School-Level Dynamic Weighting: A New Approach to Weighted-Student Funding Models

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Introduction

Researchers and policymakers looking to address school-finance equity concerns at the state level often turn to weighted-pupil unit (WPU) or weighted-student funding (WSF) formulae (J. G. Chambers, Levin, & Shambaugh, 2010; W. Duncombe, Ruggiero, & Yinger, 1996; Guthrie & Rothstein, 1999; Malen, Dayhoff, Egan, & Croninger, 2015; Odden & Picus, 2014).\(^1\) Increasingly, school districts also rely on WSF formulae as a method of distributing resources directly to schools (J. G. Chambers et al., 2010; Malen et al., 2015).

In the paper that follows, I discuss the theoretical and empirical context related to WSF model design at the school district level. I then survey the extant literature related to district-level WSF implementation of these funding models and the capacity of WSF models to advance fiscal equity concepts at the district-level. Given mixed findings related to WSF initiatives’ capacity to advance fiscal equity, I then level a critique of current WSF models. Specifically, I highlight the lack of nuance and flexibility in district-level WSF models. Finally, I propose a new method of WSF formula design.

To date, WSF models do not accommodate between-school variation in student need.\(^2\) WSF models that employ static weights—those are weights that are the same across all districts and/or schools—are blunt funding instruments that cannot attend to variations in student need between schools. Specifically, no student group is monolithic

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\(^1\) In this paper, ‘school finance equity’ will focus on horizontal equity, vertical equity, and adequacy equity concepts. Horizontal equity is the ‘equal treatment of equals’ in resource distribution; vertical equity is the differential treatment of different groups in resource distribution; and adequacy is resource distribution that will be sufficient to achieve a particular (or a range of) student outcome(s) (See Berne & Stiefel, 1984, 1999; Odden & Picus, 2014 for a more detailed discussion of equity concepts).

\(^2\) Student need refers to the amount of resources required to educate different types of students in different contexts (Malen et al., 2015).
and localized needs will necessarily vary across schools based on population differences and on concentration of particular types of students (Berne & Stiefel, 1999; Odden & Picus, 2014).

Subsequently, I pose a potential remedy to weaknesses in existing district-level WSF models. I posit and then iterate a new approach to WSF model design that includes dynamic weights. That is, the WSF model in this paper employs a weighting system wherein each school has different weight values that correspond to student need and the concentration of student need within the specific school. These weights are based on empirical calculations of student-level data that correspond to district-perceived areas of need. Further, the dynamic weighting system has a base weight that changes for each school based on actual teacher salaries at the school level to attend to fundamental inequities in teacher distribution patterns. I describe and layout the funding model and its components, and I offer additional weights and adjustments, including methods for employing the funding model to a fixed pot of money/resources. I conclude with a discussion of the funding model and its implications in WSF research, broadly, and advancing fiscal equity, specifically.

**Theoretical Context**

WSF formulae are mathematical approaches to resource allocation that set some resource (most often per-pupil funding) equal to a function of: the overall proportion of certain student subgroups or characteristics in the total school-age population; and the resources required to educate students within each category, trait, or subgroup or the relative amount of resources a district can afford to allocate to the various student characteristics (J. G. Chambers et al., 2010). Researchers and advocates compute these
categories, traits, and/or subgroups along with amount of resource need for each group using varying design approaches, namely: true adequacy or relative need. The capacity of WSF formulae to advance fiscal equity (regardless of which equity conception the formula is tied to) pivots on two assumptions: 1) the use of valid weights; and 2) that the WSF formula allocates money according to the formula design (Malen et al., 2015).

**Designing a Traditional WSF Model**

The extant school finance research does not offer specific strategies to constructing district-level WSF formulae. Instead, evaluations of implemented WSF relative need formulae and publications from issue advocates and practitioners offer the most insight into formulae design. Two general themes emerge from the literature, specifically: formulae are built to target school-district perceived need without overly disrupting existing programmatic and operational allocations (Baker & Thomas, 2006; J. G. Chambers et al., 2010; J. Chambers, Shambaugh, Levin, Muraki, & Poland, 2008; Childress & Peterkin, 2008; Doyle, Boast, Rosch, & Hassel, 2012; Education Trust West, 2005; Hill, 2008; Levin et al., 2013; Malen et al., 2015; Shambaugh, Chambers, & DeLancey, 2008); and technical, economic and political considerations circumscribe the amount of an organizations resources that are allocated to formulae and subsequently drive total resource expenditure (Malen et al., 2015). These district-level WSF formula designs typically have three steps, namely: 1) identify the categories/types of students/schools and student/school subgroups or areas of need; 2) assign weights to each category that reflect differences in relative need; and 3) determine a foundation or base cost and apply the formula (Baker, 2009; Baker & Elmer, 2009; J. G. Chambers et al.,
Step 1: Identify the Categories/Types of Students or Indicators for Weight.

The first step of WSF relative need formulae construction is to answer the question: relative to what/whom (Malen et al., 2015)? WSF relative need formulae pivot on the assumption that certain groups of students (or schools/districts with students that have certain characteristics) cost more to educate than others (J. G. Chambers et al., 2010; Fahy, 2011; Malen et al., 2015; Rubenstein, 1998; Shambaugh et al., 2008). However, given that WSF formulae based on relative need do not rely on costing out studies, the research shows little consensus as to which specific groups or subgroups belong in a WSF relative-need formula.³ The broad spectrum of district-level WSF formulae includes a wide range of differing categories that receive weight, including: high-achieving students; low-achieving students; students in circumstances of poverty, students with English-Language Learner status, students with disability/ability status, and students in certain grade levels (Archer, 2005; Baker & Thomas, 2006; J. G. Chambers et al., 2010; Childress & Peterkin, 2008; Cooper et al., 2006; Education Resource Strategies, 2010, Education Trust West, 2005; Frank, 2012; Furtick & Snell, 2013; Hill, 2008; Miles & Roza, 2006; Petko, 2005; Roza, Hill, Sclafani, & Speakman, 2004; Samuels, 2012; Shambaugh et al., 2008; Snell, 2009; Ucelli et al., 2002). Ultimately, generic assumptions rooted in available literature or existing costing-out study data can—but are not required to—undergird the selection of weighted groups.

³ Costing out studies refer to cost-analysis methods in school finance that attempt to define the precise amount of resources required to deliver a particular, usually ‘adequate’, education. See Odden & Picus (2014) for a more detailed discussion of costing-out methods.
**Step 2: Assign Weights that Reflect Relative Need.** Once formula designers select the categories and subgroups, designers then assign a numeric weight that reflects district perceptions of the magnitude of category/subgroup need (J. G. Chambers et al., 2010; Cooper et al., 2006; Petko, 2005; Ucelli et al., 2002). Actual weights correspond to a numeric value relative to 1.00, which is the base amount of dollars required to provide an education to a student without any weighted characteristics. For example, a weight of 1.50 will allocate 1.5 times the given resource (most often, per-pupil dollars) to the weighted student subgroup. Malen et al., (2015) note that a wide range of disparities exists in weight values across WSF relative-need formulae. That is, similar group categories often receive very different weight values in different contexts (Baker, 2009; J. Chambers et al., 2008; Childress & Peterkin, 2008; Doyle et al., 2012; Fahy, 2011; Frank, 2012; Furtick & Snell, 2013; Levin et al., 2013; Rubenstein, 1998; Shambaugh et al., 2008; Snell, 2009).

**Step 3: Determine Foundation Weight Amount and Apply the Formula.** The final component of WSF relative need design is to assign a dollar value to the base weight (1.00), and then to multiply the weight by the number of students eligible to receive the given weight (Malen et al., 2015). For example, given a WSF formula with a foundation amount of $1,000 and a low-performing student weight of 2.0, an entity with 1,000 low-performing students would receive an additional $2,000,000 total (or $1,000 per-pupil) above and beyond the base amount (1,000 * 2.0 * $1,000 = $2,000,000). District-level WSF formulae often derive formula foundation dollar amounts from the amount of resources already available rather than the amount of resources required to...
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advance particular student outcomes (as in true adequacy WSF formula design) (J. G. Chambers et al., 2010; Malen et al., 2015).

**Summary.** Overall, most approaches to relative-need WSF formulae are rooted in an assessment of what resources an entity can expend to advance equity at time of implementation. These differences affect which entities (schools, districts, or states) choose to implement a WSF formulae, which WSF formulae approach an entity selects, and how (or in what form) WSF formulae are ultimately implemented.

**WSF Implementation**

Districts implement different WSF formulae in different ways and, as a result, see various impacts on horizontal equity, vertical equity, and adequacy (J. G. Chambers et al., 2010; Hanushek, 2006; Malen et al., 2015; Odden & Picus, 2014). This disparity relates to the WSF model design or designs and the fidelity of the WSF implementation to its original design. WSF formulae at the local level are often operationalized as the fiscal equity component of site-based management (SBM) initiatives (J. G. Chambers et al., 2010; Foley et al., 2010; Ucelli et al., 2002). WSF formulae are conceptually distinct from SBM reforms in that WSF formulae do not include a range of goals beyond fiscal equity. Consequently, WSF formulae need not be a part of broader SBM reforms and can, theoretically, be implemented absent SBM reform (Frank, 2012; Ucelli et al., 2002). This section attends only to the implementation of WSF formulae and not other program or reform goals often intertwined with SBM initiatives.

Implementation of WSF formulae differs across institutions and reflects the values and priorities of the implementers. Indeed, WSF formulae are implemented based primarily on district-perceived areas of need and the amount of resources a district can
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(or is willing to) afford to allocate to schools (Levin et al., 2013; Malen et al., 2015).

Interestingly, no evidence exists to suggest that relative need WSF formulae are tied to or
rooted in a state’s costed-out funding system (in localities where the respective state has
an adequacy-based WSF formula). As a result, the reliance upon district-perceived need
in local WSF formulae implementation rather than absolute need (as with cost study-
based formulae) leads to disagreement regarding the selection of weighted groups and the
assigning of weights to those respective groups (Foley et al., 2010; Frank, 2012; Malen et
al., 2015; Miles, Ware, & Roza, 2003; Ucelli et al., 2002).

In addition, school finance literature suggests that WSF formula specification
often omits a variable complicit in advancing fiscal equity, namely, teacher salary (Baker
& Elmer, 2009; Levin et al., 2013; Malen et al., 2015). For example, the use of average
rather than actual teacher salaries can offset intended equity effects in WSF
implementation due to the uneven distribution of experienced teachers, but extant
research does not provide examples of WSF formulae that include mechanisms to offset
teacher distribution effects on school finance equity (Baker & Thomas, 2006; J. G.
Chambers et al., 2010; Doyle et al., 2012; W. D. Duncombe & Yinger, 1999; Foley et al.,
2010; Levin et al., 2013; Malen et al., 2015; Petko, 2005).

Implementation Challenges. Extant research documents a number of contextual
t_factors that circumscribe WSF formula implementation. In their analysis of a
contemporary WSF model implementation, Malen et al., (2015) group these factors into
three streams: technical, political and economic (p.18). The lack of technical expertise to
identify subgroups that cost more and to assign weights to those subgroups is consistent
across WSF formula implementation (J. Chambers et al., 2008; Doyle et al., 2012; Levin
et al., 2013; Malen et al., 2015). A lack of technical expertise is, by its nature, a design problem but also contributes to how an institution rolls out a WSF formula. Political considerations subsequently affect districts’ willingness 1) to fund the work to build more precise WSF models; and 2) to fully fund (or provide sufficient funds to) recommended weights (Malen et al., 2015). Malen et al., (2015) also note that political considerations can result in the use of limits to funding changes in order to make WSF implementation more palatable for local actors. The extent to which resulting resource allocation from WSF implementation may or may not lead to economic variation in school budgets can further result in modifications to WSF implementation that undermine the original formula (and its possible effects) (Malen et al., 2015).

WSF implementation rarely matches the design steps for district-level WSF formulae whether due to technical, political, and/or economic reasons. Indeed, WSF formulae implementation is not tied to educational costs as much as it is tied to district priorities, which may or may not conflict with programmatic or funding-related decisions that can advance district aims, particularly fiscal equity. As a result, advancing fiscal equity, in particular, can be suspect.

**Fiscal Equity**

The capacity of local WSF formulae to advance horizontal and vertical fiscal equity is, indeed, mixed (J. G. Chambers et al., 2010; Fahy, 2011; Foley et al., 2010; Malen et al., 2015), though the research base is limited. Some studies suggest positive, albeit marginal, horizontal and vertical equity effects resulting from WSF formulae implementation. For example, Miles and Roza (2006) found evidence of decreased variation in school funding, by student subgroup across schools in Houston, Texas—an
increase in horizontal equity. Similarly, Malen et al., (2015) found reduced per-pupil variation between schools in Prince Georges County, Maryland after implementing a SBM reform with a WSF formula. In addition, researchers found evidence of WSF formulae implementation resulting in increased per-pupil dollars for schools with, on average, higher need students in Texas, Ohio, California, Maryland, and Hawaii (a single, school district) (Baker, 2009; J. G. Chambers et al., 2010; Doyle et al., 2012; Levin et al., 2013). Specifically, these studies found a positive relationship between per-pupil funding and targeted student groups, broadly (Baker, 2009; Malen et al., 2015), per-pupil funding and high-poverty schools, specifically, (J. G. Chambers et al., 2010; Doyle et al., 2012), and per-pupil funding and student need (Levin et al., 2013)—all increases in vertical equity.

These positive equity findings are not without caveats. In particular, findings from Baker (2009) and Chambers (2010) challenge a causal link between WSF implementation and advancing equity. That is, both studies found that despite positive relationships between per-pupil allocations and targeted groups during WSF implementation, either other districts and schools outside the scope of WSF had stronger positive equity relationships or the positive equity relationships already existed prior to WSF implementation. Moreover, Malen et al., (2015) identified equity outcomes opposite the intended effect wherein more per-pupil funding, on average, went to schools with above average amounts of academically proficient students.

In sum, WSF formula implementation and respective challenges to implementation appear to inhibit the capacity of WSF formulae to advance fiscal equity, particularly vertical equity and adequacy conceptions.
Critique

Malen et al (2015) note that valid weights, the power of those weights (the dollars and/or resources tied to the weights), and the consistency of the weights’ implementation drive the capacity of a weighted-pupil unit funding system to advance fiscal equity (pp. 22). However, in practice, using a WSF approach that is not tied to educational outcomes can lead to a potentially crippling consequence: formula weights may not, ultimately, be based upon any empirical measure of student need but rather a cursory examination of district goals and/or readily available data (Malen et al., 2015). Indeed, existing district-level WSF designs lack a systematic or empirical approach to determining valid weights or allowing for nuanced funding allocations between schools with differing populations and population concentrations. Further, research related to the political, economic, legal, conceptual, and technical context around WSF formula implementation casts doubt on whether and to what extent a district can meet the assumptions required to design and implement a WSF model that advances any type of fiscal equity.

The contextual factors that impede formula implementation and implementation fidelity are difficult to attend to systematically. Context matters and these will necessarily vary with each different WSF initiative. However, attempts to enhance WSF design may be one avenue for more systematic calculation of weights and, as a result, increasing the capacity of these initiatives to advance fiscal equity, particularly horizontal and vertical equity.

Discussion: A New Conceptual WSF Funding Model

The extant literature related to district-level WSF formulae is clear: WSF models that districts currently use establish, for a range of different reasons, a weight—or
weights—that corresponds to one group of students (or to particular student characteristics), apply that weight universally across a district, then attempt to allocate funding according to that weight. In order to foster more nuanced funding distributions, a funding model calculated at the school-level (rather than the district level) with weights that vary across schools based on school-level need may offer a better approach to resource allocation within a district.\(^4\) In its broad, aggregate form, the functional form of the funding model is similar to other WSF models in that the model uses weights as a multiplier for particular student populations and a pre-determined dollar amount as the foundation funding to set equal to 1.0 (e.g., a weight of 1.0, or an average student with no extra need = $X,XXX.XX). The foundation dollars are key to the funding formula. They are the dollar multiplier for the formula weights and are the mechanism that transforms the formula from numerical data to dollars. Written mathematically, this general funding model is:

\[
Y_{\text{school}} \frac{\text{averagePPdollars}}{\left(\frac{(BW \times BW_{\text{students}}) + (PW \times PW_{\text{students}}) + (ESOLW \times ESOL_{\text{students}}) + (EGW \times EGW_{\text{students}})) \times FD}{TE}\right)}
\]

where:

\(BW = \text{Base Weight}\)

\(PW = \text{Performance Weight}\)

\(ESOLW = \text{ESOL Weight}\)

\(EGW = \text{Early Grade Weight}\)

\(FD = \text{Foundation Dollars}\)

\(TE = \text{School-Level Total Enrollment}\)

\(Students = \text{students eligible to receive respective weight}\)

\(^4\) This funding model specifically attempts to advance horizontal and vertical equity concepts because it assumes a district is not/has not undertaken a full adequacy cost study.
The fundamental difference between this funding model and traditional, district-level WSF models is the components within the formula. Whereas traditional WSF models employ weights that are the same for each school, this model relies on weights that differ across schools. In this section, I describe the conceptual approach to this new funding model design.

**Base Weight**

The primary component of a WSF formula is most often a base weight of some kind that drives the largest portion of resource allocation in the formula. The first step to calculating the base weight is to standardize the relevant data that will be included in the school-specific base weights (general formula in equation 2a). In this model, we use non-school based program costs (NSBP), which are central office dollars that flow to schools for programs outside the scope of the weighted-student funding model; and we use actual teacher salaries (ATS).\(^5\)

\[
ATS = \frac{SchoolAverageSalary - \mu_{DistrictSalary}}{\sigma_{DistrictSalary}}
\]  

For example, to calculate the standardized actual teacher salary value (equation 2b), subtract the mean district salary from the school-level salary average and divide by the standard deviation of district average salaries.

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\(^5\) Extant WSF literature posits that teacher distribution patterns can offset potential equity gains from funding models. That is, some schools, usually schools that enroll, on average, larger proportions of high-needs students, will overpay for teachers because they are more likely to have staff who are, on average, less experience (and who are paid less), than schools who enroll, on average, smaller proportions of high-needs students (J. G. Chambers, Levin, & Shambaugh, 2010; Education Trust West, 2005; Malen, Dayhoff, Egan, & Croninger, 2015).
The base weight is then calculated separately for each school within a district and is a function of the standardized values from equation (2a). Mathematically, a school’s base weight is the sum of the standardized values from equation 2a and one multiplied by -1 (see equation 3, below).

\[ NonNormedBW = (1 + NSBP + ATS) \times (-1) \]  

We begin equation 3 with a value of one to ensure that each school starts with a base value of 1 and we multiply the sum by -1 in order to ensure that schools with more need have a positive value and that schools with less need have a negative value. To complete the base weight calculation, we normalize the value from equation 3 for each school using the formula:

\[ BW = \frac{NonNormedBW - \min(NonNormedBW)}{\max(NonNormedBW) - \min(NonNormedBW)} \]

The final base weight values drive an adjusted foundation dollar amount for each school that reflects systemic inequities resulting from dollar and staffing distributions outside the control of the school (and, in some cases, district).

**Base Weight Adjustments.** School districts and/or model designers can then adjust the base weight depending upon available resources and on the amount of those resources the district wants to allocate as part of the base weights rather than other, more targeted, weights. In order to make adjustments equitable and to maintain the relative distance between each school’s base weight, designers should employ a base-ten logarithmic transformation to the data. Base-ten logarithmic transformations are useful in this situation because the base weights are multiplicative rather than additive, because
resultant values will maintain their relative intervals between each other, and because the transformation will reduce variation in the base weight, mute base weight values, and resultanty bring down the cost of the base weight equitably across schools.

**Performance Weight**

The dynamic weight WSF model utilizes a similar approach to the performance weight as with the base weight. District officials should select the components of the performance weight based on school district priorities and the types of need they most want to target in their funding model. Fiscal equity advancement is measured against the question of equitable for whom and the performance weight identifies for whom a school district is seeking greater fiscal equity. Using equations 2a and 4a, we first calculate the standardized value for each performance weight component and then normalize each component. Because indicators are normalized individually, the final step to the performance weight calculation is to sum the normed need indicators from equation 5, and calculate the mean of those indicators by school.

\[ PW = \mu_{School} (\Sigma NormedNeedIndicator) \]  
\[ (5) \]

The performance weight calculation captures the relative need (according to district-identified priorities) value. The number of students who are eligible for that performance weight captures the concentration of need. The eligible students value is the average proportion of students in a given school scoring below a given threshold (to be defined specifically by a school system) across all measures incorporated into the performance weight as a proportion of the total enrollment. Mathematically, that is:

\[ PW_{Students} = \left( \frac{n_1 + n_2 + n_-}{\Sigma n} \right) \ast TE \]  
\[ (6) \]
where \( n \) refers to the proportion of students identified as high-need for each metric in the performance weight component (e.g., a low SAT score). Once you calculate the average proportion of students identified as in need of support across all of the selected assessments/data points in the composite performance weights to identify the concentration of need, multiply the value by the total enrollment to get the number of weight-eligible students.

**Additional Weights and Adjustments**

Ad hoc and additional district priorities can drive the implementation of additional supplemental weights, which can be either static or dynamic. For example, a school district wishing to target programs for early learners may add an early grade weight. Similarly, district may create weights for ESOL, Special Education, or other categories of student characteristics that correspond to federal monies.

**Fitting the formula into a fixed allotment.** Adjusting the final model to fit resource constraints and mute year-to-year school-level per-pupil dollar change may be necessary for districts with limited resources or with fixed pots of money in their WSF school allocation budget. The approach to setting a specific per-pupil dollar change between fiscal years requires three steps: 1) Standardize the initial per-pupil dollar change between the prior year and current year using equation 2a, 2) normalize the data using equation 4a, and 3) scale the data to fit into the desired range using equation 7, below.

\[
PP_{dollar\Delta_{Adjusted}} = \frac{(X-0)\times (NewMax-NewMin))}{(1-0)\times (NewMin))}
\]

In equation 7, ‘newmax’ and ‘newmin’ refer to the desired maximum and minimum values into which the data will scale. This process allows users to reduce unwanted skew
and variation in per-pupil dollar distribution and maintain intervalllic relationships within the data.

**Conclusion**

The dynamic-weight system posited in this paper is not without flaws. This WSF model approach relies on district-defined priorities rather than cost-study determined weights that are tied directly to student outcomes. Indeed, this dynamic-weight approach targets fiscal equity concepts of vertical and horizontal equity with the assumption that advancing these equity concepts is one of many levers that may ultimately advance equity in the distribution of student outcomes. Moreover, this funding model is susceptible to the same technical, political, and economic factors that circumscribe traditional WSF models. Regardless, districts continue to implement WSF formulae despite mixed evidence as to their effectiveness and a host of challenges that impede optimum formulae implementation. These challenges, which include limited resources, competing perspectives about WSF aims, and the overarching school finance trend toward equilibrium in the face of persistent residential (and therefore wealth) segregation, do not change statutory requirements for equitable educational services.

Consequently, researchers will continue to employ methods and approaches to WSF formulae design and implementation. This research exposes potential weaknesses in contemporary methods and illuminates windows into potential pathways forward in WSF research and practice. WSF formulae are here to stay, but their design and implementation must evolve to meet their equity potential.
Works Cited


