A Validation Study of the Oklahoma Education Funding Formulae Weights

Full Report
ISEF – 003FR

Jeffrey Maiden, Ph.D.

Senior Researcher and Director
Institute for the Study of Education Finance

Professor of Educational Administration, Curriculum and Supervision
University of Oklahoma

maiden@ou.edu

Note: The original unpublished report was submitted to the Cooperative Council for Oklahoma School Administration, the Oklahoma Education Association, Oklahoma State School Boards Association, and the United Suburban Schools Association in November, 2001 (Maiden, 2001).

A Validation Study of the Oklahoma Education Funding Formulae Weights

Preface

This study was made possible by a grant funded by the Cooperative Council for Oklahoma School Administration, the Oklahoma Education Association, Oklahoma State School Boards Association, and the United Suburban Schools Association. The author is grateful for the support of these organizations as well as the Oklahoma State Department of Education and several Oklahoma school districts that provided data to support the study. The report in its entirety is the result of the work of the author, and does not necessarily express the views of any of the supporting organizations.

Table of Contents

List of Tables

A Validation Study of the Oklahoma Education Funding Formulae Weights

Introduction

The thrust of this study was to provide comparative cost estimates among the various categorical weights imbedded in the formulae utilized to distribute state aid to Oklahoma school districts. The goal was to estimate the extent to which current weights utilized in the formulae accurately represent the costs of educating students, and if not, to recommend alternatives given the cost estimates. The study focused on the following weighting systems:

Grade level weight
Pupil category weight
Transportation per-capita allowance and transportation factor
District small school weight
District sparsity-isolation weight
Teacher index

The findings are intended to guide policy-makers who are responsible for reviewing and maintaining the formulae, bearing in mind the social demands that undergird the existence of such formulae. It is important to note that the results provide data to inform decision making, and that these data are based strictly on cost estimates. Any given estimate should be considered in context, because the thrust of this study was to provide relative *cost* estimates. The fact that educating student *x*, who has a specific set of educational characteristics, may cost proportionally more than educating student *y* does not in itself imply this additional cost should be the lone factor in determining the formula weight for student *x*. Other considerations, such as a perceived need to invest more resources to buttress the education of students with characteristics similar to student *y*, should bear upon the decision-making process. Nevertheless, the relative costs of educating these students might provide useful information as policy makers examine the funding formulae.

These weights have a substantial impact on the revenue received by Oklahoma school districts from the state. Nearly one-third (32.23 percent) of weighted average daily membership (ADM) for the fiscal years in the study was attributable to the funding weights (the remaining 67.77 percent was attributable to unweighted ADM). Clearly, these weights have a profound impact on local school district funding.

What is the rationale for the inclusion of the weights in the distributional formulae? The answer is deeply rooted in fiscal equity, an economic (and social) construct that in simplest terms refers to providing a level playing field (financially) for public school students. The ideal fiscal equity condition is one in which the resources supporting the education of any child should not be a function of factors beyond his or her control. Fiscal equity has a rich foundation of research literature that defines, conceptualizes, measures, and/or applies the construct to various contexts (Adams & White, 1997; Burke, 1999; Dayton, 1998; Fastrup, 2002; Fox, Murray, & Price, 2002; Hartman, 1994; Ladd and Hansen, 1999; Maiden & Wood, 1995; Owens & Maiden, 1999, Verstegen, 1994; & Verstegen, 2004). Education funding mechanisms have been designed and utilized in the various states that, to a certain extent, endeavor to alleviate economic or social conditions (outside the control of students) that tend to be naturally unequal. Examples of these localized conditions include insufficient local tax bases, population diseconomies of scale, and the existence or relatively high populations of economically disadvantaged students. The Oklahoma formulae used to distribute state financial resources to local school districts are intended to help ensure fiscal equity among these districts. A brief description (more conceptual than technical) of the Oklahoma education funding formulae may be useful in understanding context.

Formula Description

The ultimate responsibility for providing and funding public education rests with the state, according to the Oklahoma Constitution (Ok Const.). Specifically, the document decrees that "[t]he Legislature shall establish and maintain a system of free public schools wherein all the children of the state may be educated (Ok Const. art. XIII sec 1)," and provides the Legislature the authority to establish appropriations to financially support education (Ok Const. art. XIII sec 1a.). Though equalization of funding among districts is not required by the Oklahoma Constitution, the Oklahoma Legislature has established as a goal the maintenance of a degree of inter-district funding equity, as specified in state statute (Ok Const. art. XIII sec. 1a.).

To this end, the state has utilized a two-tiered equalization education funding formula system since 1981. The equalization components of the Oklahoma education funding system include a foundation formula, a transportation supplement to the foundation formula, and the second tier salary incentive aid (a modified guaranteed yield formula).[1]

Similar to other state finance distribution systems, the Oklahoma system is enrollment driven. Both the foundation formula and salary incentive aid are based on weighted average daily membership (ADM). The ADM for the foundation and salary incentive aid formulae are weighted according to four criteria: grade level, pupil category, the district calculation (small school and district sparsity-isolation), and the teacher index.

Grade level and pupil category weights are intended to reflect variant programmatic costs, typical of state weighting systems. The weighted district calculation is designed to assist small and isolated districts facing relatively higher per-pupil costs due to diseconomies of scale. Basically, eligible districts are categorized into one of two weighting adjustments. The small school district weighting provides supplemental funding for any district that has a low ADM, while sparsely populated districts are eligible for a supplemental weighting through the district sparsity-isolation factor. The teacher experience and degree calculation are used as an additional weighting factors, giving districts the fiscal incentive to hire more experienced and educated teachers.

The foundation program for a given local district includes a legislatively determined statewide base support factor multiplied by the district's weighted ADM. The foundation program income for the district, consisting of revenues derived from a variety of sources, is subtracted from this product. Two of these foundation program chargeables are derived from property taxation. The first of these consists of a local district 15-mill tax levy, based on an annual certification of need for each school district submitted to the respective county equalization board without a vote of the electorate. The millage rate is applied to net assessed valuation in the district from the preceding fiscal year. The second property tax component includes 75 percent of actual collections in the district from a 4 mill countywide levy received from the preceding fiscal year.

The remaining components of the foundation program income are derived from state dedicated revenues from several sources. A certain percentage of revenue derived annually from each of these sources was earmarked for the financial support of common education. These sources include motor vehicle collections, gross production tax revenues, rural electrification tax revenues, and school land earnings. The subtraction of the foundation program income from the total foundation program results in state foundation aid to the district. State appropriated aid to school districts is therefore disbursed in inverse proportion to local ability to raise revenue.

Districts are also provided a transportation supplement to the foundation program. The transportation supplement is calculated by multiplying average daily haul (ADH) by a per-capita transportation allowance and then multiplying this product by a transportation factor. ADH for a district represents the number of students legally transported who live at least one and a half miles from school. The transportation supplement provides general aid intended to supplement local district transportation costs, though the dollars provided to districts constitute general rather than categorical aid.

The salary incentive aid component of the Oklahoma funding system, basically a guaranteed yield formula, constitutes a second tier resource equalization program. The local portion of the program is derived from an annual levy of a maximum 20 mills for each local district, from three property tax sources. The state annually guarantees a certain dollar amount per weighted ADM (the incentive aid guarantee) for every mill levied up to 20. The ADM is weighted according to grade level, special education, district size or sparsity, and the teacher index, identical to the foundation formula.

The foundation and salary incentive aid constitute a two-tiered system of general equalization aid from the state to local school districts in Oklahoma. Studies have demonstrated that the formula has distributed monies in such a way as to fiscally equalize across districts, or at least to distribute funding in such a way as to alleviate disequalizing effects. In fact, studies have shown that the formula has evolved in such a way as to increase interdistrict fiscal equity (Maiden, 1998; Deering & Maiden, 1999). Such equalizing effects assume, however, that a fundamental component of formula calculation (weighted membership) is valid. The current study is designed to assess the validity of the weighting systems utilized in the formulae.

Estimating Costs

A central feature of an assessment of the validity of funding weights is to estimate the costs associated with the students, teachers, or districts that these weights represent. Though various economic models are available to assess and estimate contextual costs, the Resource Cost Model (RCM), focused primarily on estimating the costs of educating special education students, has been widely used in a variety of state settings (Brewer, Krop, Gill, & Reichardt, 1999; Chambers, 1999a; Chambers, 1999b; Fowler & Monk, 2001; Parrish, Gerber, Kaleba, & Brock, 2000). Like other economic cost estimating models, the RCM includes a holistic approach to ascertaining the amount of teaching and support resources needed to provide a certain level of education to a particular student, addressing the student's unique educational needs. The model focuses on estimating the teaching costs for students, then using a variety of data (often derived from accounting systems) to estimate non-teaching costs. Although these estimation procedures have been used primarily to estimate special education costs (both absolute dollar costs as well as costs relative to general education), the methodology may be modified to estimate costs in order to compare other facets of cost weighting, such as grade level.

Although, theoretically, cost is an economic concept while expenditure is an accounting concept, expenditure data may be useful in estimating costs (and, in fact, these data are used as part of the RCM approach). Often, cost estimates based on these economically based models have correlated highly with estimates based on *expenditures*. Intuitively, costs drive expenditures, and expenditures are a mechanism by which educational experts (those in the field who bear responsibility for specifying expenditures) recognize and ascribe fiscal value to the costs of educating children. Typically, state accounting systems may be *cost* accounting systems, with emphasis on the cost elements of educational programs. These systems may provide a resourceful mechanism for providing a picture of the relative costs of education students across a range of student-centered categories and characteristics of school districts.

The current study bases cost estimates on expenditures. To check the validity of these estimates, traditional cost estimates that utilized a modified RCM procedure were also calculated. The cost data used in the RCM analysis were generated by the Personnel reports, class size reports, and Oklahoma Cost Accounting System data provided by the Oklahoma Department of Education. Additional district field data were collected. The RCM analysis included a stratified sample of 100 districts across the state. Further, field data about class size, student classifications, and salaries and stipends collected and used in the analysis. Districts in the sample were stratified according to district student population (including districts with less than 100 students and one of the two urban school districts) and geography (all four quadrants of the state were represented).

The primary purpose of the modified RCM analysis was to check the validity of the cost estimates based on expenditures. Overall, there was a statistically significant direct relationship between the RCM cost estimates and the cost estimates based on expenditures.[2] The results of the comparison indicated that estimates based on the RCM procedure were not significantly different from those expenditure generated cost estimates. The assumption follows that expenditures provide valid cost estimates. The cost estimates reported in this study, therefore, are expenditure based. The rationale for utilizing cost estimates based on expenditures rather than those derived through the RCM (or other economic cost models) includes the following:

> Expenditure data are more readily available, providing ease of conducting follow up studies;
> The substantial size of the expenditure database results in increased reliability of the cost estimates;[3]
> The expenditure data have been validated by the State Department of Education;
> The expenditure based estimates are equivalent to the economic cost-based estimates (statistically), as indicated in the analysis of the current study.

Clearly, a potential pitfall of utilizing expenditure data to estimate costs is inconsistencies in account coding practices. Statistically, it was assumed that such inconsistencies were randomly distributed across districts and across weights, and that the overall results were not biased. The following sections describe the estimating procedures and concomitant results for each of the individual weighting systems.

Grade Level Weight

If the purpose of a weighting system based on student grade level is to match the weight to the costs of educating the students across the grade levels, then it is critical that these weights truly reflect the costs. If the costs associated with educating a secondary school student is 20 percent higher than the costs associated with educating a student in fourth grade (assuming that other student and district characteristics are equivalent), then the weight should reflect this 20 percent disparity. The specification of the appropriate weight is critical because concept of fiscal equity. In the condition cited above, if the funding associated with this student were less than that 20 percent dictated by the additional costs, then districts with a relatively large proportion of secondary students would be financially penalized when compared to districts with fewer secondary students. Ultimately, such a situation would result in an under funding of the education of students residing in these districts with larger proportions of secondary students, which would be fiscally inequitable.

To reflect these variances in costs, grade level weights are commonly utilized in state education funding systems. Twenty-five (half) of the states include grade level weighting as part of distributional formula calculation (Dayton, Holmes, Sielke, & Jefferson, 2001). In Oklahoma, grade level weight is a substantial part of the weighting mechanism, representing 11.58 percent of total weighted ADM in fiscal years 1998 to 2000.

To validate the grade level weight, as much of the structure of the current weighting system as possible was included in the analysis. Grade level weighting categories that existed during the time represented by the data was kept intact (including both half- and full- time pre-kindergarten and kindergarten). The fourth through sixth weight was maintained at 1.0, consistent with the current system (the number is arbitrary; weights at other grade levels are simply compared to this criterion in a relative context).

Because the grade level weight is student based, the cost estimates were based on pupils as the unit of measurement. Costs were categorized into two components: 1) per-pupil costs directly related to teaching, and 2) per-pupil non-teaching costs. The cost estimate was simply a sum of these two components. Because the funding formulae are designed to distribute general revenues to support current school operations, the analysis did not include an estimate of capital costs.

The data used in making the estimates were derived from the class size reports, the personnel reports, and the Oklahoma Cost Accounting System. Estimating the amount of teaching resources basically included the matching of students to teachers using the class size reports, supplemented by the calculation of salaries, benefits, and stipends from a combination of the personnel reports and data derived from the OCAS. For each district, an average per-pupil cost of providing teaching services for each of the current grade level categories (used in fiscal years 1998 through 2000) was estimated.

An average per-pupil non-teaching cost was then estimated for each of the current grade level categories for each district. Estimating non-teaching resources was not as precise, requiring that certain assumptions be incorporated into the estimation procedure. In some instances, coding was available to directly match costs to particular grade levels. In the absence of coding, the assumption was that resources were provided in an even distribution, on a per-capita student basis. Statistically, is assumed that coding irregularities were randomly distributed across school districts in such a way as to not bias the resultant cost estimates.

The teaching and non-teaching per-pupil cost estimates were combined then weighted according to district raw ADM for that year. The final cost estimate for each grade level category included the overall mean per-pupil cost across all districts (weighted by ADM) and across the three fiscal years used in the analysis. Each cost estimate was then compared, as a percentage, to the estimate of the 4^{th}, 5^{th}, and 6^{th} grade overall cost estimate.

Table 1 includes the cost estimates across the grade level categories. The current formula weights are imbedded in the middle column, with the cost estimated weights in the right column.

Table 1

Grade Level Weight Results

Grade	Formula Weight	Cost Estimate
PK Half	0.7	0.7505
PK Full	1.3	1.1612
KG Half	1.3	0.7536
KG Full	1.3	1.2130
1st 2nd	1.351	1.1139
3rd	1.051	1.1098
4th 5th 6th	1.0	1.0000
7th – 12th	1.2	1.3079

For each of the weights analyzed, a dependent samples t-test was used to determine if there was a statistically significant difference between the weight currently imbedded in the formulae and the weights resulting from the cost estimations. In each of the categories, there was a statistically significant difference between the current weight and the weight based on the cost estimate.

It should be noted that because of the enormity of the database used in the analysis, confidence intervals were extraordinarily small, and even a slight deviation (such as PK half, with a .0505 difference between the formula and estimated weight) demonstrated statistical significance. Policy makers may wish to examine the results considering *practical*, rather than *statistical*, significance.

The general trend indicated in the results indicate that current weights tend to inflate the amount of revenue generated for early childhood and elementary students while generating revenues that do not match the cost requirements of educating secondary students. Each weight used in the formulae up to and including third grade is higher than the cost estimate with the exception of half-time pre kindergarten. Conversely, the seven through twelve cost estimated weight is over one-tenth higher than the formula weight (1.3079 estimated versus 1.2 current weight).

It should be emphasized that these estimates are strictly reflective of relative *costs*. Does the current study does support the conclusion that increased financial investment into secondary schooling at the expense of early childhood education is more pedagogically sound, or that depleting the critical resources required by early childhood educators is wise policy? Certainly not! The results simply indicate that the secondary costs are greater (and currently underweighted).

Pupil Category Weight

Using funding weights to assist local school districts with extraordinary costs of educating special needs students is commonly utilized in state funding mechanisms. State education formulae of 23 states include funding weights to address extra costs of special education students (Dayton, Holmes, Sielke, & Jefferson, 2001). In Oklahoma, pupil category weights accounted for a substantial proportion of weighted ADM during the fiscal years included in the study. Together, this weight constituted 17.63 percent of weighted ADM during fiscal years 1998 to 2000, specifically as follows:

- Gifted weight 2.73 percent;
- Bilingual weight 0.92 percent;
- Economically Disadvantaged weight 8.07; and,
- Special education weighting (combined) 5.91 percent.

If the purpose of a weighting system based on student category is to reflect the relative costs of students across these categories, and further to match the financial needs of the students to the concomitant formula funding weight, then it is critical that these weights truly reflect the costs. If the costs associated with educating a student identified as having a speech impairment is 5 percent higher than the costs associated with educating a student without such identification (assuming that other student and district characteristics are equivalent), then the weight should reflect this 5 percent disparity. The specification of the appropriate weight is critical because concept of fiscal equity. In the condition cited above, if the funding associated with this student were less than that 5 percent dictated by the additional costs, then districts with a relatively proportion of these exceptional students would be financially penalized when compared to districts with fewer special needs students. Ultimately, such a situation would result in an under funding of the education of students residing in these districts with larger proportions of special needs students, which would be fiscally inequitable.

Because the pupil weight is student based, the cost estimates were based on pupils as the unit of measurement. The exception was the economically disadvantaged weight, which because of lack of detail included district aggregate estimates. For each of the categories except economically disadvantaged, costs were categorized into two components: 1) per-pupil costs directly related to teaching, and 2) per-pupil non-teaching costs. The cost estimate was simply a sum of these two components. Because the funding formulae are designed to distribute general revenues to support current school operations, the analysis did not include an estimate of capital costs.

The data used in making the estimates were derived from the class size reports, the personnel reports, and the Oklahoma Cost Accounting System. Estimating the amount of teaching resources basically included the matching of students to teachers using the class size reports, supplemented by the calculation of salaries, benefits, and stipends from a combination of the personnel reports and data derived from the OCAS. For each district, an average per-pupil cost of providing teaching services for each of the current pupil categories (used in fiscal years 1998 through 2000) was estimated.

Additionally, an average per-pupil non-teaching cost for each district was estimated for each of the current pupil categories. Estimating non-teaching resources was not as precise, requiring that certain assumptions be incorporated into the estimation procedure. In some instances, coding was available to directly match costs to particular pupil categories. In the absence of directly linked coding, the assumption was made that the distribution of costs was partly per capita and partly per category. Accordingly, half of the unidentified costs were allocated on a per pupil basis among the pupils of pupils served in the particular category in the given district, and half were allocated across the pupil categories extant in a given district. Statistically, it is assumed that coding irregularities were randomly distributed across school districts in such a way as to not bias the resultant cost estimates.

The teaching and non-teaching per-pupil cost estimates were combined then weighted according to district ADM for that year. The final cost estimate included the overall mean per-pupil cost across all districts (weighted by ADM) and across the three fiscal years used in the analysis. A final cost estimate was calculated for each of the pupil categories (with the exception of economically disadvantaged) utilized in the formula during fiscal years 1998-2000. The overall cost estimate was then compared to the estimated mean overall cost of uncategorized students. The result was a percentage, or weight, representing the estimated excess costs associated with educating students (on average) in that particular category.

The economically disadvantaged weight was not estimable on a per-student basis because of the lack of specific reporting. In fact, neither the field data nor the expenditure data provided the detail necessary to estimate the economically disadvantaged weight in the same manner as the other pupil category weights. Therefore, out of necessity, this weight was estimated on an aggregated, district level basis. Controlling for the revenues generated through the existence of the current economically disadvantaged weight, the costs per pupil of educating students across districts were estimated. A multiple regression analysis was utilized with the estimated per-pupil costs as the dependent variable, the number of unweighted ADM as one of the independent variables, the number of students identified as economically disadvantaged as the second independent variable, and the revenues generated by the current economically disadvantaged weight as an independent control variable. The weight estimated by the study was simply the ratio of the second to the first independent variable, representing the per district excess costs of educating economically disadvantaged students. While lacking the amount of precision noted in the estimates of the other pupil category weights, the number of economically disadvantaged students across districts was significantly related to average district per-pupil costs.

Table 2 includes the cost estimates across the pupil categories. The current formula weight is imbedded in the middle column, with the cost estimated weight in the right column.

For each of the weights analyzed, a dependent samples t-test was used to determine if there was a statistically significant difference between the weight currently imbedded in the formulae and the weights resulting from the cost estimations. In each of the categories, there was a statistically significant difference between the current weight and the weight based on the cost estimate.

Table 2

Pupil Category Weight Results

Category	Formula Weight	Cost Estimate
LD	0.4	0.3587
HI	2.9	2.5121
VI	3.8	2.4281
MH	2.4	3.4346
SI	0.05	0.2510
Bilingual	0.25	0.1204
TBI	2.4	2.8984
Autism	2.4	2.2592
MR	1.3	1.3824
ED	2.5	1.6604
PH	1.2	1.1294
Gifted	0.34	0.3305
D/B	3.8	4.5298
Econ Disadvantaged	0.25	0.1105[a]

[a]The economically disadvantaged weight is based on aggregated district level data. Other weights are basec level cost estimates.

Additionally, a single-sample t-test was used to test the estimated cost-based weight for each category against a criterion of zero (because pupil category is an add-on weighting system) to provide statistical evidence in support of including the weight. In each category, the estimated additional costs were significantly higher than zero.

Again, policy makers may wish to examine the results considering *practical* rather than *statistical* significance. The enormity of the amount of data resulted in exceptionally narrow confidence intervals, and statistically significant differences between the estimated weights and the actual weights were observed even in those cases where the deviations were superficially quite small. Many of the estimated weights did not deviate widely from the current weight (for example, the LD, Autism, MR, PH, and Gifted estimates). Conversely, in some instances the estimated weight varied dramatically from the current weight For example, the SI weight was estimated to be higher than the current weight by a factor of more than 5, while the Bilingual and Economically Disadvantaged weights were estimated at less than half of the current formulae weights.

Again, proper perspective is necessary in examining the results of the pupil category analysis. These estimates represent the excess costs (expressed as a proportion) incurred, on average, in educating pupils in the category. The results should not be interpreted as supporting the need for either increased or decreased financial investment in any of the pupil categories.

Transportation Supplement Weights

The transportation supplement to the foundation formula is based on average daily haul (ADH), defined in statute as the number of children in a district who are legally transported and who live one and one-half miles or more from school (Ok Const. 70 O.S. sec. 18-200.1(D)(2)(a)). The supplement provided to any given district in any fiscal year includes the product of the ADH, the transportation factor (currently 1.39), and the per capita allowance. The per-capita allowance is an equity adjustment that provides more sparsely populated districts (that, presumably, face higher per-pupil transportation costs) with higher levels of state fiscal support. The transportation factor has the effect of moderating the amount of state funding flowing through the supplement. The current study examined both the per capita allowance and the transportation factor.

The per capita allowance has the effect of distributing supplement aid to districts in inverse proportion to district density, with the underlying assumption that more sparsely populated districts face higher transportation costs. In order to produce results that matched as closely as possible the structure of the current allowance, the density categories were maintained. Individual district per-ADH transportation costs were estimated, based on data from OCAS for each of the three fiscal years included in the study (1998 through 2000). A simple linear regression analysis was utilized with the per-pupil (ADH) transportation costs specified as the dependent variable and the sparsity category as the independent variable. The resultant regression coefficient represented the estimated dollar amount increase (per ADH) related to a one step increase in the sparsity category. The regression coefficient was then applied to the original categories, with the lowest category (9.6668 or more) originating at the current level of 33.00, consistent with the current allowance structure.

Table 3 includes the per capita allowance estimates. The first and fifth columns represent the density categories, derived from the current structure of the supplement. The second and sixth columns include the current per capital allowance figures. The third and seventh columns indicated the estimates generated by the regression analysis. The fourth and eight columns include these same estimates in rounded format.

Table 3

Per Capita Allowance Results

Density Figure	Per Capita Allowance	Estimate	Estimate Rounded	Density Figure	Per Capita Allowance	Estimate	Estimate Rounded
.3000 - .3083	167	242.83	243	.9334 - .9599	99	136.20	136
.3084 - .3249	165	239.39	239	.9600 - .9866	97	132.76	133
.3250 - .3416	163	235.96	236	.9867 - 1.1071	95	129.32	129
.3417 - .3583	161	232.52	233	1.1072 - 1.3214	92	125.88	126
.3584 - .3749	158	229.08	229	1.3215 - 1.5357	90	122.44	122
.3750 - .3916	156	225.64	226	1.5358 - 1.7499	88	119.00	119
.3917 - .4083	154	222.20	222	1.7500 - 1.9642	86	115.56	116
.4084 - .4249	152	218.76	219	1.9643 - 2.1785	84	112.12	112
.4250 - .4416	150	215.32	215	2.1786 - 2.3928	81	108.68	109
.4417 - .4583	147	211.88	212	2.3929 - 2.6249	79	105.24	105
.4584 - .4749	145	208.44	208	2.6250 - 2.8749	77	101.80	102
.4750 - .4916	143	205.00	205	2.8750 - 3.1249	75	98.36	98
.4917 - .5083	141	201.56	202	3.1250 - 3.3749	73	94.92	95
.5084 - .5249	139	198.12	198	3.3750 - 3.6666	70	91.48	91
.5250 - .5416	136	194.68	195	3.6667 - 3.9999	68	88.04	88
.5417 - .5583	134	191.24	191	4.0000 - 4.3333	66	84.60	85
.5584 - .5749	132	187.80	188	4.3334 - 4.6666	64	81.16	81
.5750 - .5916	130	184.36	184	4.6667 - 4.9999	62	77.72	78
.5917 - .6133	128	180.92	181	5.0000 - 5.5000	59	74.28	74
.6134 - .6399	125	177.48	177	5.5001 - 6.0000	57	70.84	71
.6400 - .6666	123	174.04	174	6.0001 - 6.5000	55	67.40	67
.6667 - .6933	121	170.60	171	6.5001 - 7.0000	53	63.96	64
.6934 - .7199	119	167.16	167	7.0001 - 7.3333	51	60.52	61
.7200 - .7466	117	163.72	164	7.3334 - 7.6667	48	57.08	57
.7467 - .7733	114	160.28	160	7.6668 - 8.0000	46	53.64	54
.7734 - .7999	112	156.84	157	8.0001 - 8.3333	44	50.20	50
.8000 - .8266	110	153.40	153	8.3334 - 8.6667	42	46.76	47
.8267 - .8533	108	149.96	150	8.6668 - 9.0000	40	43.32	43
.8534 - .8799	106	146.52	147	9.0001 - 9.3333	37	39.88	40
.8800 - .9066	103	143.08	143	9.3334 - 9.6667	35	36.44	36
.9067 - .9333	101	139.64	140	9.6668 or more	33	33.00	33

The results were rounded to the nearest whole number to maintain consistency with the current formula designation. The results suggest that, as district sparsity increased the per capita allowance tended to under fund districts that faced higher per-pupil (ADH) costs related to the increased sparsity.[4]

The transportation factor, currently established by law at the level 1.39, has the effect of regulating the amount of money flowing through the transportation formula. For the current study, assessing the factor was a matter of exemplifying the value of the factor given certain assumptions about the proportion of transportation costs funded through the transportation supplement. Percentage levels of 50, 75, and 100 were arbitrarily specified, and the concomitant transportation factors simulated. It should be noted that these factor estimates are based on current formula per capita allowance figures. If these figures were modified, the transportation factor estimates would necessarily change.[5]

Table 4

Transportation Factor Results

Percent Transp. Costs from Supplement	Estimated Transportation Factor
23.9	1.39
50	2.95
75	4.12
100	5.89

These simulated factors are based on estimated transportation costs during fiscal years 1998 through 2000, and assume the current formula per capita allowances. Independent changes in either of the two transportation supplement elements would affect changes in estimates of the other.

Small School Weight

Weights designed to assist school districts serving small populations of students are based on the well documented phenomenon of diseconomy of scale (Alexander, 1990; Bass, 1990; Fowler & Monk, 2001; Fox, 1990; McLure, 1947; Tholkes & Sederberg, 1990). Providing educational services in small districts are costlier, on a per-pupil basis, than in larger districts. Without additional support from the state (through a weight, for example) an inequitable condition affecting students served in smaller school districts naturally occurs. In addressing this naturally occurring inequity, several state education funding formulae include weights or other mechanisms that provide additional financial support to small and/or sparsely populated districts (Dayton, Holmes, Sielke, & Jefferson, 2001).

The Oklahoma funding formula small school supplement is calculated as follows:

$$W = ((529 - ADM) / 529) * .2 * ADM$$

Where

W = the per student weight;

ADM = the same year raw ADM of the district

Clearly, any district with an original ADM of 529 or more would generate a funding weight of zero. The current study examined two elements of the small school weight. First, the criterion used to qualify districts for the weight (ADM of 529) was examined in an attempt to ascertain its validity as a line of demarcation between districts operating at a diseconomy and other districts. Second, the validity of the constant of .2 used in calculating the small school weight was assessed.

The small school weight is based on district rather than individual student qualification, and the current study included aggregated district per-pupil costs as the object of measurement. These costs were estimated utilizing the Oklahoma Cost Accounting System, and were restricted to those traceable to the funding formulae.[6] Additionally, the revenues generated through the current small school supplement were statistically controlled.[7]

To test the validity of the 529 small school weight qualification criterion, the controlled per-pupil costs of districts with ADM of less than 529 were compared to districts with populations of 529 and greater. These costs were calculated for each district in each of the fiscal years 1998 through 2000, and then aggregated across the two comparison categories. The results indicated that those districts currently qualifying for the small school weight faced significantly higher per-pupil costs than districts in the latter category.[8] The statistical evidence, therefore, supports the validity of 529 ADM as district eligibility criterion. This analysis, however, did not endeavor to explore whether 529 ADM is the *optimum* line of demarcation.[9]

To estimate the validity of the constant used to calculate the weight (specified as .2 in the current formulae), the aggregated estimated controlled per-pupil costs across the two categories were compared. The percent difference between these across category costs was .1425. Districts serving student populations of less than 529 ADM were subject to per-pupil costs that were, on average, 14.25 percent higher than districts serving student populations of 529 or greater. The results of the district sparsity-isolation weight, included in the following section, generate additional findings germane to the district small school weight.

Table 5

Small School Weight Results

	Current	Estimated
Criterion (raw ADM)	529	529 is valid[a]
Formula Constant	.2	.1425

[a]Refer to Table 6 for an additional estimate

District Sparsity-Isolation Weight

The rationale supporting a sparsity weighting system is similar to that of the small school weight, to alleviate inequities based on diseconomy of scale. However, the literature dealing with small and rural schooling does not present as dramatic empirical evidence supporting the reality of a sparsity-based diseconomy as with the diseconomy based on size.

Bearing the greater evidence in support for size diseconomy, at an intuitive level it may be possible to explain diseconomy based on isolation at least in part because of district size. Districts in sparsely populated areas tend also to serve smaller student populations. This assumption was tested in the analysis of the district sparsity-isolation weight in the current study.

The first part of the analysis included a statistical assessment of the extent to which districts qualifying for the isolation sparsity weight faced higher per-pupil costs compared to other districts. The procedure was equivalent to that utilized in assessing the district small school weight. Namely, overall per-pupil costs were estimated using expenditure data, aggregated at the district level across the three fiscal years used in the study.[10] A multiple regression analysis was conducted with *per-pupil costs* specified as the dependent variable, *district qualification* as the first independent variable (0 for non-qualifying districts, 1 for qualifying districts), and the *revenues* generated through the current isolation weight as the independent control variable.[11] Similar to the findings of the district small school weight, those districts identified as isolated faced higher estimated per-pupil costs compared to other districts.

The results of this initial analysis support the existence of a diseconomy. The second part of the analysis included an assessment of the extent to which higher costs were truly related to these districts being in isolated or sparsely populated areas, or whether the higher costs were a function of a size diseconomy, a derivative of student population.

The second part of the sparsity-isolation analysis addressed this question, *was the diseconomy the function of district isolation, of number of students, or both*? The question was addressed by utilized the multiple regression analysis employed in the first analysis, except that the model was complicated by replacing the qualification independent variable with two independent variables. The first of these was population per square mile of the district, a statistic used in areal density calculation upon which district sparsity-isolation qualification is based. The second independent variable was raw ADM, an additional statistic used in calculating the weight. A third independent variable, district revenues generated through the current sparsity-isolation weight, was included as a control variable.

The results of the multiple regression analysis indicated no statistically significant relationship between per-pupil costs and population per square mile.[12] The results indicated, however, that per-pupil costs were significantly and inversely related to raw ADM.[13] Based on this analysis, there is empirical evidence in support of the diseconomy of scale being a function of district student population. Smaller districts face relatively higher per-pupil costs, but not population density.

Given the finding that the higher estimated per-pupil costs are related to a diseconomy of scale based on student population, the third analysis involved determining an optimum criterion level indicating the point at which districts might be eligible to receive a weight to alleviate the effects of the diseconomy. The finding generated by the small school weight analysis suggested that 529 is a valid, but not necessarily the optimum, criterion. Because the current findings suggested that districts qualifying for the sparsity-isolation weight face higher estimated costs than districts not qualifying for this weight, and because the majority of these districts had more than 529 raw ADM, it was deduced that the optimum criterion level is above 529.

In order to ascertain the optimum level of raw ADM, a series of independent samples t-tests were utilized at varying levels of raw ADM. The dependent variable specified in the t-tests was estimated district per-pupil costs across the three district years, and the independent variable was whether the district had a student population smaller or greater than the selected level of raw ADM. The goal of these t-tests was to find the point of inflection at which districts above that tested level of ADM faced statistically lower estimated costs than those districts with those districts below the ADM level.

The findings of the t-tests indicated an optimum criterion of 750 in ADM. There was a statistically significant difference in per-pupil costs between districts with less than 750 in raw ADM and those districts with 750 or higher raw ADM. The differences were not statistically significant in t-tests using criterion levels higher than 750 in raw ADM.

The t-tests results were checked by utilizing a series of multiple linear regression analyses, at these same various levels of raw ADM. Estimated per-pupil costs was specified as the dependent variable in each of the regression equations, while district raw ADM was specified as a dichotomous nominal independent variable (0 if less, 1 if greater or equal). The second independent variable included per-pupil revenues generated by the current sparsity-isolation weight, included for statistical control. The findings of the regression analyses fully support the findings generated by the t-tests. There was a statistically significant relationship between the primary independent and dependent variables using 750 raw ADM as the criterion of separation for the independent variable.

The final part of the district sparsity-isolation weight was to specify the magnitude of the estimated per-pupil cost difference between those districts above and below the calculated optimum criterion level of raw ADM. The aggregated estimated controlled per-pupil costs across the two categories (less than 750 raw ADM compared to greater than or equal to 750 raw ADM) were compared. The percent difference in estimated per-pupil costs was .1473. Districts serving student populations of less than 750 ADM were subject to per-pupil costs that were, on average, 14.73 percent higher than districts serving student populations of 750 or greater.[14]

Table 6 includes the results of the analyses of the district sparsity-isolation weight. Current features of the formulae are indicated in the middle column, and estimates based on the analyses are included in the right column.

Table 6

Sparsity-isolation Weight Results

	Current	Estimated
Qualification/calculation basis	Area/areal density	Student population (raw ADM)
Criterion (raw ADM)	none	750
Formula Constant	none	.1473

These findings suggest the need to reconsider the calculation of the two district weights. There is empirical support for expanding the small school weight and eliminating the district sparsity-isolation weight. Consistent with the findings presented here, a revised district calculation might be:

$$W = ((750 – ADM) / 750) * .1473 * ADM$$

Where

W = the per student weight;

ADM = the same year raw ADM of the district

Teacher Index

The teacher index weight is based on the credited experience and degree levels of teachers within a given district. Districts that employ teaching staff with above average levels of experience and with relatively more advanced degrees are provided additional financial support through the formulae. The teacher index weight constituted 0.92 percent of total weighted ADM in fiscal years 1998 to 2000, collectively.

Because the weight is calculated based on teachers in the various districts, the teacher was the unit of measurement in the analysis. The salary cost was estimated for each teacher, across the three fiscal years included in the study, based on the state personnel reports. A statistical relationship between teacher salary cost and the combination of experience and degree level was determined using a multiple regression analysis. The dependent variable used in the model was teacher salary cost (in dollars). The two independent variables included teacher experience (expressed as number of years) and teacher degree (dummy coded). The resultant standardized regression coefficients were then used to generate the teacher index estimates.

Estimates were made both across individual years' experience, providing greater detail than current categorization of the weighing system, as well as degree levels. The current weighting system specifies 1.0 at the 9-11 years' experience and bachelor's degree level. To maintain consistency with the current structure, the level of 10 years' experience (the median between 9 and 11) and bachelor's degree level was also set at 1.0 for the estimates. The standardized regression coefficient of the experience variable generated by the multiple regression analysis[15] was subtracted at each level below 10 years, and added to each level beyond 10 years. Likewise, the standardized regression coefficient of the degree level variable[16] generated by the multiple regression analysis was added across the degree columns at each experience level.

The resultant teacher index estimates are included in Table 7. The current index statistics are in the four columns to the left, and the estimates are included in the four columns to the right.

Table 7

Teacher Index Results

Current				Estimates			
Exp	B	M	D	Exp	B	M	D
0	0.7	0.9	1.1	0	0.80	0.92	1.04
1	0.7	0.9	1.1	1	0.82	0.94	1.06
2	0.7	0.9	1.1	2	0.84	0.96	1.08
3	0.8	1.0	1.2	3	0.86	0.98	1.10
4	0.8	1.0	1.2	4	0.88	1.00	1.12
5	0.8	1.0	1.2	5	0.90	1.02	1.14
6	0.9	1.1	1.3	6	0.92	1.04	1.16
7	0.9	1.1	1.3	7	0.94	1.06	1.18
8	0.9	1.1	1.3	8	0.96	1.08	1.20
9	1.0	1.2	1.4	9	0.98	1.10	1.22
10	1.0	1.2	1.4	10	1.00	1.12	1.24
11	1.0	1.2	1.4	11	1.02	1.14	1.26
12	1.1	1.3	1.5	12	1.04	1.16	1.28
13	1.1	1.3	1.5	13	1.06	1.18	1.30
14	1.1	1.3	1.5	14	1.08	1.20	1.32
15	1.1	1.3	1.5	15	1.10	1.22	1.34
16	1.2	1.4	1.6	16	1.12	1.24	1.36
17	1.2	1.4	1.6	17	1.14	1.26	1.38
18	1.2	1.4	1.6	18	1.16	1.28	1.40
19	1.2	1.4	1.6	19	1.18	1.30	1.42
20	1.2	1.4	1.6	20	1.20	1.32	1.44
21	1.2	1.4	1.6	21	1.22	1.34	1.46
22	1.2	1.4	1.6	22	1.24	1.36	1.48
23	1.2	1.4	1.6	23	1.26	1.38	1.50
24	1.2	1.4	1.6	24	1.28	1.40	1.52
25	1.2	1.4	1.6	25	1.30	1.42	1.54

Conclusions

It should be noted that this study was entirely empirical, focusing on estimating component weights based on relative costs. Other factors, such as the need (pedagogically) to invest more fully in the education of certain students under certain circumstances, should necessarily be considered when assessing any given formula weight. Nevertheless, these findings may benefit policy makers who bear the responsibility of providing the most equitable and appropriate distribution of resources to teachers and other educators in support of the education of Oklahoma's young people. Oklahoma is truly a great state, and its most important resource (our children) deserve nothing but the best.

References

Adams, J. E., Jr. & White W. E., II. (1997). The Equity Consequence of School Finance Reform in Kentucky. *Educational Evaluation and Policy Analysis*, *19,* 165-183.

Alexander, K. (1990). Rural Education: Institutionalization of Disadvantage. *Journal of Education Finance, 16,* 121-129.

Bass, G. R. (1990). Isolation/Sparsity. Journal of Education Finance, 16, 180-191.

Bowles T. J. & Bosworth, R. (2002). Scale Economies in Public Education: Evidence from School Level Data. Journal of Education Finance, 28, 285-300.

Brewer, D. J., Krop, C., Gill, B. P., & Reichardt, R. (1999). Estimating the Cost of National Class Size Reductions under Different Policy Alternatives. Educational Evaluation and Policy Analysis, 21, 179-192.

Burke S. M. (1999). An Analysis of Resource Inequality at the State, District and School Levels. *Journal of Education Finance, 24,* 435-458.

Chambers, J. G. (1999). The Patterns of Expenditures on Students with Disabilities: A

Methodological and Empirical Analysis. Parrish T. B., Chambers, J. G., & Guarino, C. M. (Eds.), Funding Special Education (89-123). Thousand Oaks, CA: Corwin Press.

Chambers, J. G. (1999). Measuring Resources in Education: From Accounting to the Resource Cost Model Approach. Washington, DC: National Center for Education Statistics.

Chambers, J. G. (2000). The Patterns of Resources Used to Serve Students with Disabilities: A Methodological and Empirical Exploration. Journal of Education Finance, 24, 381-414.

Dayton, J. (1998). An Examination of Judicial Treatment of Rural Schools in Public School Funding Equity Litigation. *Journal of Education Finance, 24*, 179-205.

Dayton, J., Holmes, C. T., Sielke, C.C., & Jefferson, A. (Eds) (2001). Public School Finance Systems of the United States and Canada: 1998-99. Jefferson, A. (Eds). Washington, DC: US Department of Education, National Center for Educational Statistics. Retrieved from http://nces.ed.gov/edfin/state_finance/statefinancing.asp.

Deering, P. D. & Maiden, J. (1999). The Fiscal Effects of State Mandated Class Size Requirements in Oklahoma. Journal of Education Finance, 25, 195-210.

Fastrup J. C. (2002). Assessing State Performance in Equalizing Access to Educational Resources: The Case of Rhode Island. *Journal of Education Finance, 28,* 207-234.

Fowler, W. J., Jr. & Monk, D. H. (2001). A Primer for Making Cost Adjustments in

Education. Washington, DC: National Center for Education Statistics.

Fox, W. F. (1990). Reviewing Economies of Size in Education. Journal of Education Finance, 6, 273-296.

Fox, W., Murray M., & Price, P. A. (2002). Stability and Equity in Education Finance Formulas. *Journal of Education Finance*, *27,* 1013-1027.

Hartman, W. T. (1994). District Spending Disparities Revisited. *Journal of Education Finance*, *20,* 88-106.

Ladd, H. F., & Hansen, J. S. (Eds). (1999). *Making Money Matter: Financing America's Schools.* Washington, D.C.: National Academy Press.

Maiden, J. & Wood, R. C. (1995). An Examination of the Discretionary Elements of the Florida Education Finance Program. *Journal of Education Finance*, *21*, 271-290.

Maiden J. (1998). An Examination of Fiscal Effects of Statewide Education Reform on Oklahoma School Districts. The Journal of School Business Management, 10, 17-25.

Maiden, J. (2001). *A validation study of the Oklahoma education funding formulae weights*, Unpublished report to the Cooperative Council for Oklahoma School Administration, The Oklahoma Education Association, Oklahoma State School Boards Association, and the United Suburban Schools Association

McLure, W. P. (1947). The Effect of Population Sparsity on School Costs. New York: Teachers College, Columbia University.

Ok. Const. art. XIII, § 1a

Owens, T. & Maiden J. (1999). A Comparison of Interschool and Interdistrict Funding

Equity in Florida. *Journal of Education Finance*, *24,* 503-518.

Parrish T. B., Gerber, M., Kaleba, D., & Brock L. (2000). Adjusting Special Education Aid for Severity: The Case of Census-Based Funding in California. Palo Alto, CA: Center for Special Education Finance.

Tholkes, R. J. & Sederberg, C. H. (1990). Economies of Scale and Rural Schools. Research in Rural Education, 7, 219-251.

Verstegen, D. A. (1994). Efficiency and Equity in the Provision and Reform of American Schooling. *Journal of Education Finance, 20,* 107-131.

Verstegen, D . A. (2004). Reforming American Education Policy for the 21st Century. *Educational Administration Quarterly, 30,* 365-390.

Notes

---

[1] The formula description is based on 70 O.S. sec. 18-200.1.
[2] The calculated correlation coefficient was r =.92, significant at the .05 level.
[3] Over one half million lines of data were used to estimate costs in the current study.
[4] It should be noted that the per-capita weight and the isolation-sparsity weight were analyzed independently.
[5] This is due to the estimation procedures employed in analyzing the per capita allowance weights. Because the original level in the current formula was maintained as the original level in the estimated allowances (33.00), other per capita cost estimates expanded throughout the distribution. Because the transportation supplement does not include local chargeable funding, increases in state distributions would result from the revised estimates.
[6] Revenues generated from federal sources were controlled, as were capital outlay and debt service dollars.
[7] The rationale for controlling current small school weight revenues was these revenues drive expenditures. This statistical control was intended to more efficiently compare the average per-pupil costs between qualifying and non-qualifying districts.
[8] The results of an independent samples t-test comparing costs per pupil of the two groups generated a t statistic of 6.097, significant at the .05 level.
[9] A discussion of the assessment of the most valid criterion of qualifying districts for a small school weight is included in the *District Isolation-Sparsity Weight* section of the current study.
[10] Revenues generated from federal sources were controlled, as were capital outlay and debt service dollars.
[11] The rationale for controlling current isolation-sparsity weight revenues was these revenues drive expenditures. This statistical control was intended to more efficiently compare the average per-pupil costs between qualifying and non-qualifying districts.
[12] $b_1 = -5.402$, $p = .354$.
[13] $b_2 = -5.176$, $p = .000$.
[14] It may appear counter intuitive that districts currently qualifying for the small school weight face a nearly equivalent percent higher cost (14.25) than those districts meeting the revised estimated criterion of 749 ADM or less (14.73). It should be recognized that the small school finding was generated through comparing small school eligible districts to all other districts, including those currently eligible for the isolation/sparsity weight. The second analysis included current small school weight eligible plus virtually all of the current isolation weight districts to those districts qualifying for neither.
[15] $b_1 = .0191$, rounded to .02.
[16] $b_2 = .1160$, rounded to .12.