investment Scenarios

Under *Leandro*, the Court affirmed that local education agencies (LEAs) are "entitled to funding by the state sufficient to provide all students, irrespective of their LEA, with at a minimum, the opportunity to obtain a sound basic education" (*Hoke County Board of Education v. State*, 2004). The first scenario (Ongoing A) describes the cost estimate for an ongoing investment that would ensure the "minimum standard" is achieved for *all students*. In the context of student growth, that means that every child is achieving average annual growth for one year of instruction. In modeling student growth, this equates to a conditional normal curve equivalent (NCE) score of 50. A conditional NCE score of 50 indicates that, on average, the students performed exactly as expected given their

prior test performance. (By contrast, a conditional NCE score of 80, for example, would indicate that, on average, they performed as well as or better than 80% of their peers.)

Further, as the ruling refers explicitly to "funding by the state," this study assumes that to meet its obligation under *Leandro*, the state must at least provide sufficient funds to meet a sustained, minimum standard. Therefore, under Ongoing A, the cost estimate represents the state's obligation. Exhibit 23 outlines the differences in spending between the state's current investment and its potential investment under the Ongoing A scenario.

Exhibit 23. Comparison of Current Spending Versus Ongoing A

	Current	Ongoing A	Difference	% Difference
Total State Spending ($ in billions)	$8.29	$11.99	$3.70	44.6%
Per-Pupil Cost Estimate ($)	$5,690	$8,230	$2,540	

Note: Includes efficiency adjustment to account for the average 6.3% of funds identified as "inefficient" by the model. Dollar values adjusted for inflation to 2019 dollars using the Bureau of Labor Statistics CPI calculations over the period July 2017 to July 2019. These figures would need to be further adjusted for inflation over the next eight years.

The cost associated with Ongoing A is an additional $3.70 billion investment, or approximately $2,540 per pupil on average. If this amount were distributed equally over an eight-year period, it would mean an investment of approximately $463 million per year, or $318 per pupil per year. Although Ongoing A (and in the next section, Ongoing B) are presented as an investment over eight years to match the short-term investment models, in practice, they represent ongoing annual investments. Unlike the short-term investments, which would be completed after eight years and are modeled as a *supplement* to ongoing funding, the annual ongoing investment would need to continue indefinitely.

The second scenario (Ongoing B) recognizes that most students in some districts already outperform the standard, as do some students in even the lowest-performing districts. Under this scenario, the study estimates the amount of funding required to ensure that each individual student achieves *at least* average annual growth, maintaining the academic growth of students already performing at or above the average. This represents a conditional NCE score of approximately 58. The difference between Ongoing B and Ongoing A represents the additional spending required to maintain this above-average growth. The extent to which this additional spending is the state's obligation is less clear, given that the Court held that the state constitution does *not* require that "substantially equal educational opportunities beyond the sound basic education mandated by the Constitution must be available in all districts" (*Leandro v. State*, 1997). Thereby, this additional investment may be the responsibility of local school districts' additional funding for K–12 operational spending.

Exhibit 24 summarizes the cost estimates for Ongoing B compared with current total state and local spending.

Exhibit 24. Comparison of Current Spending Versus Ongoing B

	Current	Ongoing B	Difference	% Difference
Total State/Local Spending ($ in billions)	$11.08	$14.86	$3.78	34.1%
Per-Pupil Cost Estimate ($)	$7,601	$10,199	$2,598	

Note: Includes efficiency adjustment to account for the average 6.3% of funds identified as "inefficient" by the model. Dollar values adjusted for inflation to 2019 dollars using the Bureau of Labor Statistics CPI calculations over the period July 2017 to July 2019. These figures would need to be further adjusted for inflation over the next eight years.

The cost associated with Ongoing B is an additional $3.78 billion investment, or approximately $2,598 per pupil on average. If this amount were distributed equally over an eight-year period, it would mean an investment of approximately $473 million per year, or $324 per pupil per year. As with Ongoing A, the Ongoing B annual investment would need to continue indefinitely in order to maintain annual student growth.

Sum of State Funding Under Ongoing A and Short-term C Scenarios

In presenting these various ongoing and short-term scenarios, this study intends to provide the state with options to use as they deliberate the best course of action when considering the distribution, alignment, and adequacy of funding for K–12 operating expenditures.

However, when determining which scenarios most accurately meet the standard of the *Leandro* ruling — reducing gaps for the state's lower-performing students and maintaining such growth so that students achieve at grade level each year — Ongoing A and Short-term C appear to mostly closely fit that definition. Therefore, Exhibit 25 below displays the sum total of these scenarios relative to the state's current investment in public education, showing the additional amount of funding needed if the state were to pursue the Ongoing A and Short-term C scenarios.

Exhibit 25. Ongoing A and Short-term C Implemented Over Eight-Year Period

	Sum Total ($ in billions)	Sum Total per Pupil ($)	Total per Year ($ in billions)	Average per Pupil Per Year ($)
Current State Spending	$8.29	$5,690		
Ongoing A Scenario	$3.70	$2,540	$0.46	$318
Short-term C Scenario	$3.16	$2,170	$0.39	$271
Ongoing A + Short-term C	$6.86	$4,710	$0.86	$589

Note: Includes efficiency adjustment to account for the average 6.3% of funds identified as not contributing directly to the outcomes incorporated into the model. Dollar values adjusted for inflation to 2019 dollars using the Bureau of Labor Statistics CPI calculations over the period July 2017 to July 2019. These figures would need to be further adjusted for inflation over the next eight years.

Other Factors That Influence the Effectiveness of Additional Investments

As is clear from the findings displayed in Exhibit 25, the cost function analysis found the current level of state spending to be inadequate based on the minimum standard of average annual academic growth and for accelerating underperforming students to proficiency. Notably, these models are based on the previously identified assumptions about student growth and the attainment of schools' overall proficiency rates. Important also in the context of this modeling is that the choices of policymakers and practitioners about the use of these resources, and the resulting outcomes for students, cannot be observed. This fact reinforces the importance of pursuing the findings and recommendations in this section in tandem with the other recommendations included in the report as a means to leverage evidence-based practices that help ensure resources are used effectively to meet the standard of student outcomes identified in the *Leandro* ruling. Research and experience indicate that increased spending alone will not produce improved student outcomes without attention to how the resources are distributed and used.

Though this study cannot know the choices of policymakers and practitioners about the use of these resources, this study's findings and recommendations provide guidance on how to effectively distribute, use, and monitor K–12 funding.

Inadequate Resources for Practitioner-Recommended Priority Areas

Although the cost estimates provide a total amount of money required to achieve a specific set of outcomes, the estimates cannot be disaggregated into the specific categories of resources (e.g., staff, materials, etc.) necessary to provide all students with access to a sound basic education. Put simply, the cost function is not able to explain *how* the money should be spent to achieve target outcomes; it can only estimate the total level of spending required to achieve these outcomes.

Findings from the professional judgment panel, therefore, complement the cost estimates by providing a rich set of qualitative recommendations of how to allocate resources effectively at the school level.

Across all three panels, there were several consistent resource categories identified as high priority. Notably, each panel communicated that the recommended resources extend well beyond what they are currently able to provide under North Carolina's funding system. In summary, panelists recommended the following priority areas for resource allocation:

- A supportive school climate, including mental health supports and social-emotional learning
- Access to adequate technology, STEM (science, technology, engineering, and math), and other training and classes to prepare for contributing to the 21st-century workforce
- Effective professional development and incentives to develop and retain high-quality educators
- Sufficient educator-to-student ratios to provide for an effective learning environment and differentiated instruction

Each of these priority areas is described in more detail in the sections that follow.

School Climate and Supporting the Whole Child

All three professional judgment panels identified support for the whole child as critical for student success and described numerous specific resources needed to address these needs. To support the whole child, all three panels recommended support for the following positions at all schooling levels: school nurses, social workers, guidance counselors, and school resource officers. For middle schools and high schools, panelists recommended additional positions, such as youth development coordinators, student concerns specialists, and parent/community liaisons, to name a few. Panelists also emphasized the importance of providing opportunities for these support staff and their colleagues to collaborate with and learn from each other to enable classroom teachers to create more accessible, supportive classroom environments in which all students can thrive.

Panelists also identified program enhancement classes (e.g., art, music, and other electives) as a necessary resource for supporting student well-being, keeping students engaged with learning, and providing students with diverse skill sets. Finally, all three panels strongly emphasized the importance of one-on-one, adult-student relationships as critical for providing a school climate in which students feel supported and cared for, a view supported by research (Hamre & Pianta, 2001).

Technology and Preparation for the 21st-Century Workforce

Technology and workforce preparation were a frequent focus in panelists' resource allocation discussions. They were also identified as significantly underfunded areas. Panelists described how preparing students for life after high school — whether that means college, career, or the military — requires investments in classroom materials and equipment as well as in staff to provide a personalized education for each student. This included recommended investments in classroom materials (books, art supplies, etc.) to support project-based learning; classroom technology for educator use, such as smartboards and teacher devices; 1:1 devices for students, such as iPads, Chromebooks, or laptops; digital textbooks and software; and equipment for STEM, Career Technical Education (CTE), and lab courses. Panelists described how these resources and staff are critical for enabling students to explore and develop their interests and skill sets, which, in turn, enables students to recognize how they can contribute to the workforce and society and helps them plan for life after high school.

Panelists also noted that preparing students for the 21st century would require staff investments, such as training teachers on effective use of classroom technology and hiring staff to teach career-focused enhancement courses such as STEM and CTE. Panelists identified out-of-school activities, such as regional and statewide conventions and competitions, as important opportunities not only to allow students to explore their interests and talents, but also to help students connect their in-school learning with real-world experiences. Although these offerings were identified as especially important in high school, all panels recommended that these opportunities be introduced in elementary and middle school as well.

Support for Educators and Balancing Staff Expertise

Keeping in mind the costs related to staffing, panelists provided recommendations on how resources could be restructured to ensure all schools had sufficient staff to meet student needs and improve student performance. To begin with, panelists highlighted the potential to leverage the diverse skill set among instructional staff, including, for example, the opportunity for teachers to cycle through a variety of grades and courses depending on their skill set. Another panel recommended hiring based on an assessment of the gaps among current staff capacities. To grow staff capacities, panelists discussed the importance of more effective investments in professional development, describing it as a top-priority investment and an important part of improving teacher quality and integrating new, innovative techniques and resources. All three panels emphasized the importance of balancing schoolwide professional development that is differentiated, teacher-driven, and aligned with school goals, with some recommending providing funding for each teacher to use at their discretion.

Panelists also recommended providing adequate, protected planning time for lesson planning, collaboration, or professional development. Recommendations ranged from 60 minutes a day to 90 minutes a day. "Protected time," the panelists emphasized, means there is no risk of the teacher being pulled back into the classroom (e.g., to fill in when a substitute teacher is not available). The school would therefore need sufficient staff to ensure their students are under the supervision of another qualified adult. Panelists also identified instructional support staff as necessary for developing staff capacity and expertise, with each panel recommending at least one instructional coach and/or interventionist per school to provide instructional strategies and content-specific coaching and to direct additional support to students.

Ensuring Sufficient Adult-to-Student Ratios Provide Personalized Learning

Although panelists acknowledged the significant costs tied to class sizes, they asserted that funding must be preserved to keep class sizes manageable and that investing in other resources must not be at the expense of class sizes. They emphasized that sufficient pupil-teacher ratios are critical not only to help ensure classroom management, but also — and more important — to enable teachers to personalize instruction and to develop a relationship with each student. Nonetheless, panels did not determine class size recommendations easily; they often hesitated as they balanced the cost pressures with the need for individual attention to students. Ultimately, all three panels emphasized that, even with the associated costs, maintaining appropriate class sizes is an important investment for the system.

Panels agreed that teacher assistants at the elementary level are an important investment as well, with all three recommending a full-time TA be available for all K–3 classrooms (i.e., 1:1 ratio of teachers to TAs) and, at the minimum, a half full-time equivalent (FTE) TA for all fourth and fifth grade classrooms (one panel recommended a full FTE for these grades as well). These recommendations for additional TA support were not made in isolation of class sizes, and all three panels noted that if TA support were insufficient, then class size ratios would have to be lowered. In other words, in the view of the panels, additional TA support frees up classroom teachers to provide more personalized instruction, even with larger class sizes.

Funding Must Increase With Rising Costs and Student Needs

Similarly, during our needs assessment interviews and focus groups, district CFOs consistently identified the need for specific resources to better support students, as well as the need for an increase in funding overall, particularly as costs increase.[25]

According to CFOs, regardless of the funding model, North Carolina's system needs to include a plan for updating funding amounts to keep pace with rising costs and emerging student needs. As one CFO explained, the state needs to make sure any new system doesn't replicate the current problems in the state, asserting that "you don't put a funding mechanism in place 30 years ago and you never correct it. … Things should always be indexed on the cost of either what the services are or expansion of services." Another CFO noted that student needs are changing, and funding must reflect these new needs.

At the same time, recognizing that teacher compensation represents one major area in which costs are rising, CFOs expressed strong support for keeping the Classroom Teacher allotment as a position allotment. Among other reasons, CFOs noted the rising costs of teacher benefits, such as health care and pensions (see Exhibit 4, displaying the increasing proportion of funds going toward employee benefit costs). CFOs recognized that because the state guarantees funding for each Classroom Teacher position, this model can protect districts from these rising costs. As such, the Classroom Teacher allotment can promote annual cost adjustments in funding for teacher compensation that help contribute to, if not achieve, funding adequacy. Although this study as well as previous research have found that the Classroom Teacher allotment is problematic due to its inequitable distribution of state funding, CFOs' concerns underscore the need for a funding system that continually accounts for rising staff costs.

25 It should be noted that one to two district CFOs participated in each professional judgment panel and that there is, in some cases, overlap between panelists and CFOs interviewed or engaged in a focus group setting.

Conclusions

Across all three study components, common themes emerged regarding the needs and challenges with North Carolina's funding system. These needs and challenges are outlined in this section, followed by a section on best practices and potential opportunities for strengthening North Carolina's funding system.

Needs and Challenges

Equity of Distribution: Students With Greater Needs Require More Funding Than Others; Resource Distribution Is Inequitable

» The cost function results indicate that additional spending is required to achieve the same student outcomes for economically disadvantaged students, English learners, and exceptional children, compared with other student populations. Regional cost differences also require additional spending.

» Professional judgment panels recommended additional resources across numerous categories to meet the needs of economically disadvantaged students.

» Needs assessment findings suggest local funds are too often required to fill a gap in what is provided by the state, disproportionately impacting low-wealth communities, where students' needs are typically greater.

» Disparities in local funding and state funding received through the Classroom Teacher allotment exacerbate inequities.

Alignment: Unpredictability and Increasing Restrictions on Funding Flexibility Stymie Efforts to Spend Current Resources Effectively

» Needs assessment findings point to the fact that restrictions around transferring funds between allotments (i.e., a lack of funding flexibility) make it difficult to align resources with needs.

» Professional judgment panels consistently emphasized the importance of schools' ability to determine the best allocation of resources at the local level.

» Needs assessment findings suggest that frequent changes in restrictions and requirements (i.e., a lack of funding stability) hinders districts' attempts at long-term strategic planning, ultimately impacting cost effectiveness of spending.

» Prioritizing new staffing and resources for early grades may provide the highest-impact investment of new resources, though this should ultimately be left up to local leaders.

» Accountability structures should require the alignment of funding with data-driven school improvement plans, which can include locally determined measures (i.e., measures beyond standardized tests and graduation rates).

» New investments should be phased in as soon as possible and they should be announced with sufficient notice to allow districts to plan effectively.

» CFOs voiced concern that consolidating allotments would make it easier for the state to cut funding, leading to funding instability.

Adequacy: Defining Desired Outcomes Determines the Minimum Required Investment; Some Critical Educational Resources Are Currently Underfunded

» The cost estimates produced by the cost function analysis suggest that the outcomes the Court accepts as sufficient to meeting the state's obligation will determine the size of the state's investment.

» The results of the cost function analysis are based on three scenarios of short-term investments to bring lower-performing students up to various proficiency thresholds (Short-term A, B, and C), as well as two scenarios for ongoing investments to maintain student growth (Ongoing A and B). A large portion of these dollars would be allocated to schools and districts serving students in high-poverty settings.

» A combination of the Short-term C and Ongoing A scenarios would best represent meeting the standard of the *Leandro* ruling, both in regard to reducing gaps for the state's lower-performing students and maintaining such growth so that students achieve at grade level each year. The sum of the Short-term C and Ongoing A scenarios requires an additional $6.86 billion investment, or approximately $4,710 per pupil. If this amount were distributed equally over an eight-year period, it would mean an investment of approximately $860 million per year, or $589 per pupil each year.

» Following this eight-year period, the necessary additional ongoing investment (Ongoing A) would be approximately $463 million, or $318 per pupil each year.

» Professional judgment panels, as well as individual and focus group interviews, noted numerous critical, high-impact priorities that are currently not sufficiently funded or not funded at all.

Recommendations

1. Increase cost effectiveness of the North Carolina funding system so that public education investment prioritizes higher-need students and provides appropriate flexibility to address local needs.

Keep the allotment system due to widespread popularity, particularly the teacher allotments, but lift the transfer restrictions to allow more flexibility for school districts.

Revise the state's funding system so that current and additional funding is distributed to students with the greatest need. In order to do this:

1. Add weights to the position allotments to account for higher-need student groups.
2. Increase the cap on exceptional children funding.
3. Revise the central office allotment calculation.
4. Base funding for limited-English-proficient students on the number of identified students in the district, not the percentage.
5. Provide accountability and guidance for local systems to effectively align resources with local students' needs.

Make transparent the level of resource investment in North Carolina school districts to increase understanding about how state funding is helping to offset inequities in local contributions to school systems.[26] In order to do this, the state could take steps such as the following:

» More clearly articulate the amount of funding needed per student above the base for higher-need populations (such as English learners, exceptional children, and economically disadvantaged students).

» Enable an online side-by-side comparison feature that can show explicitly how state funds are helping to offset the lack of revenue-raising capacity in low-wealth communities.

» Propose three to five metrics that are tracked over time to measure investment and outcomes, such as:

  – Percentage weight of additional funding for higher-need populations
  – Measures of equitable distribution of dollars
  – Teacher salary relative to national benchmarks

Continue to increase flexibility by lifting restrictions on a number of critical allotments so that district leaders can make resource allocation decisions based on local needs.

26 The North Carolina Department of Public Instruction has begun to include some information about individual school district finances, searchable by county via: https://gdacreporting.ondemand.sas.com/srcfinance/.

Collapse allotments other than position allotments and allotments for higher-need students.

Study and expand the flexibility provisions under HB489 to enable a diversity of school systems to understand how flexibility in resource allocation can benefit local systems.

2. Modify the school finance system to ensure future stability in funding for public education, including predictable, anticipated funding levels that acknowledge external cost factors.

Establish a policy that accounts for annual increases in cost within the state's school funding formula.

Create guardrails on the level and timing of funding distributed to school districts in the future to ensure more predictability for school systems.

Incorporate factors into the school finance formula that account for regional differences in cost and that include adjustments for necessary small schools/districts and for low-wealth communities.

Revise the funding mechanism for charter schools so that funds are distributed directly from the state rather than funneled through public school districts.

Phase in a student-weighted funding formula, collapsing all remaining allotments aside from the position allotments.

Over time, phase out the position allotments and move to a student-weighted funding system.

3. Increase the overall investment in North Carolina's public schools first by identifying a small number of foundational, high-impact investments, then by continuing the investments over time marked by checkpoints for progress.

Once a small number of investments has been identified and made, establish a routine that creates an opportunity for North Carolina to revisit these investments, their impact, and future actions to further the state's stride toward meeting the tenets of *Leandro*. Some examples of these investments include:

- Early childhood staff compensation and time
- Reframing of teacher supply pipeline and compensation
- Principal preparation
- Whole child support, such as counselors and social workers

Establish a mechanism for continually updating state funding amounts to account for annual rising costs.

Provide funds for the necessary resources identified by the professional judgment panels, including additional staff positions, professional development, funding for technology and other materials, and additional supports for higher-need students.

Technical Appendix A: Protocols for Needs Assessment Focus Groups and Interviews

Introduction

Thank you for participating in today's focus group/interview. Our names are _____. We invite colleagues from our partner organizations, the Friday Institute and the Learning Policy Institute, to introduce themselves _____.

WestEd is a nonprofit, nonpartisan educational research and development organization appointed by the North Carolina Trial Court as an independent consultant to develop an Action Plan. The Action Plan must ensure that North Carolina children have an equal opportunity to obtain a sound basic education; it will recommend a roadmap that ensures constitutional compliance and that addresses these four main requirements: (1) effective teachers in all classrooms; (2) effective principals in all schools; (3) adequate resources to provide a sound basic education for all children; and (4) an assessment and accountability system that can monitor and demonstrate progress in providing a sound basic education for all children.

Your feedback about your experiences will be used to inform the development of the Action Plan.

Confidentiality

What you tell us will be kept anonymous in that we will not use your name/role or the district you serve, and we will not attribute any quotes to individuals. All the data we gather from focus groups/interviews will be synthesized and summarized and you will not be identifiable in our reports. However, we will be taking notes today, and we will record if no one has an objection. The purpose of the recording is to clarify our notes; we will destroy recordings upon completion of our summary. Please respect the privacy and confidentiality of this focus group and agree not to share what you hear in this group with others who are not present.

1. Financial Officers: Focus Group Protocol

Process

We are seeking your experiences, observations, and opinions, so please be candid. We welcome all ideas, opinions, and points of view. We want to be sure everyone has a chance to contribute, and we don't expect everyone to agree. You do not have to respond to all questions. Our role is to ask questions, listen, take notes, and keep you on track. Are there any questions before we begin?

1. What aspects of the North Carolina education finance system are the most effective (i.e., what works well)?

Probes:

- The formulas used to allocate funds through the allotments?
- The rules on how funds can be spent?
- Audits/data collection?
- Other aspects of the system?

2. Are there any aspects of the education finance system that are particularly challenging? If so, what are they?

Probes:

- The formulas used to allocate funds through the allotments?
- The rules on how funds can be spent?
- Audits/data collection?
- Other aspects of the system?

3. What skills do you think are most important to be successful as a finance officer in North Carolina?
4. What are the most difficult aspects of your job? What would help you overcome those challenges?
5. As a new finance officer, what supports did you receive? What do you know now that you wish you had known when you first started?
6. What supports do you receive as an experienced financial officer? Are there any other supports or training you wish you had access to?
7. Given current funding levels in the state, are there areas critical to providing a sound basic education that the state has not been able to provide funding for? If so, what are they?

8. If the rules on how allotments can be spent were removed and you had the ability to shift the allocation of funding around in your district, what changes would you make to the way you allocate funding in your school district, if any?

Probes:

- Where would you spend additional dollars?
- Where would you spend fewer dollars?

9. What strategies do you employ to make the most efficient use of funds? Are there specific cost-saving strategies you employ or recommend?

10. In your view, is North Carolina's school finance system equitable?
    - If so, which aspects of the school finance system contribute the most to making it equitable?
    - If not, which aspects of the system do you view as the most inequitable?
    - What could be done to make the system more equitable?

11. We have heard and read that sometimes changes are made to the rules for how allotment funds can be spent and the amount of these allotments. How do these changes impact your budgeting process? If these changes create a challenge for your work, is there a particular type of change that is more difficult to deal with than another?

Probes:

- Charter funding?
- North Carolina Department of Public Instruction revisions?
- Changes during the year vs. changes from one year to the next?

12. We know that the state is undertaking an overhaul to the data systems. Outside of the technology, are there any aspects of the budget process from a technical standpoint that you believe could be improved? If so, what are they?

13. What is one thing you think is particularly important for us to address in our study?

14. Is there anything you want to add that we haven't already discussed?

2. Financial Officers: Individual Follow-up Interview Protocol

Process

We are seeking your experiences, observations, and opinions, so please be candid. We welcome all ideas, opinions, and points of view. You do not have to respond to all questions. Our role is to ask questions, listen, take notes, and keep you on track. Do you have any questions before we begin?

Great.

We will now begin recording the conversation.

1. Please say your name and the name of your district.
   (a) Please describe your district in a couple of sentences.
   (b) How many years have you been CFO in your district? Where did you work before you became CFO there?
2. What do you believe are the top three things state policymakers could do to improve support for public education in North Carolina?
3. From your perspective, which aspects of the way funds are distributed to your school district work well?

Probes:

   (a) The formulas used to allocate funds through the allotments?
   (b) The rules on how funds can be spent?
   (c) Audits/data collection?
   (d) Other aspects of the system?

4. Are there any aspects of the way funds are distributed to your school district that are particularly challenging? If so, what are they?

Probes:

   (a) The formulas used to allocate funds through the allotments?
   (b) The rules on how funds can be spent?
   (c) Audits/data collection?
   (d) Other aspects of the system?

5. In your view, is North Carolina's school finance system equitable?
   (a) If so, which aspects of the school finance system contribute the most to making it equitable?
   (b) If not, which aspects of the system do you view as the most inequitable? What could be done to make the system more equitable?
6. Do you receive the low-wealth supplement? If so, what do you use those funds for?

Distribution of Funds

7. If the rules on how allotments can be spent were removed and you had the ability to shift funding around in your district, what changes would you make to the way you allocate funding in your school district, if any?
   (a) Where would you spend additional dollars?
   (b) Where would you spend fewer dollars?

8. We have heard and read that sometimes changes are made to the rules for how allotment funds can be spent and the amount of these allotments. How do these changes impact your budgeting process?

9. On a scale of 1 to 10, how stable is your school district budget in terms of state funding from one year to the next?

   (a) Why is that the case?
   (b) *[If they respond with a number less than 5]* What could be done to make funding more stable?

10. Would it affect your ability to hire new employees if the funding system changed from position allotments to dollar allotments for teachers? If so, in what ways?

Probes:

   (a) Do you have information on the dollar value of the teacher allotments you receive (i.e., the total the state is spending on teacher salaries in their districts)?
   (b) Would you describe the teacher allotments as equitable across districts? If so, why? If not, why? In your view, do the position allotments allow districts with high-salaried teachers to be "subsidized" by the districts with low-salaried teachers?

11. Are there charter schools in your area? If so, how have charter schools impacted funding, if at all, in your district?

12. Are you able to combine different funding streams from local, state, and federal sources (e.g., use of Medicaid, IDEA, child care subsidies, workforce development funds) to optimize your investments in particular programs or initiatives?

   (a) Are there any policy barriers to optimizing funding sources in this way? If so, do you have any recommendations for reducing these barriers?

13. What are the advantages and constraints of the three different funding sources — local, state, and federal:

   (a) In terms of the flexibility of the funding provided?
   (b) In terms of the targeted support they provide?
   (c) In terms of the adequacy of funding provided?

Adequacy

14. Given current funding levels in the state, are there areas critical to providing a sound basic education that the state has not been able to provide funding for in your district? If so, what are they?

15. If additional funding were available for the state to invest in education, where specifically would you advise policymakers to invest those additional dollars?

16. Are there any nonprofits or foundations that provide funding or services to your district? If so, which ones and what do they provide funding for?

District Budget Processes *[Time Permitting]*

17. What is the process that your school district uses to prioritize the allocation of funds? (Note: We are particularly interested in the process, rather than the specific priorities themselves.)
18. How does your school district judge the effectiveness of its resource investments?
19. Are there specific strategies you employ or recommend in order to reduce costs or maximize efficiency?
20. What are the most difficult aspects of your job? What would help you overcome those challenges?
21. Where do you receive guidance and support on how to allocate funds, if anywhere?
    (a) The North Carolina Department of Public Instruction?
    (b) Other CFOs?
    (c) Principals or teachers in your district?

Closing

22. Is there anything you want to add that we haven't already discussed?

3. North Carolina Department of Public Instruction (DPI) Officials: Individual Interview Protocol

Process

We are seeking your experiences, observations, and opinions, so please be candid. We welcome all ideas, opinions, and points of view. You do not have to respond to all questions. Our role is to ask questions, listen, take notes, and keep you on track. Do you have any questions before we begin?

Great.

We will now begin recording the conversation.

1. Please describe your role at the DPI as well as a bit about your background in school finance in North Carolina.
2. From your perspective, what aspects of North Carolina's education finance system are the most effective, i.e., what works well?

Probes:

- The formulas used to allocate funds through the allotments?
- The rules on how funds can be spent?
- Audits/data collection?
- Other aspects of the system?

3. Are there any aspects of the education finance system that are particularly challenging? If so, what are they?

Probes:

- The formulas used to allocate funds through the allotments?
- The rules on how funds can be spent?
- Audits/data collection?
- Other aspects of the system?

4. Given current funding levels in the state, are there critical areas that the state has not been able to provide funding for? If so, what are they?

Probes:

- Does the ability to fund these areas vary by district type (e.g., low- vs. high-wealth districts)?

5. Please describe a typical allocation process for the DPI.

Probes:

- For example, when do districts submit data to the DPI? Is it generally accurate?
- At what time of year do you find out how much funding will be provided to districts overall?
- When and how do you notify districts about how much funding they will receive?
  - Do they get their funds all at once?
  - Are changes made at intervals throughout the year?
- What is the process for making revisions to the budget allotments?
- From your perspective, does this process work relatively well for the state? For LEAs [local education agencies]? If so, in what ways?
- Is there anything you would change about this process if you could?

6. Please describe the allocation process for charter schools and for home-schooled students. In what ways is the process the same as/different from school districts?

Probes:

- Is there anything you would change about this process if you could?

7. Please describe your process for monitoring/auditing district expenditures of the allotments.

Probes:

- How much time and staff are dedicated to this process?
- Is there anything you would change about this process if you could?

8. Who are the key staff in the finance office at the DPI, and what are their primary responsibilities?

9. What are the primary types of support that the DPI provides to school districts when it comes to the school funding system?

Probes:

- If you had additional resources (e.g., staff, time), what types of additional support would you provide to school districts when it comes to the state's school finance system?

10. How do legislative changes to the allotment system impact your work?

Probes:

- If these changes create a challenge for your work, is there a particular type of change that is more difficult to deal with than another?

11. What aspects of the state's funding system do you most frequently hear education leaders ask to be changed, if any?

Probes:

- The allotment system?
- The allocation process?
- Data collection?

12. If additional funding was available, where would you advise policymakers to invest those additional dollars?

13. What is one thing you think is particularly important for us to address in our study?

14. Do you have any other suggestions for whom we should speak with in order to learn more about the funding system?

15. Is there anything you want to add that we haven't already discussed?

Technical Appendix B: Professional Judgment Panels Data and Methods

In its typical implementation, a professional judgment panel is designed to estimate the minimum spending associated with a set of desired outcomes by drawing on the expertise of a diverse pool of panelists representing a variety of practitioner roles. This usually includes teachers, principals, instructional support staff, school counselors, district business officers, and district leadership. Often panelists are divided by their focus and, thus, areas of expertise (e.g., a site-level panel, a district-level panel, a special populations panel, etc.) (Baker, 2009). Alternatively, panels might reflect a mixture of perspectives, with representatives from various groups (Chambers, Levin, & DeLancey, 2006).

In either approach, each group of panelists is presented with a data profile of the "typical" school environment at each schooling level — elementary, middle, and high school. Panelists are then asked to deliberate on the resources required in the specified environment to achieve a desired set of student outcomes. The research team then estimates the cost of the recommended resources and aggregates these cost estimates to provide an overall estimate of the adequate level of spending statewide.

Although the professional judgment panels implemented for the current study follow the typical panel method in general, there are a few key differences in the goals and structure of our panels. These include the following:

- **Resource allocation choices emphasized over aggregate costs**: Given that we are also estimating adequate costs through the education cost function method, the primary goal of our panels, unlike traditional panels, is to provide recommendations on the ideal allocation of resources. Although the final recommendations will have associated costs relevant to panel deliberations, we are especially interested in the resource identified as opposed to the estimated cost.

- **Upper and lower cost bounds provided**: A common critique of professional judgment panels is that they do not take into account the reality that schools and districts must always work within budget constraints and make trade-offs.[27] To mitigate this concern, we are introducing the current per-pupil spending estimated for the "typical" school environments and estimated marginal change in spending for these environments to achieve a set of outcomes. Time during each panel was reserved for panelists to consider

27 For a discussion of these critiques and other limitations of the panel method, see Hanushek (2006) or Baker (2009).

whether their recommendations align with these additional points of data and to discuss potential trade-offs to better align the cost of their recommendation resources.

» **Recommendations for implementation provided**: Another common challenge with a cost analysis is the reality that changes to education funding must be made over time and within a complex political environment. To address this, we have also reserved time in the panels for discussion of the appropriate time period to phase in the recommendations, the ideal sequencing of particular recommended changes, the level of spending flexibility provided to sites, and the accountability mechanism paired with this flexibility to ensure effective spending.

What follows is a brief overview of the method used to select panelists, structure the panel deliberations, and analyze the results.

Panel Selection Process

The most crucial component of the panel method is the composition of the panels themselves. It is imperative that the panelists represent exemplary members of their respective groups and reflect a diversity of experiences and characteristics.

Panelist Identification

To identify prospective panelists, the research team employed two complementary strategies. First, the team identified state education leaders, including those leading professional associations, prominent education organizations, and other relevant organizations. Second, the team tapped the on-the-ground engagement of others at WestEd to identify local leaders. The identified individuals were then invited to serve as "key messengers." In this role, they were asked to provide a list of prospective panelists meeting the selection criteria. Key messengers were instructed to consider: (1) how the panelists will be different from their peers and (2) how the panelists will be representative of their peers. Using this frame, specific criteria were shared with key messengers. Below, Exhibit B1 displays the selection criteria provided.

Exhibit B1. Selection Criteria Provided to Key Messengers

How Different?	How the Same?	Criteria Category	Criteria
High Quality; Prominent; Diverse Experience; Non-Typical Student Population	Geographic/ Locale/Size/ Schooling Level/Race/ Ethnicity/ Gender/Age Representation; Typical in Other Ways	Geographic Representation	There must be at least one rep from each of the four regions.
		Locale Representation	There must be at least one rep from each of the four locale categories.
		Size Representation	There must be at least one rep from each of the three size categories (small, medium, and large).
		Schooling Level Representation	There must be at least one rep from each schooling level (elementary, middle, and high) as applicable.
		Race/Ethnicity/ Gender/ Age Representation	Each panel should reflect the diversity of North Carolina in race/ethnicity, gender, and age.
		Non-Typical Student Population	All panels must have at least one representative from a school with a larger than average population of disadvantaged student groups (relevant groups: low-income students, English learners, students with disabilities).
		Typical in Other Ways	Districts must be relatively typical with respect to other populations, size, organizational structure, etc.
		High Quality	Prospective panelists must be high-quality educators in their current role.
		Prominent	Prospective panelists must be positively recognized statewide, regionally, or locally.
		Diverse Experience	Prospective panelists must be experienced and must have served in settings other than their current job.

Ultimately, out of 54 people contacted, 11 people agreed to serve in the role of key messenger and provided recommended prospective panelists. Exhibit B2 summarizes these individuals, their roles, and affiliated organizations.

Exhibit B2. Summary of Key Messengers Engaged

Name	Organization	Role
Larry Armstrong	Halifax County Board of Education	Attorney at Law
Scott Bayzle	Parker Poe	Attorney at Law
Brenda Berg	BEST-NC	President and CEO
Melanie Black Dubis	Parker Poe	Attorney at Law
Gerry Hancock	Everett, Gaskins, Hancock LLP	Attorney at Law
Dr. Jennifer F. Hefner	Alexander County Schools	Superintendent
Katherine Joyce	North Carolina Association of School Administrators	Executive Director
Freebird McKinney	Alamance County Schools	Regional TOY
Dr. Rodney Peterson	Person County Schools	Superintendent
Shirley Prince	North Carolina Principal's Association	Executive Director
Jim Simpson	North Carolina Chamber of Commerce	CAE

Based on key messenger referrals, there were 143 individuals invited to join the pool of prospective panelists, and 88 of these individuals expressed interest. Of those individuals, 55 were identified as finalists. Among the finalists, we sought to identify times and locations that were convenient for a sufficient number of panelists to create a panel (minimum of 8 invited). Simply due to availability, some panelists identified as finalists were not invited. Moreover, scheduling conflicts led to last-minute absences by confirmed panelists in a few cases. In total, our three panels consisted of 19 panelists split into groups of 8, 6, and 5 for each of the three panels respectively.

Panelist Quality and Best Fit

With respect to the overall quality of panelists, it is self-evident that a process relying on professional judgment include only individuals who have a clear record of exemplary judgment. Similarly, we sought panelists with backgrounds that suggest they are best able to speak to the resource requirements of a diversity of school environments and thus are the best fit for the panel process. In particular, due to the emphasis of this study and the ongoing *Leandro* litigation, we sought panelists with experience serving high-need groups and in low-wealth environments.

With this in mind, a variety of measures were considered in the panelist selection process to identify panelists best able to contribute to the process. These elements are identified in Exhibit B3. Also displayed is the motivating factor for the inclusion of a given measure (i.e., quality or alignment) and the possible points given to each measure.

Exhibit B3. Measures of Panelist Quality and Alignment

Measure	Description	Motivating Factor	Relative Weight
Panelist Experience	Measured within categories, including less than one year, 1–2 years, 3–5 years, 6–10 years, 11–15 years, and more than 15 years of experience.	Quality	2 points for panelists with more than 15 years of experience
Independent Recognition of Panelist Quality	Includes any awards given to the individual panelist.	Quality	2 points for receiving at least one award
Direct Reference From State Education Leader	Primarily came through the key messengers.	Quality	1 point for each key messenger referral
Work With Special Populations	Includes economically disadvantaged students, English learners, and students with disabilities.	Best Fit	1 point for at least one population; 2 points for more than one
Work in Diverse Environments	Reported by panelists, with qualitative descriptions of experiences.	Best Fit	1 point if diverse experiences are reported
Work in a Low-Wealth District	Based on receiving "low-wealth" funding.	Best Fit	1 point if working in a low-wealth district
Bonus Points*	Miscellaneous extra points awarded for a variety of specific distinctions.	Multiple	1 point for improved student outcomes, if hired as a turnaround leader, if leading a special program for students or if the recipient of more than one award 1 point removed if affiliated with advocacy group that might contribute to panel bias

** In addition, for Business Officer interviewees only, points were awarded or removed based on internal WestEd staff recommendations: 3 points for strong recommendation, 1 point for neutral, and –2 points for expressed concerns.*

Panelists were selected from among a pool of panelists in two stages. Identified as finalists were only those receiving average or above-average scores within their member group.[28]

28 These groups included (1) teachers and principals, (2) business officers, and (3) district leaders, including superintendents and assistant superintendents. Due to a very low number of prospective panelists in the instructional coach and school counselor roles (three and two individuals, respectively), all those expressing interest were considered finalists to ensure these roles were represented whenever possible.

Panelist Diversity

The value of diversity in groups and its impact on group performance is the subject of a substantial amount of previous research. Although there are competing theories about the net effect of diversity, there is some evidence of what does and does not contribute to realizing the potential benefits of a diverse group.[29]

Specifically, research supports the idea that heterogeneous groups may solve problems more effectively. The theory is that diverse groups bring constructive conflict, which will ultimately produce a more thorough analysis. Part of the theory is that such diversity sparks creativity and an ability to get beyond "redundant perspectives" in homogeneous groups.[30] However, many studies suggest that negative effects may result from comparisons between group members and the formation of "in- and out-group distinctions." The theory is that people prefer to collaborate with in-group members and distrust or derogate out-group members. The "similarity attraction paradigm" supports this idea, contending that collaboration with similar group members increases a sense of identification and social integration.[31]

Our view of the literature is that a variety of competing factors produce a net effect of diversity on group performance. In fact, there are a few evidence-based moderators that may imply strategies for making the most of diverse group collaboration:

- Shared collectivistic (vs. individualistic) culture (Chatman, Polzer, Barsade, & Neale, 1998)
- Integration-and-learning perspective as opposed to equality and fairness (Ely & Thomas, 2001) [32]
- High level of psychological safety (Gibson & Gibbs, 2006)
- History of working together (Harrison, Price, & Bell, 1998)
- High levels of interpersonal congruence (Polzer, Milton, & Swann, 2002)[33]
- Complex, nonroutine tasks (Bowers, Pharmer, & Salas, 2000)
- High-outcome interdependence (e.g., common goals) (Schippers, Den Hartog, Koopman, & Wienk, 2003)

Our emphasis on innovative thinking leads us to conclude that diversity is particularly important for our panels. As such, we took steps to select as diverse groups of panelists as possible. In addition, we sought to leverage the evidence-based moderators whenever possible through our panel structure (described in detail in the Panel Structure section).

29 For a very readable summary of the relevant literature, see Fernandes and Polzer (2015).

30 See Mannix and Neale (2005) for more information.

31 See Williams and O'Reilly (1998) for more information.

32 "Integration-and-learning" requires group members "place a high value on process — on time spent exploring their different points of view and deliberating about whether and how they should inform the work." In contrast, a focus on "equality and fairness" would emphasize either diversity for the sake of being representative of a "diverse market" or viewing diversity as a "moral imperative." These latter perspectives may not actually support making the most of what a diverse work group has to offer. For more, see Ely and Thomas (2001).

33 In other words, "the degree to which members' appraisals of one another are similar to their self-assessments on dimensions relevant to team functioning." For more on this, see here.

To increase panelist diversity, we considered a variety of panelist characteristics and the community in which prospective panelists worked. This includes panelist race/ethnicity, gender, region and locale, and district-level enrollment. To give a sense of the diversity found in our pool of prospective panelists, Exhibit B4 presents its composition, along with a few key dimensions. As is clear from the table, the final pool of invited panelists contained individuals from all locales and regions of the state, all grade levels, all sizes, and all diversities in terms of race and ethnicity. The only characteristic that clearly lacks diversity is years of experience. This likely reflects the fact that prospective panelists referred to the research team were overwhelmingly at the higher level of experience categories, as well as the fact that experience was given preference in the selection process.

Exhibit B4. Characteristics and Educational Setting of Panelist Pool

Key Measure	Overall	Finalists	Invited
Locale			
City	22%	20%	23%
Suburb	17%	13%	10%
Town	6%	2%	3%
Rural	55%	64%	60%
Multiple	1%	2%	3%
North Carolina Education Districts			
Northeast, Region 1	11%	9%	7%
Southeast, Region 2	9%	11%	10%
North Central, Region 3	24%	20%	13%
Sandhills, Region 4	15%	16%	10%
Piedmont Triad, Region 5	13%	15%	23%
Southwest, Region 6	8%	11%	13%
Northwest, Region 7	11%	7%	10%
Western, Region 8	8%	9%	10%
Multiple	1%	2%	3%
Grade Level			
Elementary	15%	13%	13%
Middle	14%	16%	23%
High	19%	20%	10%
Multiple	52%	51%	53%
District Size			
<8,214 students	29%	30%	38%
8,214 to 19,519 students	33%	31%	28%
19,520 to 51,187 students	26%	24%	24%
>51,187 students	12%	7%	10%

Key Measure	Overall	Finalists	Invited
Experience			
Less than 1 year	0%	0%	0%
1–2 years	0%	0%	0%
3–5 years	0%	0%	0%
6–10 years	11%	9%	13%
11–15 years	14%	13%	17%
More than 15 years	75%	78%	70%
Race/Ethnicity			
Hispanic	6%	5%	10%
American Indian or Alaska Native	2%	4%	3%
Asian or Asian American	0%	0%	0%
Black or African American	23%	31%	27%
Native Hawaiian or other Pacific Islander	0%	0%	0%
White or Caucasian	76%	69%	73%
Gender			
Male	45%	42%	33%
Female	55%	58%	67%

Identifying a "Typical" School Setting

As part of the professional judgment panel method, panelists are commonly asked to consider the characteristics of a variety of "typical" school settings. These settings are most often hypothetical, and the data provided typically consists of statewide averages for the reported measures (e.g., enrollment, percentage of economically disadvantaged students, etc.). The fact that these profiles do not actually correspond to a real school has been a common criticism of the method. To respond to this critique and to improve the method, the research team took a different approach to constructing these profiles.

First, using the publicly available, categorical data on school-level poverty, the research team identified "typical" schools as those with between 40% and 70% students in poverty. This is the middle of the 2016–17 distribution and captures about 37% of all traditional public schools.

Second, the team used a measure of the distance from a multidimensional reference point, the Mahalanobis distance, to identify schools clustered around the average enrollment (known as the average daily membership, or ADM), the school-level percentage of students with a disability, and the district-level percentage of English learners (ELs).

Finally, from among those schools in the bottom fifth percentile of the distance distribution, a school was selected at random and the characteristics of this specific school were reported.[34]

This process was conducted separately for each schooling level to identify the "base" schools. Then the process was repeated for each schooling level including only those schools identified as "high EDS" (economically disadvantaged student), or those with 75% or more economically disadvantaged students. Finally, the process was repeated for each schooling level, including only those schools identified as "high EC" (exceptional children), or those in the 75th percentile for percentage of students with a disability.

Exhibit B5 below summarizes the characteristics of each school profile provided to panelists.

Exhibit B5. "Typical" School Profile Data

	Base			High EDS			High EC		
	Elem	Middle	High	Elem	Middle	High	Elem	Middle	High
ADM	**550**	**600**	**900**	**475**	**450**	**425**	**350**	**600**	**650**
Pupil-Teacher Ratio	18:1	15:1	16:1	14:1	18:1	14:1	17:1	14:1	18:1
% EDS	**45% to 50%**	**45% to 50%**	**45% to 50%**	**Greater than 90%**	**Greater than 90%**	**Greater than 90%**	**55% to 60%**	**45% to 50%**	**50% to 55%**
% EC	**12%**	**16%**	**11%**	**12%**	**15%**	**11%**	**22%**	**17%**	**17%**
% EC (Low Severity)	*6%*	12%	8%	9%	8%	7%	11%	12%	10%
% EC (High Severity)	6%	4%	4%	4%	8%	4%	10%	4%	7%
% Race/Ethnicity									
American Indian/ Alaskan Native	*<1%*	*<1%*	1%	*0%*	*1%*	*20%*	*0%*	*1%*	*<1%*
Asian	*<1%*	*1%*	1%	*13%*	*<1%*	*0%*	*<1%*	*<1%*	*<1%*
Hispanic	*5%*	*14%*	12%	*46%*	*15%*	*7%*	*16%*	*17%*	*18%*
Black	*1%*	*1%*	1%	*27%*	*49%*	*40%*	*21%*	*7%*	*31%*
White	*91%*	*80%*	82%	*11%*	*31%*	*29%*	*60%*	*70%*	*47%*
Hawaiian Native/ Pacific Islander	*<1%*	*0%*	<1%	*<1%*	*0%*	*0%*	*0%*	*0%*	*0%*
Two or More Races	*2%*	*3%*	3%	*3%*	*4%*	*3%*	*3%*	*5%*	*4%*
District-Level % EL	**7%**	**7%**	**7%**	**9%**	**7%**	**3%**	**5%**	**4%**	**5%**

Panel Structure

In designing the structure of the two-day panel meetings, the research team drew on best practices in prior studies using this method. In particular, the team would like to acknowledge the work of Levin, Brodziak de los

34 All data were rounded or reported in a range to ensure anonymity of the randomly selected school.

Reyes, Atchison, Manship, Arellanes, and Hu (2018) as the model we sought to build upon. The panel process included four distinct phases of work, each with its own key components. The panel structure included an ice-breaker, a pre-reading activity, base and special setting recommendation deliberations, a cost estimate review, and an implementation discussion.

Furthermore, in an effort to take full advantage of our panels' diversity, we chose particular facilitation strategies and processes. Their connection to the previous evidence-based moderators are noted in the summary below.

Icebreaker/Group Development

To kick off each panel, we asked the panelists (and facilitators) to share a bit about themselves and their background. Specifically, panelists were asked to share their name, role, district, and most impactful educational experience. This type of warm-up is a typical aspect of any collaborative meeting and serves the purpose of getting people comfortable talking as a group early in the meeting. In this particular case, our intention was also to give each panelist an early opportunity to share their professional experiences to **foster a high level of interpersonal congruence**. As each person shared, the commonalities in their experiences provided panelists with an opportunity to see themselves as part of the same group and judge their fellow panelists to be part of the same cultural group, namely, public education.

With a similar goal in mind, we also emphasized the norms of collaboration put forth by Garmston and Wellman (2009). In our view, these norms **support instilling a more "collectivistic" culture, as opposed to an "individualistic" culture**. As Garmston and Wellman state, "People who are not talking are not necessarily listening; in fact, they might just be waiting to talk and are composing their thoughts and responses. … By applying the norms of collaboration, skilled group members, individually or together, interrupt this nonproductive pattern and establish more thoughtful forms of discourse within their group" (p. 39).

Pre-Reading Activity

After some background and framing, the first structured activity panelists engaged in was a modified version of the common jigsaw protocol published by the School Reform Initiative.[35] Panelists were randomly assigned one of the pre-readings and asked to work in pairs to identify key takeaways from the document and capture them on chart paper or a whiteboard. Then each pair shared the highlights of their discussion with the rest of the group. A common function of this sort of activity is to allow teams to go deeper with one topic while also providing the full group with a basic level of knowledge about all topics under consideration. In the panel context, this activity was explicitly **designed to contribute to interpersonal congruence** by creating a common knowledge base on key topics. It is important to note that through this activity, panelists each have the experience of receiving valuable knowledge from their peers and providing such knowledge to their peers.

35 You can access this protocol at http://schoolreforminitiative.org/doc/jigsaw.pdf

Base and Special Setting Recommendations

The overall structure of the base and special setting deliberations was, as acknowledged in an earlier section, building upon the important work of prior studies, and in particular upon Levin, Brodziak de los Reyes, Atchison, Manship, Arellanes, and Hu (2018). As in that study, panelists began by tackling the "typical" school environment as a "base" setting and then proceeded to consider special settings, including high EDS and high EC settings. Panelists were provided with data on student and school characteristics for "typical" settings and each special setting for each schooling level and instructions for deliberations. As part of these instructions, panelists received a set of operating assumptions intended to define the scope of the discussion. These assumptions were:

Panel Assumptions

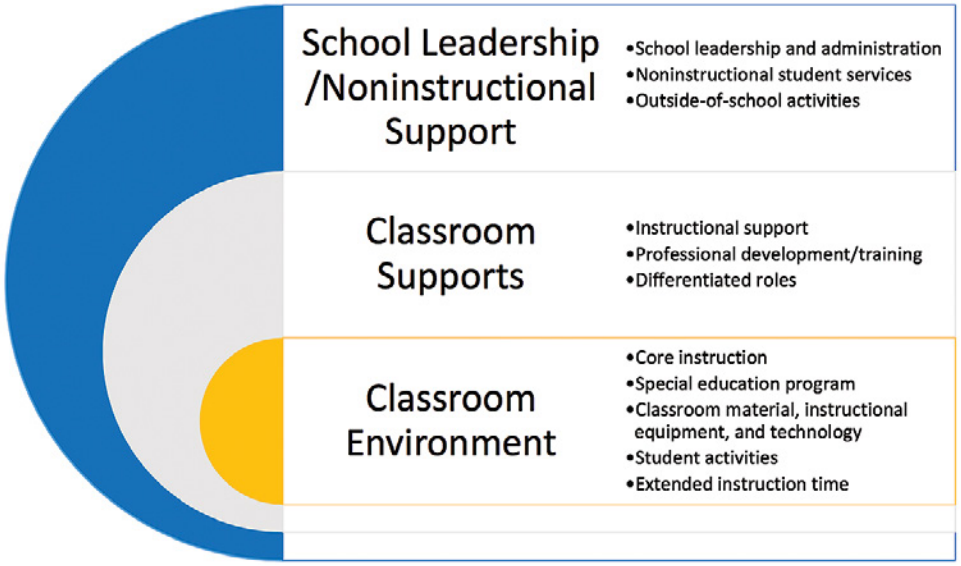
1. The characteristics of the "typical" school setting should be assumed to be as described in the relevant school profile.
2. All staff should be assumed to have minimum requisite certifications and education to serve in a given position, and staff salaries are assumed to be sufficient to attract and retain such staff.
3. A few key types of spending are not within the scope of the panels and thus can be assumed to be sufficient. These include:
   (a) Transportation
   (b) Capital expenditures/facilities
   (c) Food services
   (d) Central district administrative functions
4. All special education services within the scope of the panel process should be assumed to be provided within the school itself. This assumption does not apply to the special setting subgroup focused on students served by EC programs.

Before tackling base recommendations for each schooling level, panelists were asked to envision the *ideal* school setting for the relevant schooling level.[36] Each panelist was asked to independently describe the setting. Panelists were encouraged in this activity to think creatively and go beyond the specified scope of the panel. The panel's collective thinking was recorded on chart paper and posted for the remainder of the panel.

Following the visioning activity, the panels' deliberations were organized into three broad categories of resources, which were further divided into more specific resource subcategories. Exhibit B6 below displays these categories and subcategories.

36 Due to time constraints, one panel came to the collective agreement that they would forgo the visioning activity for the Middle School level.

Exhibit B6. Panel School Setting Framework



For each subcategory, panelists were asked a series of specific questions. Although addressing these questions was required, panelists were advised that they should not feel limited to only the provided questions. The process proceeded in sequence from Classroom Environment to Classroom Supports and finally to School Leadership/ Noninstructional Resources. In this way, panelists began by discussing the resources most directly relevant to student instruction and gradually expanded to consider aspects of the school environment that influence instruction in more indirect ways.

The process of addressing each discussion question employed a common facilitation technique designed to support creating a **high level of psychological safety**. Specifically, panelists were first given an opportunity to reflect on the questions individually, then asked to share their reflections with the group. Only after all panelists had contributed were any recommendations considered or finalized. In our view, this approach sends the signal that each panelists' contribution is equally valued and ensures that each has sufficient mental space to prepare for participation.

Recommendations for the Elementary setting were tackled first and functioned as a reference point as the process moved forward. Specifically, before the start of deliberations for Middle School environments, panelists were asked to categorize each Elementary recommendation as being (1) the same for Middle School, (2) slightly different for Middle School, or (3) sufficiently different for Middle School so as to warrant a thorough reexamination. The panels all came to a consensus on how to categorize each question before proceeding. A similar process was employed before High School deliberations, but now with both Elementary and Middle School recommendations as reference points.

This process was developed with a few specific goals in mind. One consideration was, of course, the efficiency with which the panel was able to move through their deliberations. Using Elementary and, later, Middle School settings as reference points helped to minimize duplicative conversations or unnecessary reexamination of settled issues. Likewise, by providing a high degree of specificity at each stage of the process, facilitators were better able to keep panelists within the scope of the discussion. The research team considered the possibility

that such specificity would have the unintended effect of limiting panelist creativity. It was with this in mind that each discussion began with the visioning activity. In addition to frequent reminders to treat the questions as a foundation, panelists were also referred back to their collective vision as a technique for fostering more creativity in the structured deliberations.

The process for the special settings, high EDS and high EC, was in essence the same as the base recommendations. As with Middle School and High School, the base recommendations were offered as a reference point and discussions were targeted to the particular resource categories the panel felt differed substantially from the "typical" setting.

Cost Estimate Review

Based on the qualitative recommendations made by the panels, the research team estimated a total dollar amount per pupil using a set of assumptions about prevailing unit prices. For some particular resource categories, panelists provided estimate costs as part of their recommendation. The primary purpose of creating these estimates was to prompt a discussion among panelists about how best to make necessary trade-offs when the scope of desired outcomes is narrowed and the budget is constrained. Below is a summary of the key assumptions made to construct the estimates, followed by a description of the structure of the cost estimate review discussion.

Cost Estimate Assumptions

The primary source of cost data for these estimates was the 2016–17 state salary schedule for teachers, psychologists, instructional support staff, principals and assistant principals, teacher assistants, and other staff positions (e.g., nurses, speech and language pathologists, etc.). To account for variation in teacher experience, the distribution of years of experience for core instructional staff was specified by the panel within three categories: 0 to 3 years of experience, 4 to 10 years of experience, and 11 or more years of experience. Furthermore, the distribution of educational attainment was assumed to be the same as the statewide distribution.[37] Thus the salary applied to core instructional staff was a weighted average salary within each relevant experience category, using the assumed educational attainment distribution as weights. Panelists were also asked to specify the percentage of National Board Certified Teachers in each setting so that the additional compensation provided to these teachers could be accounted for.

Other positions, including instructional support staff, administrators, and psychologists, were assumed to have the weighted average salary in the relevant position category using years of experience as the weight and assuming the statewide experience distribution.[38]

Staff stipends were also accounted for using the salary schedule daily rates for teachers and instructional staff.

For each base salary amount, the cost of several benefits was applied to estimate total compensation. This includes adding $5,471 for hospitalization, 16.12% of the base for retirement, and 7.65% of the base for Social

37 Specifically, this is as follows: bachelor's – 53%; master's – 42%; advanced – 3%; doctorate – 2%.

38 Specifically, this is as follows: 0 to 3 – 22%; 4 to 10 – 26%; 11 or more – 53%.

Security (North Carolina State Board of Education & Department of Public Instruction, 2017). Exhibit B7 below lists the average total compensation for a variety of positions.

Exhibit B7. Assumed Total Compensation by Position

Position	Description	Total Compensation
Teacher (Annual)	Average for 0 to 3 years of experience	$52,921
Teacher (Annual)	Average for 4 to 10 years of experience	$56,468
Teacher (Annual)	Average for 11+ years of experience	$65,943
Teacher (Annual)	Average across experience levels	$60,615
Instructional Support (Annual)	Average for 0 to 3 years of experience	$52,921
Instructional Support (Annual)	Average for 4 to 10 years of experience	$56,468
Instructional Support (Annual)	Average for 11+ years of experience	$65,943
Instructional Support (Annual)	Average across experience levels	$60,614
Teacher (Daily Rate)	Average for 0 to 3 years of experience	$218
Teacher (Daily Rate)	Average for 4 to 10 years of experience	$234
Teacher (Daily Rate)	Average for 11+ years of experience	$278
Teacher (Daily Rate)	Average across experience levels	$254
Psychologist	Average across experience levels	$66,630
Assistant Principal	Average across experience levels	$61,867
Principal	In a school with 0 to 10 teachers	$70,550
Principal	In a school with 11 to 21 teachers	$73,427
Principal	In a school with 22 to 32 teachers	$76,631
Principal	In a school with 33 to 43 teachers	$78,959
Principal	In a school with 44 to 54 teachers	$81,446
Principal	In a school with 55 to 65 teachers	$85,489
Principal	In a school with 66 to 100 teachers	$89,930
Principal	In a school with 101 or more teachers	$92,206
Teacher Assistants	Average within public employee salary grade	$44,796
Noninstructional Staff	Average within public employee salary grade	$39,899
Nurse	Average within public employee salary grade	$65,520
Speech and Language Pathologist	Average within public employee salary grade	$56,969
Office Staff	Average within applicable public employee salary grades	$48,986
Substitute Teachers	Maximum daily rate	$198

Aside from the salary schedule data, the research team largely relied on the expertise of the panelists — in particular, on the business officer(s) participating in the panel — to assign costs to nonpersonnel expenditures. Often panelists used reference points, such as current school budgets, to validate their recommendation.

Finally, the research team added 12.5% of total expenditures to the estimated cost of panel recommendations to account for central administrative expenditures, which were outside the scope of panelist deliberations.

The research team acknowledges here, and expressed to all panelists, the imprecise nature of these estimates. In addition to directly advising panelists to treat the estimates as imprecise, the research team provided them as a range in increments of $250. This was to further mitigate any misperception of precision.

Cost Estimate Activity

As described above, the primary purpose of these estimates was to facilitate a discussion among panelists about trade-offs in the face of a narrower set of desired outcomes and budget constraints. In addition to the estimated cost of panelist recommendations, the research team provided average school-level expenditures among the possible pool of "typical" schools for each schooling level and the average incremental cost to achieve a specific set of outcomes. These specified outcomes include a school-level graduation rate of at least 84% and at least average annual student growth.[39]

At the start of the process, the research team framed the purpose for the discussion, outlined the source of the provided cost estimates, and identified the specific target outcomes to be considered in the discussion. Panelists were then asked to consider and respond to the following discussion questions:

1. Given the opportunity to modify your previous base recommendations to ensure the Supreme Court of North Carolina's mandate is met in these new settings, what would you change?
2. Taking a step back from the recommendations, consider the broader public education system. Are there any specific resources required for large populations of these students that might best be provided outside the school setting? Please describe these.

Unlike the base and special setting recommendations, panelists were not required to come to consensus on the appropriate trade-offs. Instead, the full complexity of the discussion, including any disagreements, was captured in the notes and reported in the results.

Implementation Discussion

The final stage of the panel process was an open discussion about the process of implementing the panelist recommendations and ultimately managing additional investments in public education. Panelists were asked to proceed in two stages, considering the following discussion questions provided in each stage:

Stage 1: Timing and Sequence

1. What is the length of the transition period required to phase in the recommended changes?
2. What is the ideal sequence of additional resources/changes to resource allocations?

39 This includes allowing schools performing above these targets to maintain performance in the model, changing only those below either target.

Stage 2: Flexibility and Accountability

1. How much flexibility in resource allocation should be available to sites and for which resource components?
2. When flexibility is provided, how should sites be held accountable for effective spending?

Panel Recommendation Analysis

Throughout the panel deliberations, facilitators took detailed notes of the discussion, and these notes are the primary basis for the panel findings reported. To mitigate the potential for bias, multiple members of the research team analyzed the panel notes using a common note-taking template.[40] Likewise, both facilitators reviewed and confirmed the findings to ensure that no panel recommendations or input was lost as a result of incomplete notes.

The results of this review were then divided into overarching themes and consolidated in the Results section of this report.

40 Note-taking template is available upon request.

Technical Appendix C: Cost Model Methodology

This analysis follows Taylor, Willis, Berg-Jacobson, Jaquet, and Caparas (2018) and Gronberg, Jansen, and Taylor (2017) by using stochastic frontier analysis (SFA) to estimate an educational cost function for North Carolina. A cost function, or cost frontier, estimates the minimum cost necessary to achieve certain outcomes with specified inputs and environmental factors. In the context of education, the cost function estimates the minimum cost necessary to achieve specified education outcomes (such as test score growth), given the prices school district must pay for various inputs (such as labor and school supplies) and key characteristics of the educational environment (such as differences in student need or a lack of economies of scale).

Unfortunately, education costs are not directly observable; all we can know is school or district expenditures. Therefore, the North Carolina education cost function was estimated using SFA. SFA is an estimation technique that allows for the possibility that the expenditures might exceed minimum cost for one of two reasons: random errors *or* inefficiency.[41] If there is no inefficiency, then SFA will yield the same model estimates as ordinary regression analyses. However, if there are inefficiencies, then SFA will yield a better prediction of the cost of education than will other estimation techniques. Because research has indicated that a variety of factors — including a lack of competition — can lead to school district inefficiency, SFA is the most appropriate estimation technique for this analysis.[42]

Formally, the cost function model used in this analysis can be expressed as:

$$\ln E^* = \ln C(w_1, \ldots w_k; z_1 \ldots z_k; y, N \mid \beta) - \ln N + v + u(x, \delta) \qquad (1)$$

where E^* is observed expenditures per pupil in the school, w_1 are input prices, z_j are quasi-fixed inputs including environmental factors, y is a vector of outcomes, N is the number of students, β is the cost parameter vector to be estimated, v is the random noise component representing exogenous random shocks (e.g., noisy private construction outside on testing day), and u is the one-sided error term that is a function of factors impacting inefficiency (x) and a parameter vector (δ).

The specification in equation (1) treats school enrollments and outcomes — both of which are influenced by the decisions of school administrators — as independent variables, raising concerns about possible endogeneity

41 Specifically, it assumes that the random error consists of two parts, a standard two-sided random error that may be positive or negative and is zero on average and a one-sided error that is always positive or zero. The greater the one-sided error, the further a school is from the minimum and the more inefficient it is.

42 For example, see Belfield and Levin (2002); Dee (1998); Gronberg, Jansen, Karakaplan, and Taylor (2015); Duncombe and Yinger (2005); Grosskopf, Hayes, Taylor, and Weber (2001); Kang and Greene (2002); and Millimet and Collier (2008).

(i.e., a correlation between the explanatory variables and the error terms).[43] This analysis follows Taylor, Willis, Berg-Jacobson, Jaquet, and Caparas (2018), Gronberg, Jansen, Karakaplan, and Taylor (2015), and Gronberg, Jansen, and Taylor (2017) by adopting a control function approach to the potential endogeneity of the outcome and enrollment measures.

Data

The data for this analysis come primarily from administrative files and public records of the North Carolina Department of Instruction (NCDPI), including NCDPI data prepared and housed by the Duke University North Carolina Education Data Center. In addition, public data from the National Center for Education Statistics (NCES), the U.S. Bureau of Labor Statistics, the U.S. Department of Housing and Urban Development, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Census Bureau were used in the analysis. The analysis covers the five-year period from 2012–13 through 2016–17.

The unit of analysis is the traditional public school building. Alternative schools, charter schools, virtual schools, and special schools have been excluded because they may have different cost structures than other buildings.[44] Schools that lack reliable data on student performance (such as elementary schools that serve no students in tested grades or very small schools) have also been excluded.

Exhibit C1 provides means and standard deviations for the variables used in this analysis. Enrollment, the teacher salary index, and the Herfindahl index enter the stochastic frontier regression in logs. Variables already in percentages and the indicator variables are not logged before entering the stochastic frontier regression.

Exhibit C1. Sample Descriptive Statistics for Schools in North Carolina, 2012–13 Through 2016–17

Variable	Total	Average	StdDev	Min	Max
Per-pupil operating expenditures	11,364	$7,846	$1,457	$4,201	$35,995
Average Conditional NCE	11,364	0.50	0.04	0.27	0.75
School graduation rate	11,364	0.86	0.05	0.59	1.00
Campus enrollment (log)	11,364	6.29	0.57	3.14	8.02
District enrollment (log)	11,364	9.88	1.24	6.30	11.99
Teacher salary index (log)	11,364	0.11	0.03	0.00	0.19
% eligible for free lunch	11,364	0.57	0.27	0.00	1.00
% English learners, district level	11,364	0.06	0.04	0.00	0.20
% special education	11,364	0.13	0.04	0.00	0.39
Other school indicator	11,364	0.01	0.11	0.00	1.00
Middle school indicator	11,364	0.21	0.41	0.00	1.00

43 For example, see the discussions in Duncombe and Yinger (2005, 2011); Imazeki and Reschovsky (2004); and Gronberg, Jansen, and Taylor (2011a).

44 This includes excluding the five Restart schools operating with charter-like flexibility in 2016–17 and any schools with a reported graduation rate of zero.

Variable	Total	Average	StdDev	Min	Max
High school indicator	11,364	0.19	0.39	0.00	1.00
Herfindahl index (log)	11,364	–0.73	0.56	–1.54	0.00

Note: Virtual schools, alternative schools, charter schools, and special schools have been excluded, as have all buildings with fewer than 20 students for whom Conditional Normal Curve Equivalent (NCE) scores could be calculated and all schools with reported graduation rates below 10 percent.

The Dependent Variable

For each school, we identified total operating expenditures, including the day-to-day expenses of school districts, such as salaries, benefits, purchased services, and supplies and materials. For the purposes of this analysis, the following are not considered operating expenditures: debt service, construction expenditures, fund transfers, judgments and settlements against the district, tuition- or fee-funded programs (e.g., before- and after-school care, preschool), ancillary services, payments to other government units except indirect costs, and nonprogrammed charges. Following the literature, food service and transportation expenditures were also excluded.

The financial data provided by the NCDPI and used to create the dependent variable identified expenditures by school building, or as a central office expenditure. The following process was used to calculate school-level expenditures for any given academic year:[45]

- Calculate total school-level expenditures, pay, and benefits excluding Pre-K expenditure categories. Prekindergarten is funded primarily through the Department of Health and Human Services in North Carolina, and thus the majority of Pre-K spending is beyond the scope of this study. As such, any Pre-K expenditure categories were excluded from the dependent variable.[46]
- Calculate total payroll (salaries and benefits) for each school by adjusting the school-level salaries by the district-specific benefits ratio. In other words, if the benefits paid by District A were 25% of salary, then adjust upward by 25% the school-level salaries for all schools in District A.
- Cumulate the identified labor and nonlabor expenditures for each school.
- Assign the remaining labor expenditures for the district to the school on a per-pupil basis.
- Assign all nonlabor expenditures for the district to the school on a per-pupil basis.

Outputs

This analysis uses a levels measure of quality and a growth measure of quality. The levels measure is the summative evaluation of high school achievement — graduation rates. We were provided with student-level graduation

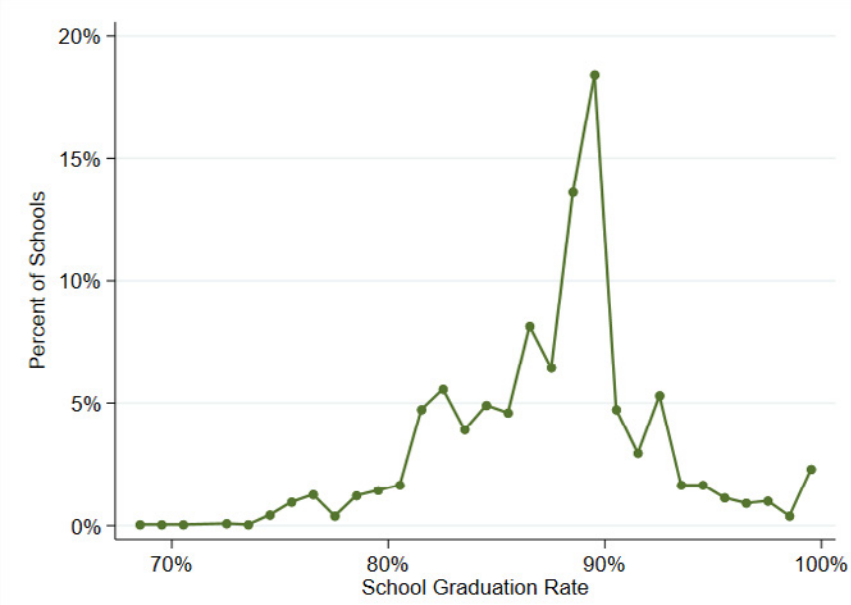
45 Gronberg, Jansen, and Taylor (2012) and Grosskopf, Hayes, Taylor, and Weber (2013) used a similar approach.

46 Specifically, this analysis excluded spending categorized within the following Chart of Accounts purpose codes: 5230, 5340, 6203, and 6304.

data, which were aggregated to the school level based on summing students identified as included in a given school's graduation rate denominator and numerator. For example, if School A had 100 students reported as included in its denominator and 90 students included in its numerator, their school-level graduation rate would be 90%. These rates represent the percentage of each longitudinal cohort that graduated within four years. We also received student-level data to calculate district-level graduation rates in the same format. The same approach was used, and students in a given district's denominator and numerator were summed to calculate its graduation rate. Again, these rates are based on a four-year cohort.

The district-level graduation rate was applied to schools with no reported graduation rate, such as elementary and middle schools. Exhibit C2 displays the distribution of graduation rates for schools included in the analysis sample in the most recent year, 2016–17.

Exhibit C2. School-Level Graduation Rates, 2016–17



The growth measure is a normalized gain score indicator of student performance on the North Carolina end-of-grade (EOG) summative evaluations in reading and mathematics in grades 3–8. Also included were high school end-of-course (EOC) exams in English language arts and mathematics.[47]

Although schools clearly produce unmeasured outcomes that may be uncorrelated with mathematics and reading test scores and standardized tests may not measure the acquisition of all important higher-order skills, these are performance measures for which districts are held accountable by the state and the most common measures of school district output in the literature (e.g., Gronberg, Jansen, & Taylor, 2011a, 2011b, 2017; Imazeki & Reschovsky, 2006). Therefore, they are reasonable output measures for cost analysis.

47 Alternative assessments were not included in the analysis due to the fact that the testing sequence for students taking these exams varied substantially and precluded the research team from appropriately calculating annual growth. About 5,000 students per year had alternative assessment test scores in the provided data.

EOG and EOC scores can be difficult to compare across years, grade levels, and test subjects. Therefore, this analysis relies on normalized (or, equivalently, standardized) test scores. The normalization follows Reback (2008) and yields gain score measures of student performance that are not biased by typical patterns of reversion to the mean.[48]

The calculation of normalized gain scores proceeds in three steps. First, transform the scores of individual students into conditional *z*-scores. Denote the test scores for student *(i)*, grade *(g)*, and time or year *(t)* as S_{igt} and measure each student's performance relative to others with same prior score in the subject as:

$$Y_{igt} = \frac{S_{igt} - E(S_{igt}|S_{i,g-1,t-1})}{[E(S_{igt}^2|S_{i,g-1,t-1}) - E((S_{igt}|S_{i,g-1,t-1})^2]^{.5}} \qquad (2)$$

For example, consider all Grade 6 students who had a score of 300 on the prior year's Grade 5 EOG Mathematics. For this subgroup of students with a Grade 5 score of 300, calculate the mean and standard deviations of the Grade 6 scores for EOG Mathematics. The mean is the expected score in Grade 6 ($E(S_{igt}^2|S_{i,g-1,t-1})$) for someone with a Grade 5 score of 300; the standard deviation is the denominator in equation (2). Thus, the variable Y_{ijgt} measures individual deviations from the expected score, adjusted for the variance in those expected scores. This is a type of *z*-score. Transforming individual EOG/EOC scores into *z*-scores in this way enables researchers to aggregate across different grade levels and test subjects despite the differences in the content or scaling of the various tests.[49]

Second, calculate the average conditional *z*-score (i.e., the average Y_{igt}) across all required mathematics and reading tests for all of the students attending each school. An average conditional *z*-score of 1 indicates that, on average, the students at School A scored one standard deviation above the expected score for students with their prior test performance. An average conditional *z*-score of –1 indicates that, on average, the students scored one standard deviation below expectations.

Finally, for ease of interpretation, transform the *z*-scores into Conditional Normal Curve Equivalent (NCE) scores. NCE scores (defined as 50+21.06*z) are a monotonic transformation of *z*-scores that are commonly used in the education literature and can be interpreted as if they were percentile ranks.[50] A Conditional NCE score of 50 indicates that (on average) the students performed exactly as expected given their prior test performance; and a Conditional NCE score of 90 indicates that (on average) they performed as well as or better than 90% of their peers.

For estimation purposes, the Conditional NCE scores are expressed as percentages. As Exhibit C3 documents, the school-level average Conditional NCE score in our estimation sample had a mean of 0.50 with a minimum of

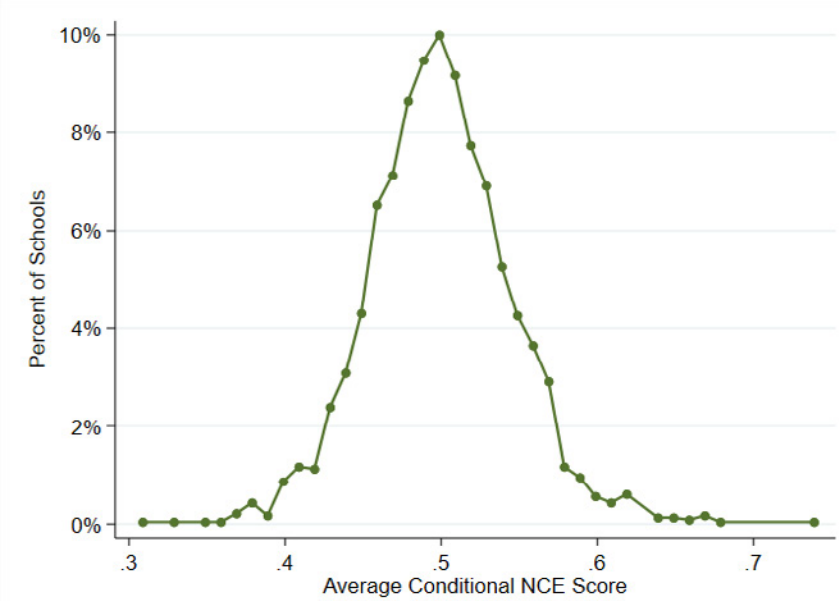
48 All students in the state, not just those in Core-Based Statistical Areas were included in the calculation of standardized scores.

49 As part of this process, the research team identified students with unusual testing trajectories. Cases were treated as administrative error and deleted if students displayed reasonably impossible assessment trajectories (e.g., moving backward in grade-level assessment, making large leaps in grade-level assessments across successive years). For other cases with nontraditional assessment order or very large gaps between current and previous test scores, we included all instances as long as the pattern occurred in at least 20 cases across the state.

50 Technically, this interpretation only holds if the scores are normally distributed. Given the large number of students tested each year in North Carolina, normality is a reasonable assumption.

0.27 and a maximum of 0.75. Exhibit C3 displays the distribution of these school-level average scores in the most recent year of data, 2016–17.

Exhibit C3. School-Level Average Conditional NCE Scores, 2016–17



Input Prices

Price of Labor

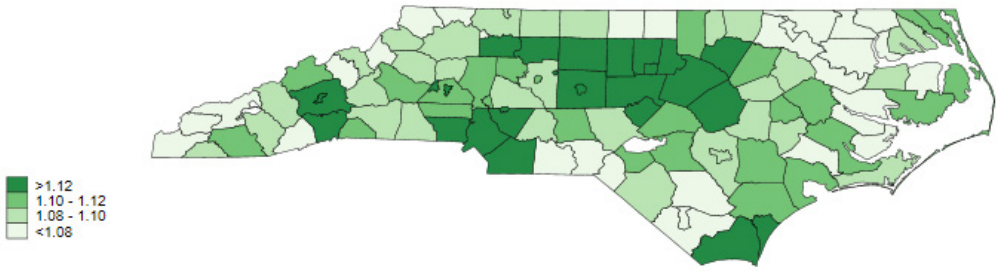
The most important education inputs are teachers, and as such, the cost function model includes a teacher wage variable. Due to differing approaches to hiring teachers employed by public schools, there is no teacher type hired by all school districts (e.g., a teacher with a bachelor's degree from a selective university and two years of experience). If there were, then arguably the model should use the wages paid to those teachers as the labor price measures. Since there is not, any observed average wage — such as the average salary for beginning teachers — reflects school and district choices about the mix of teachers to hire and the salaries offered to teachers in the hiring process.

To deal with this issue, we use a wage index that is independent of school and district choices. This index is created by estimating a hedonic wage model for teacher salaries and using that model to predict the wages each school would have to pay to hire a teacher with constant characteristics (see Technical Appendix D). The resulting index, which reflects the systematic variation in teacher salary related to cost factors beyond district control, ranges from 1.00 to 1.21. This indicates that the cost of hiring teachers is 21% higher in some of parts of North Carolina than it is in others.[51]

51 It should be noted that the raw index is reported here, as opposed to the logged index reported in Exhibit C1, for ease of interpretation.

To illustrate the salary index geographically, Exhibit C4 displays a map of the average district-level index in 2016–17. As you can see, the more costly districts are those clustered around the urban centers of the state, including Winston-Salem, Raleigh-Durham, and the interstate corridor between them; the Charlotte metropolitan area; the Asheville metropolitan area in western North Carolina; and along the coast near Wilmington.

Exhibit C4. Map of Average District-Level North Carolina Salary Index, 2016–17



Other Local Prices

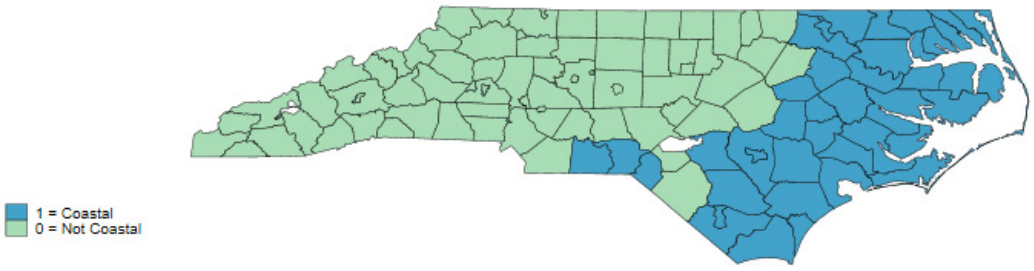
In an ideal situation, the estimated cost function would include direct measures of local prices for instructional equipment and classroom materials. Such data are, unfortunately, not available. However, prices for pencils, paper, computers, and other instructional materials are largely set in a competitive market (and therefore unlikely to vary across schools), and prices for nonprofessional labor and building rents are largely a function of school location. Therefore, the cost analysis includes a measure of the distance in miles to the nearest metropolitan or micropolitan area and for schools not found in a metropolitan or micropolitan area, this is used as an indicator of a school's rural location/remoteness. The cost analysis also controlled for very large urban centers by identifying metropolitan areas with total enrollments in excess of 450,000 students. These include the following statistical areas: Charlotte-Gastonia–Rock Hill, Greensboro–High Point, Raleigh, and Winston-Salem. "Coastal" districts are also identified to capture additional local prices (discussed in the following section).

Coastal Districts

Another key environmental factor was whether or not a district is located in a county identified as "coastal" under the NOAA definition.[52] The coastal county indicator captures any school or district cost factors associated with a coastal location, such as the increased insurance costs for flood insurance resulting from an increased risk of flooding. Exhibit C5 displays a map denoting those districts identified as "coastal" in the model.

52 The NOAA definition depends on the percentage of the county in a coastal watershed or its drainage basin. You can access a more details on this definition here: https://coast.noaa.gov/data/digitalcoast/pdf/defining-coastal-counties.pdf

Exhibit C5. Map of North Carolina Coastal Districts



Other Environmental Factors

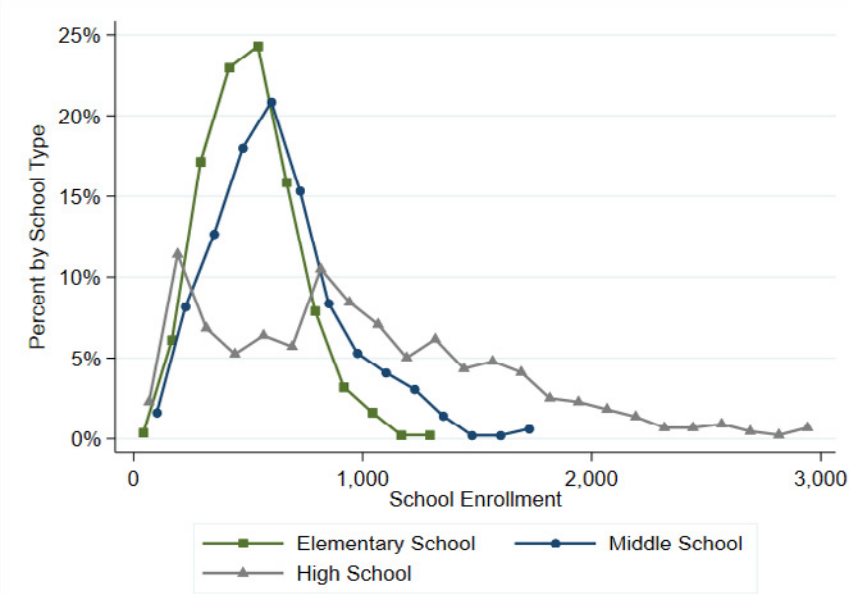
The model includes indicators for a variety of environmental factors that influence district cost, but that are not purchased inputs.

District Enrollment

A major environmental factor in this study is district enrollment, measured in this analysis using October 1 membership reported in the NCES Common Core of Data (CCD) district files. In the estimation, sample district enrollment averaged 39,424 students, with a minimum of 544 and a maximum of 160,467. The majority of districts (98%) have enrollment below 100,000. However, the two extreme outlier districts had enrollment in excess of 100,000 in all years of the analysis period. To control for the disproportionate effect these two districts could exert on the model, an indicator variable identifying them was included.

Exhibit C6 below displays the distribution of school enrollment (October 1 membership) in 2016–17 by school type. School enrollment in 2016–17 ranged from 42 students to 3,031, with an average of 624 and a standard deviation of ~386.2. School size varied slightly by school type, with elementary schools the smallest on average, followed by middle schools, and then high schools. For example, the largest four schools are all high schools and are well above the average size: Green Hope High at 2,804, Ardrey Kell High at 2,991, Myers Park High at 2,994, and South Mecklenburg High at 3,031. The largest three of the four are in Charlotte.

Exhibit C6. School Enrollment for Standard Buildings in Traditional School Districts, 2016–17



Student Needs

To capture variations in costs that derive from variations in student needs, the cost function includes the percentages of students in each district who were identified as English learners, special education students, and economically disadvantaged students.

Economically Disadvantaged Students

The measure used to identify economically disadvantaged students is the school-level percentage of students eligible for free lunch publicly reported in the NCES CCD school files. Eligibility for free lunches is determined by a student's family income and size, though students may be "categorically eligible" if enrolled in other federal assistance programs.[53]

In 2014–15, some North Carolina schools began participating in the Community Eligibility Program (CEP), a new program under the National School Lunch Program (NSLP). A school, cluster of schools, or local education agency (LEA) may participate in the CEP if the percentage of students approved as eligible for free meals who are not subject to verification (i.e., "directly certified") is at least 40 percent of the total enrollment. Participating schools or LEAs no longer collect household applications to provide students with free meals, and any student in the participating school or LEA would now be eligible for free meals. As a result, the actual percentage of students in poverty may no longer align with the percentage of eligible students. Likewise, the percentage of directly certified students is likely only a subset of students in poverty. The U.S. Department of Education uses a 1.6 multiplier to make the percentage of students eligible for free and reduced-price lunches in a CEP school comparable with

53 More information on this program and eligibility requirements can be accessed here: https://fns-prod.azureedge.net/sites/default/files/cn/NSLPFactSheet.pdf

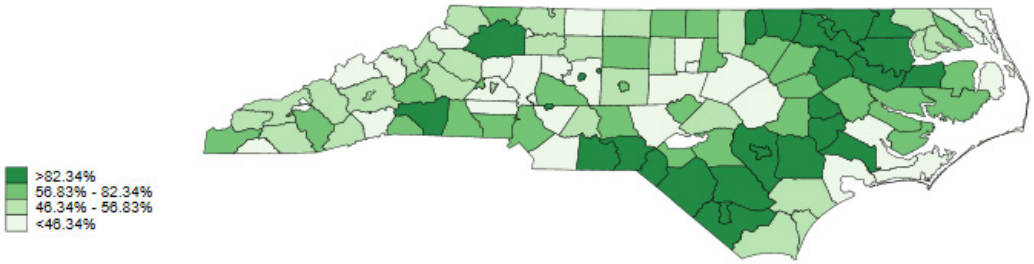
non-CEP schools. For example, a CEP school's percentage of directly certified students is multiplied by 1.6, and this is considered to be a comparable estimate.

In North Carolina, the approach to adjusting for the impact of the CEP on NSLP eligibility data is unclear. Moreover, after a comprehensive review of poverty measures available at the school level, the research team determined that the best option was to use the NCES free lunch eligibility data. The research team first determined a continuous measure of poverty to be preferable to allow the model to account for variation at very high poverty rates. By using the NCES measure, prepared by the state for a federal data collection, we ensure our preparation of the data did not introduce any error in the measure.

In addition, the choice to use free lunch eligibility, as opposed to free and reduced-price lunch eligibility, was based on two considerations. First, there was limited variation in the school-level free and reduced-price measure, which limits the efficacy of this measure as an environmental control. Second, we judged the impact of the CEP to be less meaningful given the smaller gap between categorically eligible students and students granted eligibility under the CEP when only free-lunch-eligible students are considered.

Exhibit C7 displays the geographic variation in the district-level percent of economically disadvantaged students in the most recent year of data, 2016–17.

Exhibit C7. Map of District-Level Percent of Economically Disadvantaged Students, 2016–17



English Learners

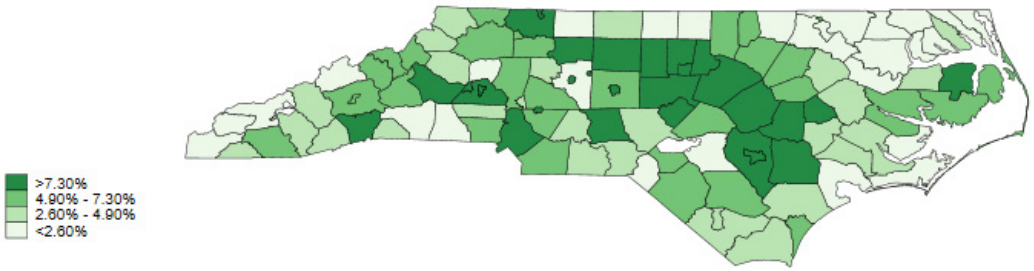
In North Carolina, English learners are identified through a three-step process. First, the student's Home Language Survey must indicate a language other than English. Any student for whom this is the case must then be assessed on a state-approved English-language proficiency assessment. A student found to be limited in any domain of English proficiency is identified as an English learner.[54]

54 More information on the identification of English learners can be found at http://www.ncpublicschools.org/docs/accountability/policyoperations/lep/eltstgd1617.pdf

The research team was unable to access accurate data reporting the school-level percentage of English learners in the available data for all years of the analysis. Instead, district-level English learner headcounts reported annually to the General Assembly were used in the model.[55]

Exhibit C8 displays the geographic variation in the district-level percent of English learners in the most recent year of data, 2016–17.

Exhibit C8. Map of District-Level Percent of English Learners, 2016–17

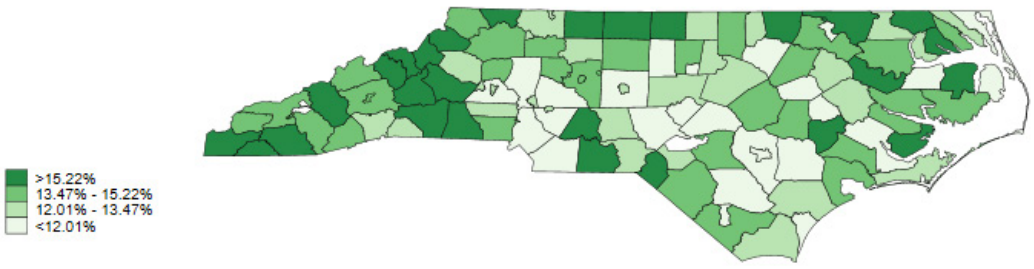


Special Education

Student-level data on special education students were provided by the Duke University North Carolina Education Data Center, and to calculate school-level percentages, student counts were summed by school per year. These students are identified as "exceptional children" through a process that begins with a written request for evaluation of a student, or referral, prepared by a teacher or parent. The identified student is then evaluated, and a group, including the parent, uses the evaluation and other information to determine if the student is eligible.[56] This variable was top-coded at 40% for estimation purposes.

Exhibit C9 displays the geographic variation in the district-level percent of students with disabilities in the most recent year of data, 2016–17.

Exhibit C9. Map of District-Level Percent of Students With Disabilities, 2016–17



55 The English learner headcounts for three districts included in the analysis were suppressed in the public reports due to the counts being below 10. To address this issue, we imputed the median value within the range of possible values for each of the suppressed observation (i.e., 5). Although not ideal, we believe that even though this makes the English learner percentage less precise, this cost is outweighed by the benefit of keeping these districts in the model.

56 More information on this eligibility determination can be found at https://ec.ncpublicschools.gov/conferences-profdev/march-institute/2018-march-institute-handouts/policy-updates-legal-trends/amendedmarch2018policy.pdf

Middle School, High School, and Other School Indicators

Finally, to allow for the possibility that the education technology differs according to the grade level of the school, the cost model includes indicators for whether or not the school serves middle grades (i.e., grades 6–8), whether or not the school serves high school grades (i.e., grades 9–12), and whether or not a school served an atypical range of grades (i.e., "Other" schools).

In addition to the above variables, the cost model includes an indicator for districts with a military base within its borders[57] and an indicator for two districts in which the legal dropout age was higher than other districts in the state.[58] These variables were included to account for unique, systematic differences in these communities that can't be controlled for directly.

Fixed effects for year control for inflation and other time trends in North Carolina education.

Efficiency Factors and Heteroskedasticity

The error terms for all frontier specifications depend on a number of factors that theory suggests may explain differences in school efficiency. The one-sided variance function is modeled as a linear combination of 11 variables falling into 3 general categories: competition and community voter monitoring, short-term infusion of grant funding, and anticipated unexplained spending. Please note that inefficiency should be interpreted as unexplained expenditures in excess of the minimum and not necessarily as wasteful expenditures. Spending on intended outcomes that are uncorrelated with the measured outcomes (such as some enrichment or student health services) will be captured in the efficiency term.

Competition and Community Monitoring

Prior research has demonstrated that competition can reduce inefficiency in public education (e.g., Belfield & Levin, 2002; Millimet & Collier, 2008; Gronberg, Jansen, Karakaplan, & Taylor, 2015) and so can ease of voter monitoring (Grosskopf, Hayes, Taylor, & Weber, 2001). Therefore, six variables are included as efficiency factors under the first category, competition and community monitoring: the degree of educational competition in the metropolitan area or county; an indicator for whether or not the school educates prekindergarteners; an indicator of a district's status as "low wealth" based on whether or not it receives an allocation of the Low-Wealth Supplement; the percentage of households that are owner-occupants; the percentage of the population with at least a bachelor's degree; and the percentage of households wherein at least one resident is over 60 years of age. We note that the latter three variables were also treated as efficiency factors in Duncombe and Yinger (2005).[59] Also included was an interaction of the percentage of households wherein at least one resident is over 60 and the indicator of a very large metropolitan area to allow the effect of the former to vary in very large metropolitan areas.

57 Military bases include Seymour Johnson Air Force Base, Fort Bragg, Base Support Unit Elizabeth City, and Camp Lejeune.

58 Specifically, although the dropout age in North Carolina is 16 years old, the state legislature instituted the higher dropout age of 18 in two pilot districts: Hickory Public Schools and Newton-Conover City Schools. The new dropout age was first implemented in 2015–16. Eventually, Rutherford County Schools was also added to the pilot, but did not implement until 2017–18, after the period of our analysis (North Carolina General Assembly, 2018b).

59 By assumption, the one-sided error term has a half-normal distribution. Jensen, 2005 find that specifying a half-normal distribution for the inefficiency term generates more reliable estimates of technical efficiency than other assumptions about the distribution of inefficiency.

As is common in the literature, the degree of educational competition is measured with a Herfindahl index of enrollment concentration. A Herfindahl index (which is defined as the sum of the squared enrollment shares) increases as the level of enrollment concentration increases. A Herfindahl index of 1.00 indicates a metropolitan or micropolitan area with a single LEA; a Herfindahl index of 0.10 indicates a metropolitan or micropolitan area with 10 LEAs of equal size. The mean value for the Herfindahl index in the estimation sample is 0.56, with a minimum value of 0.21 and a maximum of 1.00, indicating that some counties in North Carolina are served by a single unified school district.

The inclusion of the low-wealth indicator is based on the theory that in communities with relatively little local wealth, there is greater community pressure to direct scarce available resources toward outcomes on which the district and school's accountability status depend.

Short-term Infusion of Grant Funding

Included in the second category of efficiency factors, short-term infusion of grant funding, was an indicator of schools receiving Race to the Top (RttT) funds through the TALAS program and an interaction between RttT schools and the distance in years from 2017. These factors control for the impact on spending efficiency of a large infusion of additional funds, and the interaction accounts for the possibility that this impact changes over time as the annual grant funds decrease.

Anticipated Unexplained Spending

In the final category of efficiency factors, anticipated unexplained spending, was the school-level percent of students eligible for free lunch, and an interaction between percent of students eligible for free lunch and the high school indicator were included as efficiency factors. The inclusion of this poverty measure is to account for the possible impact on spending efficiency of serving a relatively larger population of students with needs for services that may not directly relate to academic growth in a given year. This is not meant to suggest that this spending is not necessary, only that it is not explained by the cost model.

Heteroskedasticity

Heteroskedasticity in the two-sided error may also arise. To capture such a possibility, the two-sided variance is modeled as a function of the share of building expenditures that was not specifically allocated to the building by the expenditures file. This variable has been included because measurement error in the dependent variable (a common source of heteroskedasticity) is likely to be a function of the extent to which the dependent variable was imputed. Likewise, the percentage of students tested in a given school has been included. This is because as the percentage of students tested goes down, one would expect more measurement error in the key independent variable, our measure of academic growth.

Instrumental Variables

The key to implementing the control function corrections is the identification of viable instruments for school quality and school size. Viable instruments for school quality and size are well correlated with quality or size and not correlated with school expenditures except through their relationship with quality or size.

Human capital theory suggests that local labor market conditions can influence the demand for educational quality and the opportunity cost of staying in school, so, as in Gronberg, Jansen, Karakaplan, and Taylor (2015) and Gronberg, Jansen, and Taylor (2017), this analysis uses labor market conditions in the vicinity of the building as instruments for the Conditional NCE scores and graduation rates. The indicators of labor market conditions — the percent of employers in the manufacturing industry and the percent of white-collar workers in the building ZIP code — reflect industrialization and the availability of the types of jobs most commonly held by workers with a high and low educational attainment. These data come from the ZIP Business Patterns and the American Community Survey, both produced by the U.S. Census Bureau. The set of instrumental variables also includes a measure of the likely demand for educational services in the community — the ratio of students to working-age adults. Also included is a measure of demand for graduates — the 10-year average unemployment rate. Finally, an indicator of whether or not a district has a University of North Carolina (UNC) campus with a teacher preparation program within its borders was included as an instrumental variable for school quality. This accounts for the unique demand by teacher preparation faculty for education quality in these identified communities, and, given that UNC campuses produce the majority of the state's teachers, this indicator captures districts where this unique demand is most pronounced.[60]

In addition, the model also includes an instrument for school size — the log of district square miles. Though school size is generally considered endogenous (i.e., within district control), the size of the district itself in square miles is, in fact, beyond district control and influences school size, making it an appropriate instrument.

Results

Exhibit C10 describes the first-stage independent variable coefficient estimates, along with their standard errors. As the exhibit illustrates, the instrumental variables are well correlated with the outcome measures; the first-stage F-statistics are 16.49, 77.40, and 68.23 for the Conditional NCE, graduation rate, and campus enrollment, respectively.

60 Identified UNC campuses include Appalachian State University, East Carolina University, Elizabeth City State University, Fayetteville State University, North Carolina A&T State University, UNC Greensboro, North Carolina Central University, North Carolina State University, UNC Asheville, UNC Chapel-Hill, UNC Charlotte, UNC Pembroke, UNC Wilmington, Wester Carolina University, and Winston-Salem State University.

Exhibit C10. First-Stage Coefficient Estimates

	(1)	(2)	(3)
Variable Name	NCE	Graduation Rate	Campus Enrollment
District enrollment	0.2649***	0.0952	–0.4164
	(0.074)	(0.085)	(0.844)
District enrollment, sq.	–0.0300***	–0.0191**	0.1175
	(0.008)	(0.009)	(0.093)
District enrollment cubed	0.0011***	0.0010***	–0.0064*
	(0.000)	(0.000)	(0.003)
Salary index (log)	–0.1180***	0.1555***	7.3644***
	(0.033)	(0.035)	(0.331)
Miles to the nearest metro or micro area	0.0917***	–0.1081***	–0.5564***
	(0.018)	(0.020)	(0.186)
Miles to the nearest metro or micro area, sq.	–0.2948***	0.4502***	1.7152***
	(0.054)	(0.065)	(0.599)
Percent eligible for free lunch	–0.1347***	–0.0552***	–0.9347***
	(0.008)	(0.008)	(0.083)
Percent eligible for free lunch, sq.	0.0671***	0.0128**	0.4873***
	(0.006)	(0.006)	(0.063)
Percent English learners (district level)	0.0027	0.0261	0.7777*
	(0.044)	(0.049)	(0.453)
Percent English learners (district level), sq.	–0.1465	–0.8498***	–5.0665*
	(0.247)	(0.281)	(2.650)
Percent of special education students	–0.5347***	–0.8922***	13.9030***
	(0.041)	(0.047)	(0.631)
Percent of special education students, sq.	1.5213***	2.6663***	–45.0274***
	(0.142)	(0.164)	(2.434)
Middle school indicator	–0.0080***	–0.0005	0.2044***
	(0.001)	(0.001)	(0.009)
High school indicator	–0.0088***	0.0171***	0.4471***
	(0.001)	(0.002)	(0.014)
Other school indicator	–0.0092***	0.0245***	–0.2230***
	(0.003)	(0.006)	(0.060)
School Year 2012–2013	0.0004	–0.0339***	–0.0361**
	(0.001)	(0.002)	(0.014)

	(1)	(2)	(3)
Variable Name	NCE	Graduation Rate	Campus Enrollment
School Year 2013–2014	–0.0002	–0.0206***	–0.0010
	(0.001)	(0.002)	(0.014)
School Year 2014–2015 (omitted)	-	-	-
School Year 2015–2016	0.0002	0.0049***	0.0120
	(0.001)	(0.001)	(0.014)
School Year 2016–2017	0.0008	0.0154***	–0.0199
	(0.001)	(0.001)	(0.014)
(School Year 2012–2013)*NOAA coastal indicator	–0.0045**	–0.0142***	0.1426***
	(0.002)	(0.002)	(0.023)
(School Year 2013–2014)*NOAA coastal indicator	–0.0050**	–0.0282***	0.1178***
	(0.002)	(0.003)	(0.022)
(School Year 2014–2015)*NOAA coastal indicator	–0.0042**	–0.0227***	0.1239***
	(0.002)	(0.002)	(0.022)
(School Year 2015–2016)*NOAA coastal indicator	–0.0028	–0.0269***	0.1123***
	(0.002)	(0.002)	(0.021)
(School Year 2016–2017)*NOAA coastal indicator	–0.0006	–0.0308***	0.1467***
	(0.002)	(0.002)	(0.022)
Big district indicator	–0.0136***	–0.0594***	0.3821***
	(0.005)	(0.005)	(0.056)
Rural indicator	0.0039*	–0.0090***	–0.0165
	(0.002)	(0.003)	(0.022)
Big city indicator	–0.0029**	0.0022	0.0413***
	(0.001)	(0.002)	(0.014)
Districts with a higher dropout age	–0.0098*	0.0180***	–0.0992**
	(0.005)	(0.005)	(0.044)
District with a military base in its county	0.0024	–0.0002	0.0249
	(0.002)	(0.002)	(0.022)
Students per working-age adults	–0.0396***	0.1570***	1.1313***
	(0.012)	(0.014)	(0.126)
Share of local establishments in manufacturing	–0.0153	0.0778***	–0.5248***
	(0.013)	(0.014)	(0.127)

	(1)	(2)	(3)
Variable Name	**NCE**	**Graduation Rate**	**Campus Enrollment**
Percent of white-collar workers	0.0002***	–0.0005***	0.0031***
	(0.000)	(0.000)	(0.001)
District square miles (log)	–0.0028***	0.0059***	–0.0530***
	(0.001)	(0.001)	(0.008)
County average unemployment rate across available years	–0.0029***	–0.0072***	0.0507***
	(0.000)	(0.000)	(0.005)
District with UNC campus indicator	–0.0054***	0.0018	–0.0238
	(0.002)	(0.002)	(0.017)
Constant	–0.1301	0.9331***	3.1710
	(0.222)	(0.259)	(2.556)
F-test for exogeneity of the instruments	16.49	77.40	68.23
Observations	11,364	11,364	11,364
R-squared	0.234	0.366	0.495

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Exhibit C11 presents four versions of the cost function coefficients. The first model is the preferred specification; the other three specifications are presented to demonstrate that certain types of schools or districts are not driving the results. This includes a model (Model 2) excluding the two largest districts in North Carolina (Charlotte-Mecklenburg Public Schools and Wake County Public Schools); a model (Model 3) excluding small districts with enrollments under 1,000 (35 districts in total); and a model (Model 4) in which schools with nontraditional grade configurations are excluded. As the exhibit illustrates, these alternative specifications — each of which excludes some of the districts suspected of having undue influence on the primary specification — yield coefficient estimates that are very similar to those from the complete specification (Model 1).

The coefficient estimates suggest that the cost function aligns with reasonable expectations about school district costs. In all cases, increases in NCE growth scores are associated with higher costs, although the marginal costs of increasing NCE scores are greater at the elementary and middle school levels than they are at the high school level. The relationship between cost and the graduation rate is not statistically significant,[61] suggesting that variations in the graduation rate (which reflects the cumulative impact of more than 12 years of formal education) are not well reflected in a single year of school expenditures. Costs per pupil are a decreasing function of school and district enrollments, but an increasing function of the teacher wage index. Costs are higher in remote locations. Costs are a nonlinear function of student need, but generally rise with student need.

61 The coefficients on the graduation rate and the interaction terms are jointly insignificant at the 5% level in all specifications.

Exhibit C11. Cost Model Coefficient Estimates

Variable Name	(1)	(2)	(3)	(4)
Frontier Variables				
NCE score	2.859***	2.712***	2.852***	2.820***
	(0.508)	(0.505)	(0.504)	(0.492)
NCE score, sq.	–0.133	–0.284	–0.0789	0.0165
	(0.421)	(0.431)	(0.419)	(0.411)
NCE score*High school indicator	–0.433***	–0.390***	–0.442***	–0.431***
	(0.0667)	(0.0726)	(0.0666)	(0.0663)
School graduation rate	–0.441	–0.610	–0.405	0.0287
	(0.530)	(0.550)	(0.524)	(0.505)
School graduation rate, sq.	0.283	–0.0684	0.277	0.0455
	(0.300)	(0.315)	(0.299)	(0.291)
School graduation rate*High school indicator	–0.0853	–0.0531	–0.0836	–0.0671
	(0.0522)	(0.0551)	(0.0519)	(0.0507)
School enrollment	0.261***	0.222***	0.262***	0.268***
	(0.0491)	(0.0548)	(0.0492)	(0.0490)
School enrollment, sq.	–0.0327***	–0.0322***	–0.0327***	–0.0336***
	(0.00383)	(0.00436)	(0.00384)	(0.00381)
School enrollment*High school indicator	0.101***	0.103***	0.103***	0.106***
	(0.00769)	(0.00843)	(0.00763)	(0.00770)
District enrollment	–1.235***	–1.511***	–1.120***	–1.109***
	(0.232)	(0.254)	(0.274)	(0.216)
District enrollment, sq.	0.102***	0.132***	0.0904***	0.0904***
	(0.0252)	(0.0276)	(0.0296)	(0.0236)
District enrollment, cubed	–0.00262***	–0.00370***	–0.00222**	–0.00226***
	(0.000905)	(0.000996)	(0.00106)	(0.000850)
Salary index (log)	1.072***	1.230***	1.054***	1.083***
	(0.177)	(0.141)	(0.171)	(0.163)
Miles to the nearest metro or micro area	–0.428***	–0.384***	–0.422***	–0.444***
	(0.0546)	(0.0587)	(0.0544)	(0.0540)
Miles to the nearest metro or micro area, sq.	1.721***	1.782***	1.704***	1.730***
	(0.182)	(0.187)	(0.181)	(0.179)

Variable Name	(1)	(2)	(3)	(4)
Percent eligible for free lunch	0.552***	0.384***	0.566***	0.569***
	(0.0636)	(0.0536)	(0.0616)	(0.0568)
Percent eligible for free lunch, sq.	–0.248***	–0.177***	–0.256***	–0.256***
	(0.0322)	(0.0278)	(0.0314)	(0.0291)
Percent English learners (district level)	–0.342***	–0.204*	–0.327***	–0.307**
	(0.123)	(0.123)	(0.122)	(0.119)
Percent English learners (district level), sq.	3.855***	2.901***	3.813***	3.711***
	(0.741)	(0.764)	(0.728)	(0.715)
Percent of special education students	2.694***	2.595***	2.705***	2.770***
	(0.255)	(0.280)	(0.255)	(0.252)
Percent of special education students, sq.	–6.083***	–5.693***	–6.105***	–6.324***
	(0.811)	(0.881)	(0.812)	(0.801)
Middle school indicator	–0.0129***	–0.00527	–0.0128***	–0.00920**
	(0.00469)	(0.00444)	(0.00468)	(0.00465)
High school indicator	–0.339***	–0.355***	–0.344***	–0.386***
	(0.0702)	(0.0782)	(0.0697)	(0.0693)
Other school indicator	0.0987***	0.112***	0.0920***	
	(0.0195)	(0.0271)	(0.0195)	
School Year 2012–2013	–0.0631***	–0.0866***	–0.0618***	–0.0598***
	(0.00892)	(0.00668)	(0.00864)	(0.00862)
School Year 2013–2014	–0.0698***	–0.0907***	–0.0688***	–0.0671***
	(0.00667)	(0.00579)	(0.00650)	(0.00650)
School Year 2014–2015	–0.0353***	–0.0462***	–0.0349***	–0.0347***
	(0.00382)	(0.00400)	(0.00378)	(0.00375)
School Year 2015–2016	–0.0263***	–0.0329***	–0.0260***	–0.0252***
	(0.00326)	(0.00379)	(0.00325)	(0.00322)
School Year 2016–2017 (omitted)	-	-	-	-
(School Year 2012–2013)*NOAA coastal indicator	0.0479***	0.0324***	0.0486***	0.0491***
	(0.00589)	(0.00611)	(0.00594)	(0.00584)
(School Year 2013–2014)*NOAA coastal indicator	0.0454***	0.0252***	0.0464***	0.0483***

Variable Name	(1)	(2)	(3)	(4)
	(0.00677)	(0.00660)	(0.00675)	(0.00666)
(School Year 2014–2015)*NOAA coastal indicator	0.0361***	0.0263***	0.0364***	0.0389***
	(0.00603)	(0.00604)	(0.00604)	(0.00596)
(School Year 2015–2016)*NOAA coastal indicator	0.0280***	0.0140**	0.0288***	0.0306***
	(0.00602)	(0.00573)	(0.00602)	(0.00593)
(School Year 2016–2017)*NOAA coastal indicator	0.0149**	0.000552	0.0148**	0.0182***
	(0.00639)	(0.00623)	(0.00640)	(0.00627)
Big district indicator	–0.0625***		–0.0646***	–0.0592***
	(0.0140)		(0.0153)	(0.0137)
Rural indicator	–0.0558***	–0.0636***	–0.0561***	–0.0553***
	(0.00504)	(0.00505)	(0.00513)	(0.00503)
Big city indicator	–0.0257***	–0.0239***	–0.0262***	–0.0245***
	(0.00436)	(0.00465)	(0.00436)	(0.00434)
Districts with a higher dropout age	–0.0841***	–0.0661***	–0.0837***	–0.101***
	(0.0114)	(0.0109)	(0.0113)	(0.0115)
District with a military base in its county	–0.0549***	–0.0407***	–0.0549***	–0.0543***
	(0.00564)	(0.00506)	(0.00555)	(0.00525)
Residuals	–2.615***	–2.315***	–2.661***	–2.729***
	(0.296)	(0.269)	(0.290)	(0.275)
Residuals	–0.0479	0.665***	–0.0740	–0.132
	(0.168)	(0.131)	(0.162)	(0.159)
Residuals	–0.0372*	–0.00554	–0.0381*	–0.0341*
	(0.0199)	(0.0173)	(0.0195)	(0.0182)
Constant	11.54***	13.19***	11.12***	10.84***
	(0.756)	(0.791)	(0.863)	(0.671)
One-Sided Error Variables				
Herfindahl index (log)	0.403***	0.698***	0.413***	0.362***
	(0.0663)	(0.0856)	(0.0669)	(0.0664)
Percent owner-occupied buildings	2.007**	2.663***	1.974**	1.649*
	(0.860)	(0.778)	(0.855)	(0.884)

Variable Name	(1)	(2)	(3)	(4)
Percent with at least one person over 60*Big city indicator	14.54***	–4.145*	14.57***	14.24***
	(1.319)	(2.463)	(1.333)	(1.284)
Percent with at least one person over 60	1.616*	1.285	1.731*	1.870**
	(0.912)	(0.913)	(0.925)	(0.936)
Percent with a college degree	7.211***	9.463***	7.378***	7.271***
	(0.569)	(0.630)	(0.569)	(0.576)
School serves Pre-K indicator	–0.587***	–0.662***	–0.592***	–0.477***
	(0.0806)	(0.0862)	(0.0806)	(0.0786)
District receives Low Wealth Supplement indicator	–0.384***	–0.198**	–0.355***	–0.299***
	(0.115)	(0.100)	(0.112)	(0.115)
School received Race to the Top funds indicator	1.304***	1.047***	1.243***	1.136***
	(0.212)	(0.206)	(0.218)	(0.194)
School received Race to the Top funds indicator*School Year 2016–2017	–0.186**	–0.198***	–0.194***	–0.230***
	(0.0730)	(0.0747)	(0.0750)	(0.0683)
Percent eligible for free lunch	1.001***	1.317***	1.011***	0.936***
	(0.242)	(0.239)	(0.242)	(0.252)
Percent eligible for free lunch*High school indicator	1.762***	1.757***	1.697***	2.022***
	(0.200)	(0.213)	(0.201)	(0.198)
Big city indicator	–5.570***	1.408*	–5.549***	–5.523***
	(0.461)	(0.843)	(0.465)	(0.454)
Constant	–9.042***	–10.18***	–9.127***	–9.039***
	(0.672)	(0.650)	(0.666)	(0.682)
Two-Sided Error Variables				
Percent of funds allocated to the school level	–4.574***	–4.296***	–4.488***	–4.237***
	(0.882)	(0.694)	(0.894)	(0.898)
Percent of students with scores	–0.544***	–0.396***	–0.557***	–0.513***

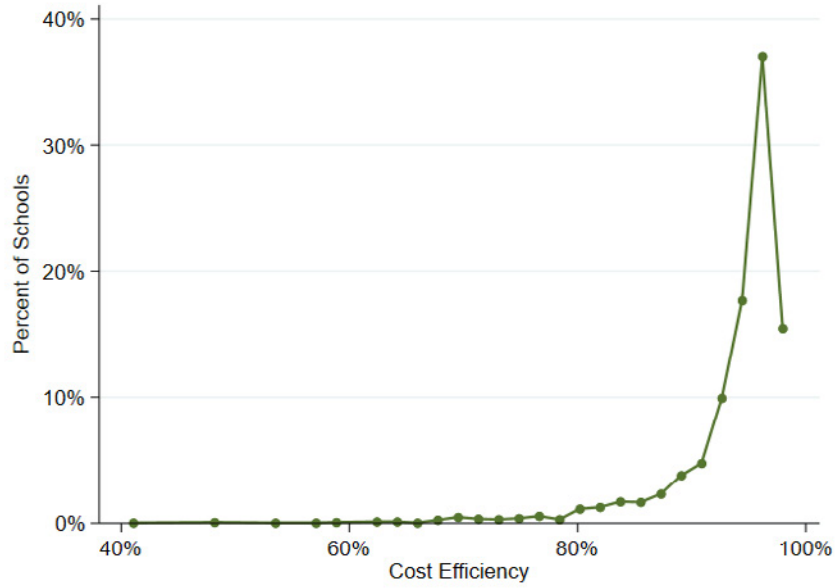
Variable Name	(1)	(2)	(3)	(4)
	(0.102)	(0.100)	(0.102)	(0.102)
Constant	–1.258*	–1.436**	–1.326*	–1.564**
	(0.696)	(0.560)	(0.706)	(0.709)
Observations	11,364	9,766	11,329	11,235

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Overall, schools in North Carolina are generally efficient, on average about 93.7% of spending is explained by the model. However, there are a handful of schools (~1%) with cost efficiency as low as 68.7% or less. Exhibit C12 displays the distribution of cost efficiency estimated by the model in the most recent year of data, 2016–17.

Exhibit C12. Distribution of Estimated Cost Efficiency, 2016–17



Adequacy Calculations

One calculates the costs associated with various performance standards by using the coefficient estimates in Exhibit C11 to predict the expenditures associated with the designated performance metrics and the observed characteristics of districts. Such calculations are very straightforward, but require making decisions about (1) the minimum performance thresholds (i.e., for the investment scenarios for Short-term A, B, and C), and (2) how to define the annual academic growth required to continually meet the state's obligation under *Leandro* (i.e., for the investment scenarios for Ongoing A and B).

In particular, one should carefully consider the options for maintaining annual growth (determining the ongoing investments). One could interpret North Carolina's obligation under *Leandro* as providing resources sufficient to ensure all students achieve average academic growth annually (Ongoing A). However, this minimum standard effectively transfers resources supporting students currently growing at above-average rates to students growing at below-average rates. Additional resources would be required to ensure that all students achieve *at least* average annual growth and no students achieve less growth than they currently achieve (Ongoing B). This higher standard represents a greater investment.

Under all assumptions about academic growth, graduation rates are held constant at the state pupil-weighted average in 2016–17: 86.3%. This reflects our view that since the effect of graduation rates on spending is found to be statistically insignificant, it would be inappropriate to create estimates based on some desired outcome.

It should also be noted that the cost model is agnostic of the time over which additional estimated spending is provided and any expectations about improvement in outcomes over time. The reported estimates represent spending associated with the assumed annual growth, controlling for all other factors in the model. Therefore, in an effort to provide policymakers with cost estimates of the most practical use and that fully acknowledge the limitations of the method, the research team has not taken the step of simulating how achieving the different assumptions about academic growth consistently year-over-year would impact the overall level of performance in the state.

Efficiency Adjustment

It should be noted that both scenarios were constructed by estimating the best practice among North Carolina school districts. Our approach allows for the possibility that districts could be spending more than would be strictly necessary to achieve their current levels of measured performance and removes any such district-specific "inefficient" spending from the cost projections. In this context, "inefficiency" refers to spending that does not contribute to the measured outcomes in the model (namely, academic growth). As such, inefficiency could include spending that simply contributes to unmeasured outcomes that are uncorrelated with academic growth (e.g., enrichment activities).

Because the study's measured outcomes likely do not capture all outcomes relevant to a sound basic education and because some amount of inefficient spending (e.g., enrichment activities) may in fact be necessary to meet the obligation under *Leandro*, the study adds to the estimates the average percentage of spending identified as inefficient, about 6.3%.

Technical Appendix D: Estimating the Teacher Cost Index

Economists commonly use hedonic wage models and regression analysis to explain variation in labor costs across school districts. Such analyses point to the fact that differences in average teacher salaries can be explained by differences in teacher characteristics (including, for example, educational attainment and years of experience), job characteristics (such as the assigned position or student characteristics), and locational characteristics (such as the local cost of living).[62] The goal in developing a teacher cost index is to isolate the variation in wage levels that is outside school district control.

The hedonic wage model used in this study has its foundation in the approach taken by Taylor, Willis, Berg-Jacobson, Jaquet, and Caparas (2018). It describes wages as a function of labor market characteristics, job characteristics, observable teacher characteristics, and unobservable teacher characteristics. Formally, the model can be expressed as:

$$ln\,(W_{idjt}) = D_{dt}\beta + T_{it}\delta + M_{jt} + \varepsilon_{idjt}$$

where the subscripts *i, d, j,* and *t* stand for individuals, districts, labor markets, and time, respectively, *Widjt* is the teacher's full-time-equivalent annual salary, D_{dt} is a vector of job characteristics that could give rise to compensating differentials, T_{it} is a vector of individual teacher characteristics that vary over time, and M_{jt} is a vector of labor market characteristics. The ε_{idjt} are random effects for individuals, which are presumed to follow the autoregressive pattern found in the data.[63] (An autoregressive pattern to teacher salaries means that if a teacher earns more than the model predicts in one year, he or she will probably earn more than the model predicts the next year too.)

The data on teacher salaries and individual teacher characteristics come from the North Carolina Department of Instruction (NCDPI) and include NCDPI data prepared and housed by the Duke University North Carolina Education Data Center. The hedonic wage analysis covers the five-year period from 2012–13 through 2016–17. As in the cost function analysis, data from open-enrollment charter campuses, virtual campuses, and all alternative

62 For more on the use of hedonic wage models in education, see Chambers (1998); Chambers and Fowler (1995); Goldhaber (1999); Stoddard (2005); and Taylor (2010, 2011).

63 See Drukker (2003) and Wooldridge (2002).

education campuses have been excluded. All teachers with complete data who worked at least half time for a traditional public district have been included in the analysis.

The measure of teacher salaries that is used in this analysis is the benefit-adjusted annual salary. It is calculated as net gross amount of salary for the individual, multiplied by (1+θ), where 1+θ is the district total expenditures for salary and benefits divided by the district total expenditures for salary. Net gross salaries less than $25,000 were deemed implausible and treated as missing.

Exhibit D1 presents the coefficient estimates and standard errors for the hedonic wage model. The dependent variable for this analysis is the log of benefit-adjusted annual salary. The independent variables (i.e., the controls) include various measures of teacher experience (the log of years of experience, the square of log experience, the cube of log experience, and an indicator for first-year teachers) and indicators for the teacher's educational attainment (bachelor's degree, master's degree, advanced degree, or doctorate).

Job characteristics in the analysis include indicators for teaching assignment (general elementary, language arts, mathematics, science, social studies, health and physical education, foreign languages, fine arts, Career Technical Education [CTE] and career education subjects, computer science, early childhood, limited English proficient (LEP) services, special education services, and other instructional duties). Any given teacher could have multiple teaching assignments (such as teaching both mathematics and science) or serve multiple student populations (such as elementary and prekindergarten). The analysis also includes an indicator for whether or not the individual is assigned to multiple buildings.

School characteristics included in the analysis are school size (the log of enrollment), school type (primary, middle, high school, and other), percentage of LEP students in the district, percentage of students eligible for free lunch, and percentage of special education students (not including disabilities associated with speech).

Finally, the hedonic wage model also included 10 variables that describe locational characteristics outside school district control that are expected to influence wage levels in the locality:

1. The American Community Survey Comparable Wage Index for Teachers (ACS-CWIFT), which reflects the prevailing wage for college graduates.[64]
2. The U.S. Department of Housing and Urban Development's estimate of Fair Market Rents for a two-bedroom apartment (in logs), which reflects deviations in the cost of living.
3. The U.S. Bureau of Labor Statistic's measure of the metropolitan area unemployment rate, which reflects job prospects outside of teaching.
4. The number of heating degree days at the nearest National Oceanic and Atmospheric Association (NOAA) weather station, which reflects regional variation in the cost of living due to energy consumption.
5. The number of cooling degree days at the nearest NOAA weather station, which also reflects regional variation in the cost of living due to energy consumption.

64 The ACS-CWIFT can be found here: https://bush.tamu.edu/research/faculty/Taylor_CWI/. Documentation on the ACS-CWIFT can be found at http://www.txsmartschools.org/

6. A U.S. Census indicator for whether or not the school district is located in a metropolitan area (with 50,000 or more population).
7. A U.S. Census indicator for whether or not the school district is located in a micropolitan area (with more than 10,000 but less than 50,000 population).
8. Distance to the nearest metropolitan or micropolitan area (measured in miles as the crow flies).
9. A coastal indicator for whether or not the district is in a county deemed "coastal" as defined by the NOAA.[65]
10. An indicator for whether or not a district is in a county with a military base.

Exhibit D1. Hedonic Wage Model Estimates

Variable Name	Hedonic Wage Model
Teacher Experience	
Years of experience (log)	–0.282***
	(0.00484)
Years of experience (log), squared	0.166***
	(0.00260)
Years of experience (log), cubed	–0.0158***
	(0.000423)
First-year teacher	–0.144***
	(0.00262)
Teacher Educational Attainment	
Bachelor's degree	–0.107***
	(0.00356)
Master's degree	–0.0210***
	(0.00356)
Advanced degree	0.0141***
	(0.00457)
Doctoral degree	-
Teacher Assignment	
Assigned multiple buildings	–0.0359***
	(0.000626)
English language arts/reading teacher	–0.00137*
	(0.000766)

65 The NOAA definition depends on the percentage of the county in a coastal watershed or its drainage basin. You can access more details on this definition here: https://coast.noaa.gov/data/digitalcoast/pdf/defining-coastal-counties.pdf

Variable Name	Hedonic Wage Model
Foreign language teacher	–0.0143***
	(0.00175)
Mathematics teacher	0.000969
	(0.000802)
Science teacher	–0.00347***
	(0.000836)
Social studies teacher	0.00263***
	(0.000806)
Arts education teacher	0.00787***
	(0.00136)
CTE and career education teacher	0.000581
	(0.00123)
Health and physical education teacher	0.0351***
	(0.00127)
Computer science teacher	0.0150**
	(0.00669)
Elementary teacher	0.00303**
	(0.00143)
Prekindergarten teacher	–0.00224
	(0.00202)
Other instructional duties	0.00333***
	(0.000509)
Special education teacher	–0.0111***
	(0.000774)
Limited English proficiency teacher	0.00103
	(0.00165)
Location Characteristics	
Miles to the nearest metro or micro area	–0.000619***
	(4.16e-05)
Annual average heating degree days	–2.90e-05***
	(1.69e-06)
Annual average cooling degree days	–3.06e-05***
	(2.91e-06)
Fair market rent (log)	0.0955***
	(0.00242)

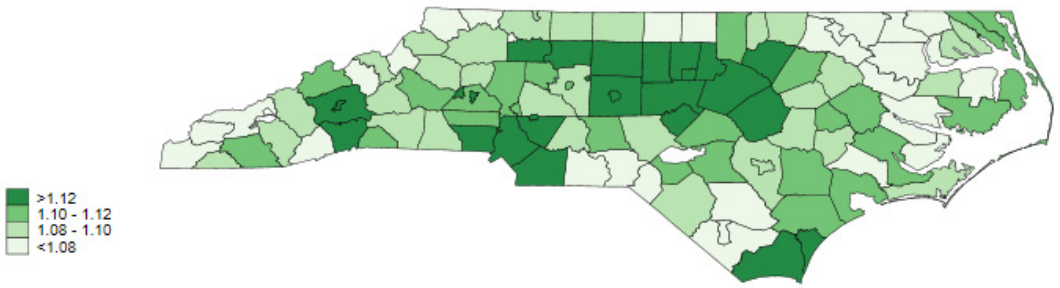
Variable Name	Hedonic Wage Model
Average annual unemployment rate	–0.000368
	(0.000259)
Metropolitan area indicator	–0.00324**
	(0.00135)
Micropolitan area indicator	–0.0127***
	(0.00146)
ACS-CWIFT	0.0615***
	(0.00510)
NOAA coastal county	–0.0231***
	(0.00102)
District with a military base in its county	–0.00228*
	(0.00132)
School Characteristics	
Percent English learners (district level)	0.00249***
	(8.55e-05)
Percent special education students	6.78e-05***
	(2.52e-05)
Percent eligible for free lunch	0.00463***
	(0.00102)
School enrollment (log)	0.00553***
	(0.000549)
Elementary school indicator	–0.00410*
	(0.00211)
Middle school indicator	–0.00597***
	(0.00176)
High school indicator	0.00911***
	(0.00182)
Other school type indicator	-
School year	
School year 2012–13	–0.0989***
	(0.00102)
School year 2013–14	–0.103***
	(0.000690)
School year 2014–15	–0.0421***
	(0.000577)

Variable Name	Hedonic Wage Model
School year 2015–16	–0.0272***
	(0.000421)
School year 2016–17 (omitted)	-
Constant	10.49***
	(0.0190)
Observations	400,726
Number of teachers	121,460

*Note: The AR(1) model was estimated with random effects for individuals. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

The Teacher Salary Index (TSI) for each building is based on the predicted salary for a teacher with 10 years of experience and a master's degree, holding all other teacher characteristics and job characteristics constant at the statewide mean, but leaving the school and locational characteristics unchanged. The location with the lowest predicted salary has a TSI of 1.00. A location where predicted wages were 10% above the minimum would have a TSI of 1.10. Exhibit D2 shows a map of the district average district-level TSI for 2017.

Exhibit D2. Map of Average District-Level North Carolina Salary Index 2016–17



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