Exploring Alternative Model Configurations

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In this memo, we explore two alternative weight estimation models requested by the Commission. In the first alternative model, we reduce the target outcome level from the state average to one standard deviation below the state average. In the second alternative model, we examine the effect of omitting the enrollment weight variables from the weight estimation model. In both alternatives, the full cost model is unaltered from the original cost model. Only the weight estimation model is changed. For reference, Table 1 shows the originally estimated base per pupil cost and weights that are included in the full AIR report.

Table 1. Original Base and Weights

	Including transportation	Excluding transportation
Base per pupil cost	$5,868	$4,973
Weights		
FRPL	1.49	1.80
Special education	4.29	4.99
EL	2.20	3.01
Enrollment categories		
≤ 200	1.08	1.18
201–600	0.57	0.63
601–1,200	0.43	0.51
1,201–2,000	0.24	0.28
Enrollment in middle grades	1.42	1.66
Enrollment in high school grades	0.42	0.56

Note. The base per-pupil cost represents the estimated base for the 2018–19 school year. The R^2 for the model including transportation is 0.983 and the R^2 for the model excluding transportation is 0.982.

Lowering the Target Outcome Level

For the alternative model estimating the base and weights necessary to achieve one standard deviation below state average outcomes, we only changed the outcome level for the purpose of generating cost predictions from the state average to one standard deviation below average. The results of this model are presented in Table 2.

Table 2. Base and Weights For a Target Outcome Level One Standard Deviation Below Average

	Including transportation	Excluding transportation
Base per pupil cost	$4,846	$3,951
Weights		
FRPL	1.40	1.77
Special education	4.20	5.05
EL	2.18	3.20
Enrollment categories		
≤ 200	1.08	1.19
201–600	0.57	0.64
601–1,200	0.43	0.52
1,201–2,000	0.24	0.28
Enrollment in middle grades	1.40	1.71
Enrollment in high school grades	0.42	0.59

Note. The base per-pupil cost represents the estimated base for the 2018–19 school year. The R^2 for the model including transportation is 0.983 and the R^2 for the model excluding transportation is 0.982.

As shown, the base for both models drops by about $1,000 per pupil, a reduction of 18% and 20% for the models including and excluding transportation, respectively. The weights remain very similar to the originally estimated weights. If no exclusions were made from the predicted costs from the cost model prior to their inclusion in the weight estimation model (e.g., for federal revenue) the weights would remain unchanged when adjusting the target outcome level.

Removing District Size Weights

Table 3 shows the results for a weight estimation model that removes the district size weights represented by the four enrollment categories. The target costs for each district generated from the cost model remain unchanged. When the enrollment categories are removed, the model accounts for variation in cost by district size through the remaining district characteristics still included in the weight estimation model with which enrollment is correlated. Notably, the base per-pupil cost increases and the EL weight and high school grade weight become negative. Districts in New Hampshire with high EL populations (Manchester and Nashua, in particular) are also the largest districts in the state. Therefore, the model conflates high EL with large size and compensates for the exclusion of enrollment from the model by reducing cost in large districts through a negative EL weight. The lay reader might erroneously interpret this finding as the incidence of EL students being associated with a *lower* cost of providing an opportunity for an adequate education. There is also a notable decrease in the R^2 values of the models that exclude district size weights from over 0.98 to just over 0.80. This indicates that even after the reassignment of some of the variation to the remaining weights a sizable portion of the variation could not be accounted for resulting in lower model fit. Clearly, district enrollment size explains a substantial portion of variation in cost, which is precisely the reason why measures of economies of scale are considered an important educational cost factor that must be taken into account (Andrews, Duncombe, & Yinger, 2002; Duncombe, Lukemeyer, & Yinger, 2003; Duncombe, Nguyen-Hoang & Yinger, 2015; Duncombe & Yinger, 2011).

Table 3. Base and Weights For a Model that Does Not Include District Size Weights

	Including transportation	Excluding transportation
Base per pupil cost	$10,318	$9,177
Weights		
FRPL	1.08	1.22
Special education	1.65	1.86
EL	-0.93	-0.71
Enrollment categories		
≤ 200	-	-
201–600	-	-
601–1,200	-	-
1,201–2,000	-	-
Enrollment in middle grades	0.45	0.52
Enrollment in high school grades	-0.09	-0.04

Note. The base per-pupil cost represents the estimated base for the 2018–19 school year. The R^2 for the model including transportation is 0.803 and the R^2 for the model excluding transportation is 0.815.

Scale of operations (represented by district size, in this case) is a necessary factor to include in cost models. There are legitimate differences in cost across districts due to the size of districts. Importantly, without the inclusion of district size the resulting estimated weights for other cost factors that are correlated with district size are highly counterintuitive.

If the commission has concerns that district size weights provide disincentives for districts to merge, there are other policy alternatives that the commission could consider to help mitigate that disincentive. For example, the commission could propose distinguishing between districts that are small by choice versus small by necessity. For districts that are small by choice, the district must be in close proximity to other districts such that consolidation is a viable option. In contrast, districts that are small by necessity are located in remote areas where distances between districts are large enough that consolidation would not be feasible. Our brief *State Funding Formulas: A National Review* provides several examples of how states define geographic isolation (Kolbe, Atchison, Kearns, & Levin, 2020).

The commission could use data on population density or travel distances or times between neighboring districts to distinguish between districts that are small by choice and those that are small by necessity. District size weights could then be applied only to those districts that are small by necessity. For example, in our work with Vermont, the Vermont Agency of Education chose to condition the application of scale weights on population density. This is a policy decision that the commission could consider that does not affect the estimation of weights but does affect the application of weights within a funding formula to eliminate the disincentive for district merger.

References

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