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Weighting for Progressivity? An Analysis of Implicit Tradeoffs Associated with Weighted Student Funding in Tennessee

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Weighting for Progressivity? An Analysis of Implicit Tradeoffs Associated with Weighted Student Funding in Tennessee

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We study the progressivity of state funding of school districts under Tennessee's weighted student funding formula. We propose a simple definition of progressivity based on the difference in exposure to district per-pupil funding between poor and non-poor students. The realized progressivity of district funding in Tennessee is much smaller—only about 17 percent as large—as the formula weights imply directly. The attenuation is driven by the mixing of poor and non-poor students within districts. We further show the components of the Tennessee formula not explicitly tied to student poverty are only modestly progressive. Notably, special education funding is essentially progressivity neutral for poor students. If we adjust the formula so all factors except individual student poverty receive zero weight and distribute the excess to poor students, we can increase the progressivity of district funding by 124 percent. We interpret this as the opportunity cost of the non-poverty-based funding components, measured in terms of progressivity.

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1. Introduction

The research literature estimating the impacts of school funding on student outcomes is extensive and expanding rapidly (for reviews, see Handel & Hanushek, 2023; Jackson, 2020; Jackson & Mackevicius, 2023). Among recent studies, researchers focus primarily on the effects of changes to funding induced by state level court-ordered or legislative finance reforms (Biasi, 2023; Candelaria & Shores, 2019; Jackson et al., 2016; Lafortune et al., 2018). However, while the summative outcomes of state funding reforms are widely studied, the mechanics through which these reforms distribute educational resources to school districts have received relatively little attention. From the perspective of a state policymaker looking to change the distribution mechanism, the literature provides little, if any, design guidance.

To contribute to this literature and inform policy discussions about state funding mechanisms, we assess the funding progressivity of a weighted student funding formula (WSFF). WSFFs are distribution mechanisms that allocate resources to school districts on a per-pupil basis. They include a base funding amount for each enrolled student and provide additional funding for students with specific attributes (e.g., poverty, language, and special education status) and students who attend schools and districts with specific attributes (e.g., schools with concentrated poverty and charter schools). WSFFs are the most common mechanism used by states to allocate centralized education funding to school districts—as of 2021, the Education Commission of the States reports 33 states used WSFFs (Fischer et al., 2021).[1]

We operationalize progressivity as the difference in exposure to district per-pupil funding between ED and non-ED students. The progressivity of a WSFF can be characterized by three features of the formula itself and the funding landscape: (1) the formula's direct progressivity, (2) the formula's indirect progressivity, and (3) student mixing within school districts. We describe direct progressivity as "formula-intended" progressivity—it is progressivity built directly into the formula through funding add-ons targeted toward ED students. Indirect progressivity depends on

[1] Of the remaining states, ten use resource-based models, which specify the inputs needed to run schools then fund districts to purchase those inputs directly. Seven other states use an alternative funding mechanism.

the degree to which formula components not explicitly targeted toward ED students—e.g., for special education students, English language learners, gifted students, etc.—are correlated with income status. Depending on the correlations, indirect progressivity can be positive or negative. Finally, student mixing by income status within school districts affects progressivity because more mixing makes it more difficult to target resources toward ED students (Jang and DiSalvo, 2023).

We use Tennessee's (TN's) newly implemented WSFF as a case study to address the following research questions:

(1) How does the formula-intended progressivity of the TN WSFF translate to actual, or realized, funding progressivity?

(2) Of the difference between formula-intended and realized funding progressivity in (1), how much can be attributed to the presence of other formula components (i.e., indirect progressivity) versus student mixing within school districts?

We find the formula-intended progressivity of the TN WSFF attenuates substantially when funding allocations are realized. Specifically, the realized gap in exposure to district per-pupil funding between ED and non-ED students is just 17 percent as large as the formula-intended gap. The attenuation is not due to the influence of indirect progressivity—in fact, we show the indirect progressivity of the TN funding formula is positive, albeit modestly. Within-district student mixing entirely drives the attenuation of formula-intended progressivity.

In an extension we divide the non-ED formula components into four categories and examine how each category contributes to indirect progressivity separately. The categories are for students (1) with language-based needs, (2) with special education needs, (3) who attend certain types of districts and schools, and (4) who participate in supplemental educational programming. Funding for students with language-based needs and for students who attend certain types of schools and districts exerts progressive pressure on district funding allocations in TN; however, funding for special education students and those who participate in supplemental educational programming is essentially progressivity neutral.

2. Context and Data

2.1 Tennessee's Student Weighted Funding Formula

TN's WSFF was approved by the state legislature in 2022 to allocate state funding to school districts beginning with the 2023-24 school year (Tennessee Department of Education, 2023). Like other WSFFs, the student is the object of the formula. The formula can be expressed as follows:

$$Y_{isj} = \theta_0 + \left[ED_i \cdot \gamma_1 \cdot \theta_0\right] + \left[\boldsymbol{L_i} \cdot \boldsymbol{\gamma_2} \cdot \theta_0\right] + \left[\boldsymbol{S_i} \cdot \boldsymbol{\gamma_3} \cdot \theta_0\right] + \left[\boldsymbol{X_{sj}} \cdot \boldsymbol{\gamma_4} \cdot \theta_0\right] + \left[\boldsymbol{Z_i} \cdot \boldsymbol{\gamma_5}\right]. \quad (1)$$

In Equation (1), Y_{isj} is the allocation for student i enrolled in school s and district j. ED_i is an indicator for whether the student is economically disadvantaged. The ED category includes students who are homeless, in foster care, unaccompanied youth, and migrants, but direct certification is the primarily driver of ED status. Directly certified students are from households that participate in the Supplemental Nutrition Assistance Program (SNAP), Food Distribution Program on Indian Reservations (FDPIR), or Temporary Assistance for Needy Families (TANF). $\boldsymbol{L_i}$ is a vector of indicator variables for three categories of unique learning needs (ULNs) associated with language, which cover students for whom English is a second language and students with dyslexia. $\boldsymbol{S_i}$ is a vector of ULN indicators for seven different special-education categories. $\boldsymbol{X_{sj}}$ is a vector of four district and school characteristics (small district, sparse district, school in concentrated poverty, and charter school), and $\boldsymbol{Z_i}$ is a vector of indicators for participation in four educational-programming categories (K-3 literacy, 4th-grade tutoring, career and technical education, postsecondary education). A description of these variables can be found in the notes to Table 1.

The formula is the product of the attributes state policymakers have elected to fund—described in the preceding paragraph—and their weights indicated by the parameters in Equation (1). The parameter θ_0 is the base per-pupil allocation. The parameter γ_1, and parameter vectors $\boldsymbol{\gamma_2}$, $\boldsymbol{\gamma_3}$, and $\boldsymbol{\gamma_4}$, are positive multipliers that increase the allocation as a function of the base amount. For instance, γ_1=0.25, which means the formula allocates an additional 25 percent of the base amount (θ_0) for each ED student. Finally, $\boldsymbol{\gamma_5}$ is a vector of fixed dollar amounts based on student i's educational programming enrollment.

Each district's funding allocation under the formula is the sum of the student-level amounts over students enrolled in the district. Thus, while the student is the object of the formula, it is a district-level funding mechanism. Importantly, the state plays no formal role in determining funding allocations to schools within districts, or students within schools. Said differently, Equation (1) describes the entirety of the flow of funds governed by state policy.[2]

2.2 Data

In 2022, the Tennessee Department of Education (TDOE) conducted funding simulations using district projections of the variables in the formula for the 2023-24 student population. The TDOE published values for the formula variables, the funding parameters, and each district's projected funding level. Data with this level of detail are rare in the education finance literature. In particular, it is uncommon for district enrollment shares of students in each unique category of the funding formula—in the level of detail of the formula itself—to be available. We refer to the dataset containing this information as the projection dataset.[3]

The projection dataset allows us to replicate TN's projected district-level funding allocations. The replication is possible because the attributes in Equation (1) increase funding additively for students who belong to multiple categories, which ensures the district shares of students in each category—which are provided in the projection dataset—are sufficient to replicate the district allocations. This contrasts with some other formulas that use "either/or" conditions (or what are referred to as "unduplicated" student counts), such as in California, in which case knowing the district shares of students in each category is not sufficient to recover the exact district allocations.

Table 1 summarizes the TN formula and the projection dataset. Column (1) shows the parameter values from the formula. Most of these parameters are expressed as shares of the base amount, θ_0; the four parameters at the bottom of the table (corresponding to $\boldsymbol{Z}_i$) are in dollars, as

[2] The TDOE's Tennessee Investment in Student Achievement (TISA) guide (https://www.tn.gov/content/dam/tn/education/tisa-resources/TISA_Guide_7-1-23_Updated.pdf) states that "funding is allocated to districts based on the students they serve, and districts have the local discretion on how funds are spent" (page 5).

[3] TDOE published the information in what we call the "projection dataset" in the form of many PDF files. We scraped and combined these files to construct a dataset suitable for analysis.

specified by the formula. Column (2) shows student-enrollment-weighted averages of the district shares of students in each funding category. Column (3) shows how the first two columns—the parameters and data weights—combine to determine the share of total funding allocated for each funding category. Finally, column (4) shows the correlation between the district-level enrollment share in each funding category and the district ED share. These correlations indicate the direction of indirect progressivity of each funding component, with the caveat that their magnitudes can be misleading about the influence of individual components over total progressivity.[4]

Table 1 shows that base funding accounts for most funding under the formula—75.6 percent (column 3). The largest funding category outside of base funding is for ED students, at 6.3 percent. Not coincidentally, the ED student category is large, accounting for 33.3 percent of all TN students (column 2). Students with language-based ULNs account for 4.4 percent of total funding. Some special education ULN categories are attached to very large individual funding parameters (e.g., ULNs 8-10), but the low incidence of students in these categories minimizes their impact—5.7 percent of total funding is distributed to students with special-education ULNs overall. The other categories in the formula—add-ons for district and school attributes, and educational programming—combine to account for the remaining 8.2 percent of total funding.

The mean of the correlations in the final column of Table 1, weighted by their contribution to total funding, is 0.18, indicating the average weighted contribution of the non-ED categories to progressivity will be positive. However, different categories move in different directions. For example, language categories ULN 4 and 5 (responsible for 2.9 percent of total funding) should increase progressivity because the shares of students covered by these categories are larger on average in districts with a greater share of ED students. Alternatively, other categories responsible for non-trivial funding allotments appear to be regressive—e.g., technical education programming is responsible for 2.4 percent of total funding and negatively correlated with the ED share.

[4] This is because the correlations do not account for the "dollar weight" of each formula component in determining the total allocation. For example, 4th-grade tutoring is highly correlated with the ED share at the district level (correlation = 0.84), but it accounts for just 0.1 percent of total funding, limiting its role in influencing progressivity.

3. Measuring progressivity

Progressivity of education funding is commonly measured by the degree to which more resources are directed toward low-income students (more broadly, progressivity can be measured with respect to any indicator of student disadvantage). We define progressivity in this vein as the average difference in exposure to district per-pupil funding between ED and non-ED students:

$$\frac{1}{N^{ED=1}}\sum_{j=1}^{J}(Y_j \cdot N_j^{ED=1}) - \frac{1}{N^{ED=0}}\sum_{j=1}^{J}\left(Y_j \cdot N_j^{ED=0}\right). \quad (2)$$

In Equation (2), Y_j is total per-pupil funding at district j, $N_j^{ED=1}$ and $N_j^{ED=0}$ are the numbers of ED and non-ED students in district j, and $N^{ED=1}$ and $N^{ED=0}$ are the numbers of ED and non-ED students in the state. This equation captures the difference in exposure to per-pupil district funding between ED and non-ED students, on average statewide. To calculate the difference using the district-level projection dataset, we first calculate total funding for each district based on Equation (1). To illustrate the calculation, consider a hypothetical district with 100 students. If the ED share is 0.08 and the share of students in ULN category 4 is 0.02, and there are no students belonging to any other category, the total district allocation is $[100 \cdot \theta_0] + [8 \cdot \gamma_1 \cdot \theta_0] + [2 \cdot \gamma_{22} \cdot \theta_0]$, where γ_{22} is the second element of the parameter vector $\boldsymbol{\gamma_2}$ (per Table 1). We divide this amount by total enrollment in district *j* to convert to per-pupil dollars, then produce weighted averages of exposure to district per-pupil funding for ED and non-ED students. The difference in the weighted averages is our measure of progressivity. A positive difference indicates a progressive funding allocation, no difference is neutral, and a negative difference is regressive. This formula follows from previous studies (see, for example, Chingos & Blagg, 2017; Knight & Mendoza, 2019; Lee et al., 2022).

Our measure of progressivity has two appealing features. First, ED status is likely an accurate indicator of income status due to TN's reliance on direct certification to identify ED students. In Missouri, which has the same direct certification rules as TN, Fazlul et al. (2023) show direct-certification-based income indicators are accurate on average. In Appendix Table A1, we conduct a test in the spirit of Fazlul et al. (2023) in TN and find that like in Missouri, the ED-based

income data are accurate. The criteria for social services programs that lead to direct certification and should identify students in families with incomes at or below 130 percent of the poverty line.[5]

The second appealing feature of Equation (2) is that the units are in dollars, which facilitates a natural comparison to the formula in Equation (1). For example, we know θ_0=$6,860 and γ_1=0.25 (see Table 1), which yields a formula-intended gap between ED and non-ED students of $1,715. Suppose we estimate Equation (2) to be $1,000. We could then say 58 percent (i.e., 1,000/1,715) of the formula-intended gap is realized in the average difference in exposure to per-pupil district funding between ED and non-ED students. Noting these advantages of how we measure progressivity, in Appendix A2 we confirm our findings are substantively similar if we use alternative measures of progressivity.

Because our calculations are at the district level, the difference in Equation (2) is driven entirely by between-district differences in student, school, and district attributes included in the WSFF. These are precisely the differences targeted by the formula. To extrapolate our findings to a lower level of aggregation—e.g., to school or even individual-student level funding gaps—would require information about how districts allocate funding internally to schools, and/or how schools allocate funding internally to support individual students. Unfortunately, there is not conclusive, systematic evidence on how districts allocate funding to schools, or how schools allocate funding to individual students. Moreover, what little evidence we do have suggests funding practices at these lower levels of aggregation are heterogeneous (Baker, 2012; Blagg, et al., 2022; Rubenstein et al., 2007).[6] Thus, we maintain our focus on measuring and understanding district-level progressivity, which is both (a) the most relevant for state policy and (b) the most tractable.

[5] The 130-percent threshold is used to determine eligibility for SNAP, the primary program that leads to direct certification in TN.

[6] Between school (within district) progressivity estimates are generally similar to between district (within state) progressivity estimates (Blagg, et al., 2022; Lee, et al., 2022), though this is not directly informative about how districts allocate resources to schools because (a) the degree of within- and cross-district segregation can play an important role in the alignment of progressivity as measured at different levels of aggregation and (b) this result on average can mask heterogeneity in district behavior.

4. Results

4.1 RQ 1: How does the formula-intended progressivity of the TN WSFF translate to actual, or realized, funding progressivity for economically disadvantaged students?

As noted above, the formula-intended funding gap between ED and non-ED students is $1,715.[7] The first row of Table 2 shows that after we implement the formula and estimate Equation (2), the actual gap in exposure to district per-pupil funding between ED and non-ED students is $299, or 17.4 percent of the formula-intended gap. While it would be naïve to assume the formula-intended gap would carry through in full to the realized gap, this is a dramatic decline.

The difference between the formula-intended and actual gap is driven by two factors: (1) the indirect progressivity of the formula via the non-ED funding components and (2) student mixing within districts by income status. To see why this is true, note that if the non-ED formula components were independent of ED status (i.e., indirect progressivity was zero), and if students were perfectly segregated by ED status across districts (i.e., there was no student mixing), the formula-intended and actual funding gaps would be identical.

4.2 RQ 2: Of the difference between formula-intended and actual funding progressivity, how much is attributable to the presence of other formula components (i.e., the influence of indirect progressivity) versus student mixing within districts?

To isolate the extent to which these factors are responsible for attenuating the formula-intended funding gap, we use a hypothetical parameterization of the funding formula that sets all add-on parameters to zero except the add-on for individual ED status, γ_1. We distribute the savings equally to all students to maintain budget neutrality. By zeroing out the add-on parameters $\boldsymbol{\gamma_2}$ to $\boldsymbol{\gamma_5}$, we remove the influence of the formula's indirect progressivity on the actual funding gap.

[7] This can be viewed as a simplification because one other formula component—the poverty concentration component—is explicitly income targeted. However, we treat the poverty concentration component like the other non-ED components in the formula and attribute its impact to the formula's indirect progressivity. Conceptually, we prefer this approach because poverty concentration is treated as a school-level condition in the formula and the per-pupil add on is applied equally for ED and non-ED students in a school. If we treated the school poverty concentration component of the formula as contributing to direct progressivity, the direct (indirect) progressivity of the formula would be higher (lower) than what we report below.

A technical issue is that when we redistribute the savings to all students, we do it via a lump sum transfer and not by manipulating θ_0. While it is conceptually useful to think of the redistribution as happening through θ_0, this complicates tractability because γ_1 is multiplied by θ_0 to get the per-pupil ED amount. Thus, if θ_0 changes, so does the dollar value of the formula-intended funding gap. By allocating the savings from zeroing out $\boldsymbol{\gamma_2}$ to $\boldsymbol{\gamma_5}$ as a per-pupil lump sum outside of the formula, we hold the dollar value of the formula-intended ED gap fixed at $1,715. This allows us to maintain comparability across the real- and hypothetical-formula scenarios we consider.

The second row of Table 2 shows that if we zero out the non-ED formula components and redistribute the savings to all students equally, the realized ED funding gap declines from $299 to $173, a reduction of $126. The reduction is because the non-ED add-on categories, weighted by their parameters in the formula, are positively correlated with ED status and progressive on net. This result rules out negative indirect progressivity as an explanation for the sharp drop-off between the formula-intended and realized ED funding gap. Thus, the entirety of the observed drop-off, and more, is explained by the mixing of ED and non-ED students within districts.

Student mixing within districts depends on a combination of residential segregation by income, district boundary locations, and the size distribution of districts. The interactions between these factors can be complex. In results omitted for brevity, we confirm the prevalence of large districts in TN does not dull funding progressivity. In fact, larger districts in TN tend to be more segregated by income status than smaller districts (due to residential segregation in the areas they operate), and thus their presence contributes positively to funding progressivity statewide.[8]

The non-ED formula components are progressive on net, but their degree of progressivity is unclear. To gain insight into the magnitude of indirect progressivity, we consider another alternative parameterization of the formula where we again zero out $\boldsymbol{\gamma_2}$ to $\boldsymbol{\gamma_5}$, but this time we maintain budget neutrality by redistributing the savings to ED students only. This gives an upper bound on

[8] Monarrez (2023) shows residential segregation is the predominant driver of racial-ethnic student mixing at the school level. A reasonable prior is that the substance of this finding also applies to income-based school (and district) segregation, but this merits attention in future research.

how much we could increase the ED funding gap defined by Equation (2) if we hold fixed (a) the degree of student mixing within districts, and (b) the total amount of funding allocated outside of base funding (24.4 percent of total funding per Table 1).

Row (3) of Table 2 shows that we can increase the ED funding gap to $670 per pupil if we redistribute the entirety of non-ED funding to ED students directly. This is a 124 percent increase of the actual gap. The difference between this upper-bound gap and the actual gap of $299 can be interpreted as a measure of the opportunity cost of the non-ED funding categories in terms of progressivity. That is, Table 2 shows the resources devoted to the non-ED formula components have the upper-bound potential to increase the ED funding gap from $173 (when the non-ED formula components effectively do not exist) to $670 (when the non-ED resources are devoted entirely to the ED gap), but in reality, they only increase the gap from $173 to $299. Our interpretation of this result—which follows from the summary of the correlations in the last column of Table 1—is that the non-ED formula components are modestly progressive.

5. Extensions

5.1 The indirect progressivity of different formula components

We explore the indirect progressivity of the formula more deeply by isolating the impacts of different categories of non-ED funding. We do this by calculating total formula progressivity after zeroing out, in turn, weights on the following sets of variables in the funding formula: (1) language-based ULN categories, (2) special-education-based ULN categories, (3) district and school categories, and (4) educational programming categories. In each instance, we first consider reallocating the savings to all students, and then to ED students only, which helps us understand the magnitudes of progressivity of the different formula components.

The first row of Table 3 reproduces the progressivity result using the actual formula from the first row of Table 2 for ease of comparison. Then, rows (2) to (5) show progressivity when we zero out funding for the four broad funding categories in turn and allocate the excess to all students equally, and rows (6) to (9) repeat this exercise but allocate the excess to ED students only.

Rows (3) and (5) show funding for special-education ULNs and educational programming is essentially progressivity neutral for ED students—when we remove these categories from the formula and redistribute the excess equally to all students, the ED funding gap changes very little. In the case of special education students, this is because their enrollment is weakly and inconsistently correlated with ED enrollment across the special education ULNs per Table 1. In other words, special education students are not strongly sorted to districts that differ by the poverty level. Table 1 further shows that funding for educational programming is primarily allocated for K-3 literacy programs and career and technical education, and these programs are correlated with ED status in opposite directions and of a similar magnitude, resulting in (roughly) neutral progressivity on net.

In contrast, rows (2) and (4) show funding for language-based ULNs, and district and school attributes, is progressive—the ED funding gap declines substantially when these funding categories are removed. The progressivity of the language-based ULNs is consistent with evidence that students with language needs are disproportionately from low-income families (National Academies of Sciences, 2017; Quintero & Hansen, 2021).The finding that the school and district formula components are progressive is also not surprising—as shown in Table 1, about two-thirds of total funding in this category is awarded for enrollment in schools with concentrated poverty, which is highly correlated with the ED share.[9]

In rows (6) to (9) we consider the upper bound on progressivity if we re-allocate the resources from each non-ED category to ED students. The results mirror our findings in rows (2) to (5). Specifically, when we zero out funding for special-education ULN students (row 7) and educational programming (row 9) and allocate the excess to ED students, we see a marked increase in progressivity. This reflects the fact that these formula components are not progressive. When we zero out language-based ULNs (row 6) and district and school attributes (row 8), the changes in progressivity are smaller because these components are already quite progressive.

[9] Table 1 shows that about 4.0 percent of total funding statewide is allocated for school and district attributes, and 2.6 percent is in the concentrated poverty subcategory. As indicated in the Table 1 notes, the concentrated poverty designation is based on federal Title-I eligibility.

5.2 Alternative measures of progressivity

While we prefer our ED-based measure of progressivity, a shortcoming is that ED status is a coarse indicator of family income. This may lead us to draw an incomplete picture of funding progressivity. Therefore, we supplement our findings thus far by drawing on data from the Education Demographic and Geographic Estimates (EDGE) program at the National Center for Education Statistics (NCES) to consider funding gaps along alternative dimensions and how they change when we adjust the formula. Appendix A2 shows results across nine different measures of disadvantage taken from the EDGE data, which cover dimensions of disadvantage including family structure, education levels, residential stability, income, and racial/ethnic demographics. The pattern of results in the appendix is substantively consistent with our results in Tables 2 and 3, demonstrating that our primary findings are robust to alternative measures of disadvantage.

6. Discussion and conclusion

We study the progressivity of district funding under the WSFF in TN. The realized progressivity of the TN formula—or any WSFF—depends on three factors: (1) direct, or formula-intended progressivity, (2) indirect progressivity, and (3) student mixing by income status within districts. We show the realized progressivity of district funding is much smaller than formula-intended progressivity in TN due to student mixing within school districts.

The indirect progressivity of the TN formula—which comes from formula components that are not explicitly targeted toward ED students but are correlated with ED enrollment—is positive and helps to offset some of the attenuation of formula-intended progressivity caused by student mixing. However, in terms of magnitude, we characterize the level of total indirect progressivity in the TN formula as modest.

Our findings highlight the tradeoffs policymakers face in the construction of WSFFs, which are the predominant mechanism used by states to distribute funding to school districts. For instance, we find special-education funding is not meaningfully progressive. Thus, as more funding is allocated to special education students rather than ED students, all else equal, funding progressivity will attenuate. We do not take a normative stance on which tradeoffs to make in the design

of a WSFF—it may be that the level of special education funding in the TN formula is appropriate and educationally necessary despite the progressivity cost—but rather, we provide positive evidence to help policymakers make informed decisions.

We maintain that the state-to-district portion of the flow of funds is of independent interest, and of first-order interest, to state policymakers, as this is the only portion they control. That said, it is also of interest to understand how funding flows from districts to schools, and even schools to individual students (to the extent this happens in practice). However, better data are needed to track funding flows down to schools, and perhaps individual students, with confidence. Over time, we expect school finance data required under the Every Student Succeeds Act (ESSA) to improve as schools and districts improve their reporting processes and researchers interrogate the data.[10] As we gain confidence in these data, deeper investigations of funding flows will be possible. In the meantime, our work is informative about the mechanics of how states distribute funding to school districts. We hope it can spur a richer and more systematic literature from which generalized insights may emerge.

[10] School-level spending is a new reporting requirement under ESSA. While TN has complied with the requirement, like other states, the data have not been rigorously scrutinized and their accuracy is uncertain (e.g., see Presume and Morgan, undated).

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Table 1: Variables and variable weights used in TN funding formula

Variable	Amount or Weight (γ)	Share of students in 2024	Share of total state allocation in 2024	Correlation with ED Share (District Level)
Base	$6860		0.756	0.00
Economically Disadvantaged (ED)[1]	0.25	0.333	0.063	--
Language-Based Unique Learning Need Categories[2]				
ULN 2: ELL designation or dyslexia	0.20	0.100	0.015	-0.334
ULN 4: ELL designation	0.60	0.002	0.001	0.172
ULN 5: ELL designation	0.70	0.052	0.028	0.330
Special Education-Based Unique Learning Need Categories[3]				
ULN 1	0.15	0.058	0.007	-0.324
ULN 3	0.40	0.032	0.010	0.247
ULN 6	0.75	0.019	0.011	0.126
ULN 7	0.80	0.016	0.010	-0.271
ULN 8	1.00	0.001	0.001	0.197
ULN 9	1.25	0.018	0.017	0.037
ULN 10	1.50	0.001	0.001	0.093
District and School Categories[4]				
Small District	0.05	0.013	0.0004	0.030
Sparse District	0.05	0.326	0.012	0.065
School in Concentrated Poverty	0.05	0. 676	0.026	0.723
Charter School	0.04	0.044	0.001	0.726
Educational Programming Categories[5]				
K-3 Literacy	$500	0.300	0.017	0.262
4th Grade Tutoring	$500	0.016	0.001	0.837
Career and Technical Education	$5000	0.044	0.024	-0.192
Postsecondary Assessment	$185.34	0.072	0.001	-0.302
N (Districts)		140		

Notes: Weights in column (1) indicate the share of the base amount applied for the indicated student or district condition; dollar values indicate dollar-amount add-ons. All dollar amounts are in projected 2024 USD. The sum of the state allocation shares slightly exceeds 1.0 due to rounding. The correlation with the ED share is a weighted correlation at the district level and gives a general sense of the direction of progressivity of each formula input.

[1] Economically disadvantaged is defined as a student identified as experiencing homelessness, foster care, unaccompanied youth, or migrant status, or directly certified. The latter group drives most membership in the ED category.

[2] There are three unique learning need categories that involve language learner status. These are ULN 2: Student with Minimal Special Education Direct Services Characteristics of Dyslexia; and/or English Learner Tier I, ULN 4: Student with English Learner Tier II, and ULN 5: Student with English Learner Tier III.

[3] There are seven unique learning need categories that involve special education for students with disabilities. language learner status. These are ULN 1: Student with Special Education Consultation Services, ULN 3: Student with Limited Special Education Direct Services, ULN 6: Student with Moderate Special Education Support Direct Services, ULN 7: Student with High-Support Special Education Direct Services, ULN 8: Student with Ancillary Special Education Direct Services, ULN 9: Student with Most Intensive Special Education Support Direct Services, and ULN 10: Student with Special Education Residential/Homebound/Hospital Services.

[4] The four school and district categories are: (1) Small district, defined as an LEA with a student membership of 1,000 or fewer, (2) sparse district, defined as a district located in a county with fewer than 25 students per square mile, (3) schools in concentrated poverty, defined as a school eligible for Title I schoolwide designation, i.e., the schoolwide poverty rate is equal to or greater than 40%, and (4) public charter schools.

[5] The four educational programming categories are (1) any student in grades kindergarten through 3rd grade intended to support early literacy instruction, (2) rising 4th grade students for additional supports in literacy based on their performance on the 3rd grade English Language Arts test score, (3) funding for student participation in Career and Technical Education, and (4) students who take the ACT in their 11th or 12th grade year.

Table 2: Difference in average per pupil state funding for poor vs non-poor using various funding formula

	Average per-capita allocation to ED students $E(Y_j \mid ED_i = 1)$	Average per-capita allocation to non-ED students $E(Y_j \mid ED_i = 0)$	Difference between average per-capita allocation between ED and non-ED students $E(Y_j \mid ED_i = 1) - E(Y_j \mid ED_i = 0)$
(1) Actual formula	\$9277	\$8978	\$299
(2) Cut all non-ED add-on funding, allocate to all students	\$9193	\$9020	\$173
(3) Cut all non-ED add-on funding, allocate to ED	\$9525	\$8855	\$670
N		140	

Notes: In each funding scenario, the total state budget is kept constant at the level with the actual funding formula. All numbers are in 2024 USD.

Table 3: Difference in average per pupil state funding for poor vs non-poor using various funding formula

	Average per-capita allocation to ED students $E(Y_j \mid ED_i = 1)$	Average per-capita allocation to non-ED students $E(Y_j \mid ED_i = 0)$	Difference between average per-capita allocation between ED and non-ED students $E(Y_j \mid ED_i = 1) - E(Y_j \mid ED_i = 0)$
(1) Actual formula	$9277	$8978	$299
A. Adjust formula parameters and allocate to all students			
(2) Cut funding for language based ULN students, allocate to all students	9243	8995	248
(3) Cut funding for special ed base ULN students, allocate to all students	9269	8982	287
(4) Cut funding for district or school attributes, allocate all students	9230	9002	228
(5) Cut funding for educational-programming attributes, allocate to all students	9283	8975	307
B. Adjust formula parameters and allocate to ED students			
(6) Cut funding for language based ULN students, allocate to ED students	9323	8955	368
(7) Cut funding for special ed based ULN students, allocate to ED students	9371	8932	439
(8) Cut funding for district or school attributes, allocate to ED	9303	8965	338
(9) Cut funding for educational-programming attributes, allocate to ED	9361	8936	425
N		140	

Notes: In each funding scenario, the total state budget is kept constant at the level with the actual funding formula. All numbers are in 2024 USD.

Appendix

A1. Assessment of Tennessee's measure of economic disadvantage

ED status is primarily determined in Tennessee by direct certification. Given Tennessee's direct certification rules, the expectation is that the ED share should approximate the share of students living at or below 130 percent of the poverty line. The geospatial estimate of the share of students living at or below 130 percent of the poverty line is calculated following Fazlul et al. (2023). The two estimates are closely aligned, which is consistent with the ED designation categorizing students by income status accurately.

Appendix Table A1: Alignment between the TDOE reported ED share and a geospatial estimate of poverty at the same poverty threshold (130 percent of the poverty line), statewide.

Statewide share of ED students	33.3%
Statewide share of students living at or below 130 percent of the poverty line, geospatial estimate	35.4%

Notes: The statewide ED share is based on TDOE data. The underlying data for the geospatial estimate are from the School Neighborhood Poverty estimates from the NCES, manipulated following Fazlul et al. (2023) to produce an estimate of the fraction of students living at or below 130 percent of the poverty line statewide.

A2. Alternative measures of progressivity

We supplement our findings in the main text by drawing on data from the Education Demographic and Geographic Estimates (EDGE) program at the National Center for Education Statistics (NCES) to consider funding gaps along alternative dimensions and how they change when we adjust the formula. For each comparison in this section, we use the EDGE data to divide the 140 TN districts into quartiles of disadvantage and document the difference in per-pupil funding, on average, between the most- and least-disadvantaged quartiles. The EDGE data are available with a lag; we use the most recent data from NCES, which are based on five-year American Community Survey (ACS) estimates from 2016-20.

Table A2 shows results across nine different measures of disadvantage in the EDGE data, indicated by the rows. The measures of disadvantage cover family structure, education levels, residential

stability, income, and racial/ethnic demographics. We calculate funding gaps between districts that differ along the nine dimensions using the same three versions of the funding formula from above, as indicated by the columns: (1) the actual funding formula, (2) a version of the formula that cuts out all non-ED model components and distributes the excess to all students, and (3) a version of the formula that cuts out all non-ED components and distributes the excess to ED students. The "difference" columns in Table A2 show the value of average per-pupil funding in the most disadvantaged quartile of districts minus average per-pupil funding in the least disadvantaged quartile of districts. Thus, positive differences indicate greater general funding progressivity.

The pattern of results in Table A2 is substantively consistent with our results in Tables 2 and 3. That is, the actual formula is progressive, it becomes less progressive when we cut the non-ED formula components and redistribute the excess to all students, and it becomes more progressive when we cut the non-ED components and redistribute the excess to ED students. Some of the dollar-value differences as we move across columns within rows of Table A2 are more pronounced than in Tables 2 and 3. This is especially true in the final set of columns when we redistribute the excess resources to ED students. The reason is that in Tables 2 and 3 we compare ED and non-ED students on average throughout the entire school system, while in Table A2 we compare districts with the most and least concentrated disadvantage. That is, the results in Tables 2 and 3 include comparisons of ED and non-ED students in the middle quartiles of district-level disadvantage, who likely attend districts with more mixed enrollment, and thus experience average differences in district per-pupil funding closer to zero. In contrast, Table A2 omits these students by focusing on districts in the edge quartiles, resulting in larger dollar-value gaps on average.

Our results in Table A2 demonstrate that our primary findings are robust to alternative measures of disadvantage. In fact, Table A2 suggests our findings in Tables 2 and 3 may understate the opportunity cost of the non-ED formula components in terms of progressivity, which becomes more pronounced when we focus on gaps in per-pupil funding in the tails of the distribution of district disadvantage.

Appendix Table A2: Funding gaps in average per-pupil funding across districts with varying characteristics, using the actual and modified funding formulas.

	Actual Formula			Cut all non-ED funding categories by 100%, allocate to all students			Cut all non-ED funding categories by 100%, allocate to ED students only		
	Most Disad-vantaged Quartile	Least Disad-vantaged Quartile	**Difference (Most-Least)**	Most Disad-vantaged Quartile	Least Disad-vantaged Quartile	**Difference (Most-Least)**	Most Disad-vantaged Quartile	Least Disad-vantaged Quartile	**Difference (Most-Least)**
Percent Married	$9430	$8648	**$782**	$9308	$8845	**$463**	$9971	$8174	**$1797**
Percent HS Graduate	9400	8837	**563**	9191	8955	**236**	9518	8602	**916**
Percent BA Degree	9401	8977	**424**	9184	9067	**117**	9491	9035	**456**
Percent housing change	9241	9265	**-24**	9216	9089	**127**	9614	9123	**491**
Median income	9203	8826	**377**	9170	8942	**228**	9438	8551	**887**
Percent poor	9493	8661	**832**	9428	8886	**542**	10437	8333	**2104**
Percent White	9230	9286	**-56**	9189	9115	**74**	9510	9224	**286**
Percent Black	9238	9300	**-62**	9194	9091	**103**	9530	9128	**402**
Percent Hispanic	9213	9224	**-11**	9157	9147	**10**	9384	9348	**36**

Notes: Each cell is a student weighted average of district per-pupil funding for either the top or bottom quartile of districts by the characteristic indicated in the row and using the formula indicated by the top column header. Going down the rows, the most disadvantaged quartile is the one with: (1) lower percent married, (2) lower percent HS graduate, (3) lower percent BA degree, (4) higher percent changing housing, (5) lower median income, (6) higher percent poor, (7) lower percent White, (8) higher percent Black, and (9) higher percent Hispanic. In each scenario, the total state level budget is kept constant at the actual funding formula level. NCES EDGE data are based on total population estimates within the geographic area defined by school district boundaries. All numbers are in 2024 USD.