Geographic Cost of Education Adjustment for Maryland

Prepared for
The Maryland State Department of Education

By

Jennifer Imazeki

Picus Odden & Associates

Submitted by
APA Consulting

Revised November 23, 2015

In 2002, the Maryland General Assembly enacted Chapter 288, the Bridge to Excellence in Public Schools Act. The Act established new primary state education aid formulas based on adequacy cost studies. These adequacy cost studies – conducted in 2000 and 2001 under the purview of the Commission on Education Finance, Equity, and Excellence – employed the professional judgment and successful schools methods and other education finance analytical tools. State funding to implement the Bridge to Excellence Act was phased in over six years, reaching full implementation in fiscal year 2008. Chapter 288 requires that a follow-up study of the adequacy of education funding in the State be undertaken approximately 10 years after the enactment of the Bridge to Excellence in Public Schools Act. The study must include, at a minimum, (1) adequacy cost studies that identify (a) a base funding level for students without special needs and (b) per pupil weights for students with special needs, where weights can be applied to the base funding level, and (2) an analysis of the effects of concentrations of poverty on adequacy targets. The adequacy cost study will be based on the Maryland College and Career-Ready Standards (MCCRS) adopted by the State Board of Education. The adequacy cost study will include two years of results from new state assessments aligned with the standards. These assessments are scheduled to be administered beginning in the 2014-2015 school year.

There are several additional components mandated to be included in the study. These components include evaluations of (1) the impact of school size, (2) the Supplemental Grants program, (3) the use of Free and Reduced-Price Meals eligibility as the proxy for identifying economic disadvantage, (4) the federal Community Eligibility Provision in Maryland, (5) prekindergarten services and the funding of such services, (6) equity and the current wealth calculation, and (7) the impact of increasing and decreasing enrollments on local school systems. The study must also include an update of the Maryland Geographic Cost of Education Index.

APA Consulting, in partnership with Picus Odden & Associates and the Maryland Equity Project at the University of Maryland, will submit a final report to the state no later than October 31, 2016.

This report, required under Section 3.2.3.6 of the Request for Proposals (R00R4402342), evaluates the current Maryland Geographic Cost of Education Index and makes recommendations for possible revisions. This review provides information on the benefits and costs of different methods that could be used to estimate geographic costs. The objective of this review is to give policy makers the information necessary to determine the best approach for Maryland.

Suggested Citation: Imazeki, J. (2015, November). A Geographic Cost of Education Adjustment for Maryland. Denver, CO: APA Consulting.

Executive Summary

This report (1) reviews methods for estimating variations in educational costs by geographic locations, (2) evaluates the current Maryland Geographic Cost of Education Index (GCEI), and (3) makes recommendations for possible revisions to the GCEI.

Schools and districts in different parts of the state face different costs to provide comparable educations to children. This is primarily because of differences in the wages that must be paid to teachers and other employees. There may also be variations between geographic areas of a state in terms of needs for physical inputs. Schools and districts in different climates will have different needs for energy for heating and/or cooling. Schools in rural, sparsely populated areas will have different transportation needs than schools in urban areas. Wages, which make up the largest share of districts' budgets by far, are far more subject to location-based variation (Odden and Picus, 2014).

This report focuses on geographic variations in wages and reviews the three standard measures that analysts have used to capture variations in wages across different areas: (1) cost of living, (2) comparable wages, and (3) hedonic wage models. Cost of living measures are based on prices for a basket of consumer goods, usually dominated by housing costs. These measures do not take into account area amenities that may offset higher housing prices. The comparable wage approach uses the wages paid to all workers in an area to estimate the overall impact of a location on wage levels, incorporating both the cost of living and area amenities. The federal government collects data for comparable wage models and makes these data available on an annual basis. Hedonic wage models use data on actual teacher salaries, teacher characteristics, and a number of other school and district variables, including location characteristics, to estimate the impact of each individual variable on teacher salaries. These data are often compiled from multiple sources, which may or may not be readily available on an annual basis.

The current Maryland GCEI is based on two hedonic indices for professional and non-professional district workers, a hedonic index of energy costs, and a non-varying measure of other instructional expenditures. The current GCEI is included in the Maryland school finance program as an add-on to the base foundation formula, and the hedonic index is truncated at 1.0. (That is, districts with values less than 1.0, e.g. with costs that are lower than average, are treated as if their value is 1.0.)

The research team has developed three recommendations for policy makers to consider with regard to revising the GCEI:

1. The current wage indices within the GCEI should be replaced with indices estimated using comparable wage methodology.
2. The Energy Cost Index and the other expenditures should be removed so that the GCEI cleanly isolates the wage costs associated with geographic location. These wage costs could still be a combination of professional and non-professional wages, weighted for budget shares.
3. The GCEI should not be truncated, and should be integrated into the base foundation formula rather than treated as a separate, add-on program.

Contents

I. Introduction

It is well-established that the cost of educating students is not the same across all schools and students. Costs can vary for many reasons, some of which are under the control of local school officials (such as decisions about the size of classes or about curricular offerings) but many costs cannot be controlled by local school districts. Costs outside the control of school officials include the costs associated with educating certain types of students – such as at-risk students, English Language Learner (ELL) students, and students with disabilities – and with operating in certain geographical locations. When allocating funds through a state finance formula, it is appropriate for policy makers to compensate districts for differences in these uncontrollable costs. But ensuring that formula adjustments accurately reflect these cost differences can be quite challenging.

For many years, the Geographic Cost of Education Index (GCEI) in Maryland has been one way the state has accounted for some of the variation in the cost of providing a comparable education in different counties across the state. However, the methodology used to create the current GCEI is just one of multiple methods a state might use to capture these geographical, cross-district cost differences. This report discusses the advantages and disadvantages of various methods, all within the context of Maryland's foundation formula, to recommend the best approach for Maryland going forward.

To understand the nuances of the methods for measuring geographic variations in education costs, one must first have a general understanding of (1) what causes variations in the costs of providing a comparable education across schools and districts and (2) how such variations might be included in a state school finance formula. Section II of this report contains a general discussion of education costs, highlighting the primary sources of variation in such costs. Section III reviews the methods for estimating variations in education costs due specifically to geographic location. Section IV provides an overview and assessment of the GCEI. Section V describes Maryland's school finance formula and how the GCEI is used with the formula. Section VI summarizes the relevant issues and makes recommendations for changes to Maryland's approach to adjusting for geographic cost differences.

II. Variation in Educational Costs

Economists define the *cost* of producing any product as the minimum amount of money necessary to buy the *inputs* required to produce one unit of *output*. For physical goods like cars or computers, this calculation may be relatively straightforward, but when the product is education, the model is more complicated. This is true, in part, because a unit of education output has to be defined before the required inputs can be determined. Thus, most discussions of the costs of education begin with some outlining of expectations for student performance (an education output). This preliminary outlining is then followed by discussions of what inputs are needed to produce desired student performance in a given school, what prices a school faces for those inputs, and how those inputs and input prices might vary across schools and districts.

Education outputs are typically defined in terms of student performance. Student performance might be measured through scores on state accountability assessments or other standardized tests; dropout and/or graduation rates; some other measure; or some combination of measures. Regardless of the measure of student performance used, education cost calculations are associated with given levels of performance. That is, if the expectations for student performance increase, then the costs of achieving that improved performance will also necessarily increase (see Baker, 2005, and Baker, Taylor and Vedlitz, 2008, for a summary of the educational adequacy literature).[1] This is true because higher levels of student performance require more inputs (which, in turn, require more money). In most states, the legislature or the Department of Education has established baseline expectations for, and/or agreed-upon measures for, student performance. These benchmarks are used to guide calculations of the amount of funding that is necessary, or adequate, to ensure all districts have the capacity to reach minimum student performance expectations. The adequacy goal behind Maryland's funding formula suggests that the formula should provide the amount of money necessary for all districts to provide every student an equal opportunity to meet the State's College and Career Ready Standards.

Variation in Educational Costs across Schools and Districts

Once an output (student performance) expectation is established, schools can consider how to reach that level of output. In general, student performance depends on the interaction between students and direct school inputs (e.g. teachers, books, and extra help services). The total cost of education is calculated by multiplying those inputs by their prices.

By far, the most important input to educational production is personnel: teachers, administrators, aides, support staff, etc. The importance of personnel is reflected in the fact that the bulk of any district's budget is spent on employee salaries and benefits (Odden and Picus, 2014). Districts also have to buy materials (e.g. books and technology) and pay for physical inputs (e.g. utilities and building maintenance). While all districts purchase these inputs, the specific amount and mix of inputs needed in any individual district depends on the characteristics of that district. For example, a district with a high number of special needs students may require more inputs, or a different combination of inputs, than a district with a lower number of special needs students. A district located in a very warm area will need to spend more on energy than a district in a more temperate area. Similarly, a district's characteristics, particularly its geographic location, will influence its specific input prices. For example, a district in an area with a high cost of living will need to offer higher wages to attract and retain employees.

While expectations for student performance will presumably be the same for all schools and districts across a state, the cost of achieving those levels of performance is known to differ from school to school. There are two main factors behind these variations in costs: (1) differences in who schools serve (in terms of both student body characteristics and school/district characteristics) and (2) differences in where schools are located (in terms of geographic location). These factors, in turn, affect costs through two main channels: (1) differences in the level and/or mix of inputs needed and (2) differences in the prices of needed inputs. Although many cost analyses focus on the impact of the cost factors overall,

[1] This is not intended to imply that the relationship between costs and performance expectations is one to one, nor that the relationship is the same in every state or in every district, but simply that the two are positively correlated.

this analysis focuses on the channels through which these factors impact costs. In this way, the analysis highlights how cost variations are best measured, as well as how and why these variations should be incorporated into funding formulas.

Variation in the Level and Mix of Educational Inputs

To achieve a given level of student achievement, different districts may use different levels, or combinations, of inputs. Some of this variation stems from the choices that districts make to achieve their expected levels of student performance and achievement. For example, one district might choose to prioritize a well-stocked library, while another may choose to limit class sizes so that student-to-teacher ratios are smaller. These sorts of choices are typically referred to as “discretionary factors” and, to the extent possible, should be held constant when measuring the variation in costs that will be addressed in the funding formula.

Other variation in input levels stems from “cost factors” – characteristics that influence the amount of resources used but that are outside the control of local officials. For example, Andrews, Duncombe, and Yinger (2002) and Imazeki and Reschovsky (2003) find that very small districts typically have higher per-pupil costs than larger districts, primarily because their fixed costs (e.g. physical infrastructure, administrators) are spread over fewer students. A number of different studies (see Baker, 2005, for a summary) have found that costs are higher in districts with larger proportions of low-income students, ELL students, or students with disabilities. It is generally thought that, because these students may face extra challenges at home and in the classroom, they require more resources from schools to reach the same levels of achievement as their peers. These additional resources may include smaller classes, more instructional time, special materials, etc. Depending on location, districts may also require different levels of physical inputs (Rose et al., 2008). For example, districts with more variation in temperature may require more energy for heating and cooling.

Thus, districts with these identifiable cost factors – small size, low-income students, ELL students, and challenging geographic location – typically require more inputs to reach the same levels of performance as other districts. Because these cost factors are outside a district’s control, it is appropriate for the state to compensate districts for these identifiable cost factors via additional revenue.

Variation in the Prices of Educational Inputs

Even if two districts use the same level and mix of inputs, total costs may still vary if the districts face different prices for those inputs. As mentioned earlier, teachers are the most important input in education production. Correspondingly, teacher wages are the most important input price. In Maryland, wages and benefits for all district personnel account for 80 percent of total current expenditures (Maryland State Department of Education, 2014).

Some of the cross-district variations in personnel costs stem from choices districts make. For example, districts that hire more experienced and/or more educated teachers will have higher salary costs because such teachers command a wage premium. Some states provide additional revenue to districts that have more experienced and/or educated teachers;[2] however, there is little theoretical or practical justification for this sort of aid adjustment. Not only are teacher experience and/or education levels within the control of a district, but research has also found very little connection between teacher experience and/or education (beyond the first few years of teaching experience) and student outcomes (Betts, Zau, and Rice, 2003; Monk, 1994). In fact, policies that compensate districts for having more experienced and/or educated teachers may create perverse incentives. For example, such policies might encourage districts to hire teachers who have Master's degrees but who are not necessarily providing greater contributions to student performance levels compared to teachers who do not have Master's degrees. These sorts of choices should be held constant when adjusting a funding formula for variations in teacher wage costs.

Nonetheless, there are some differences in personnel costs that *do* come from factors outside the control of districts. The most important of these is the difference between geographic locations in terms of the price required to hire a teacher – or any personnel – of a given quality. Wages vary across geographic locations, in part because the purchasing power of a dollar is not the same in all places. It costs more to achieve a given standard of living in Montgomery County or Howard County than in Allegany County or Garrett County (Duncombe and Goldhaber, 2003). Because it takes different amounts of money to buy the same bundle of goods in different locations, equivalent workers will demand different wages for equivalent jobs. If a district's wages are not sufficiently high to compensate workers for higher costs of goods and services, then it will be harder for that district to attract and retain workers in high-cost areas.

At the same time, the experience of living in some places is also more pleasant than the experience of living in other places. For example, although New York City and San Francisco have much higher costs of living than other cities, each city also offers amenities (e.g. museums, heightened access to businesses, desirable weather) that may not be available in other cities or areas of their respective states. Of course, these cities may also have more prevalent crime, poverty, and urban problems than other cities. If a location is attractive enough, positive amenities can offset higher living costs, so workers may not expect or demand wages that are quite as high as would otherwise be expected. Thus, the true differences in wages needed to attract and retain equivalent workers between locations will depend on worker preferences, living costs, and local amenities.

There is a large body of literature on teacher mobility and attrition to support adjusting state aid for locational variations in wage costs (see Imazeki and Goe, 2009, for a summary). When salaries are not high enough to compensate for high costs of living or a lack of amenities, teacher turnover is higher and recruitment is more difficult. Thus, all cost studies provide some acknowledgement of these different salary needs as part of the determination of adequate levels of funding for different districts.

[2] For example, New Mexico computes a "training and experience index" based on five experience categories and five education categories. Districts with more teachers in higher categories have higher index values and receive more revenue per pupil. Wyoming has a similar adjustment for education and experience in its determination of costs for each school district.

Adjusting for local living conditions is especially appropriate because such conditions affect *all* school worker wages, not just teacher wages. Teacher salaries may also vary from district to district because of the working conditions for teachers. Several studies have found that teachers are more likely to leave schools with certain characteristics, including schools with larger shares of students with special needs (e.g. special education students, low-income students, and ELL students). As mentioned above, schools with larger shares of students with special needs generally need to hire more teachers or a different mix of teachers to help their students achieve similar levels of performance as schools with fewer special needs students. The argument here is that on top of needing more inputs, schools with larger populations of special needs students may also need to pay higher wages to attract and retain similar teachers. However, as Rose and Sengupta (2007) pointed out, it is worth considering whether these are really uncontrollable salary costs that the state should include in funding formula adjustments. Put differently, it is important to ask *why* it is considered more difficult to teach in schools with larger numbers of special needs students. Most likely, the answer is that special needs students face additional educational challenges, placing additional demands on teachers. However, it may not be necessary to pay teachers higher wages if schools are able to improve working conditions in other ways, such as providing additional supports or reducing class sizes. The literature on teacher labor markets suggests that teachers generally care more about working conditions than salaries (Hirsch, 2008), so it may also be more cost-effective to change these sorts of inputs than to raise salaries. Thus, while it may be appropriate to provide additional revenue to districts serving more special needs students (because such districts may need to spend more money to buy more inputs), it is unclear whether it is appropriate to measure or allocate additional revenue for the impact on teacher wages as well.

In addition to variation in wages, districts may face different prices for other inputs, such as energy or supplies. These expenditures constitute a much smaller share of district budgets, under four percent in most cases, and price variation is likely to be more correlated with district size, as larger districts may have access to volume discounts that are unavailable to smaller districts (Duncombe and Goldhaber, 2003).

Measuring and Adjusting for Variation in the Cost of Education

Overall, the uncontrollable factors that affect educational costs for a given school boil down to (1) who the school serves (student characteristics) and (2) where the school is located (geographic location). As discussed, many of these cost factors can impact total educational costs through two channels: (1) input levels and (2) input prices. It is important to keep these two channels in mind when measuring and incorporating costs in a state funding formula, as these channels influence estimation methods and applications of the resulting adjustments.

When the primary channel of impact is input prices, it makes sense to measure how variables directly impact input prices. It is established economic practice to use models that have prices as the dependent variable. Thus, analyses intended to isolate the impact of geographic location, which affects costs primarily through wage effects, tend to estimate models that use salaries as the dependent variable. State funding adjustments based on these models should reflect that the models capture variation in prices only; for example, an adjustment for geographic wage costs might be applied to 80 percent of district revenue to reflect that salaries constitute 80 percent of most districts' budgets.

In contrast, when the primary channel of impact is input levels or a mix of level and prices (where the dollar impact must be measured by combining those input levels with prices), or when it is unclear how much of the impact is on input levels versus prices, analyses typically focus on the impact of variables on total costs. Thus, analyses intended to isolate the impact of district characteristics, which affect both input prices and levels, will use models with total expenditures as the dependent variable. Funding formula adjustments based on these models should then be applied to total district revenues, since they capture variation in overall costs. For example, many states use pupil weights to increase aid for districts with larger shares of students with special needs (e.g. low-income students, ELL students, and special education students). The analytic methods used to determine the magnitude of these weights all focus on the relationship between district cost factors and district total expenditures (see Baker, Taylor, and Vedlitz, 2008) and provide one number for the overall cost impact of each variable. These adjustments are then applied to total revenue to calculate the revenue allocation.[3]

III. Measuring Variation in Wage Costs Associated With Geographic Location

As discussed in the preceding sections, variation across districts in the costs of providing comparable educations is due to both (1) discretionary factors within the control of district officials and (2) uncontrollable cost factors outside the control of district officials. Uncontrollable cost factors include (1) location characteristics (e.g. cost of living and area amenities) that can lead to higher input prices, and (2) district characteristics (e.g. enrollments and student demographics) that can lead to higher input needs and/or higher input prices. It is appropriate for the state to provide additional revenue to compensate for these cost factors. There are multiple methods available to estimate the magnitude of the differences associated with different cost factors.

As discussed in the previous section, geographic location primarily affects district costs through input prices, namely wage costs. This section will focus on how location affects wage inputs. Geographic location can also affect costs of expenditures for other inputs, such as energy or transportation inputs. Expenditures for such other inputs are likely to have greater impacts on input *levels* (e.g. districts needing to buy more buses or maintain lengthier bus routes) rather than impact *prices*. Expenditures for these other inputs demand a much smaller share of district budgets than expenditures for personnel. The report will therefore return to these other inputs as a separate issue in Section IV below.

[3] Alternatively, those separate weights and adjustments could also be combined into a comprehensive index that captures variation in all costs, including the impact of both district characteristics and location factors, and differences in both input levels and prices (see Reschovsky and Imazeki, 1996). This sort of summary index is easy to incorporate into a foundation funding formula and greatly simplifies the calculation of adequate funding but further obscures the underlying sources of cost variations.

There is a well-established body of literature on adjusting state aid formulas to account for geographic variation in teacher wages. A number of states include such adjustments. There are three possible adjustments: (1) cost of living adjustments, (2) comparable wage indices, or (3) hedonic wage indices.

Housing-Based Cost of Living Adjustment

The first option is to adjust for the cost of living by computing the price of a basket of goods associated with each location (similar to how the Consumer Price Index is calculated across time). Typically, that local basket of goods is dominated by housing costs, although other goods' prices are also usually included (McMahon, 1996). This approach has the advantage of being straightforward to calculate and update over time, as long as data on housing costs and other items in the basket are available. The major disadvantage of a housing-based cost of living adjustment is that it does not include any information about area amenities which may also impact the wages needed to attract and retain workers. As mentioned in Section II, workers will generally accept lower wages to work in locations with pleasant amenities, such as desirable weather or vibrant cultural life. Thus, even though housing costs are higher in such locations, wages may not need to be equally high. A cost of living adjustment based primarily on housing and other consumer costs will tend to overestimate the wage differential needed to attract and retain school employees in locations with high costs of living and underestimate it in locations with low costs of living.

Comparable Wage Index

A Comparable Wage Index (CWI) is calculated by measuring the variation in non-teacher wages across localities. CWIs therefore account for the impacts of both cost of living and area amenities. The assumption is that workers who are similar to teachers in terms of their levels of education, their training, and their job responsibilities will have similar preferences as teachers. For example, if non-teacher workers in the City of Baltimore are paid, on average, 10 percent more than non-teacher workers in the City of Cumberland, then the CWI would suggest Baltimore City Public Schools should receive 10 percent more revenue for teacher salaries than Allegany County Public Schools where the City of Cumberland is located. By examining the regional wage differentials of a large sample of workers with characteristics similar to teachers, the CWI implicitly accounts for a wide range of factors that influence the salary levels necessary to attract teachers to live and work in particular districts or regions. These include factors such as cost of living and desirability of place, including climate, cultural amenities, safety, commute times, and recreational opportunities. In comparison, with a hedonic index the analyst must identify each appropriate variable to include in the regression equation along with a data source (if one exists). If the analyst miss-specifies the equation or is unable to obtain valid data for one or more of the identified factors the result of the analysis will be biased, resulting in the cost index over- or under-adjusting school system revenues. Further, by relying on data external to school districts the CWI specifically excludes cost differences among districts that are under the control of boards of education, such as district wages and working conditions, as the economic literature suggests (Fowler and Monk, 2001; Taylor and Fowler, 2006).

Specifically, following Taylor and Fowler (2006), a CWI is created by estimating the following equation:

$$LnAnnualSalary_i = \beta_W W_i + \beta_O O_i + \beta_I I_i + \beta_R R_i + \varepsilon_i$$

In this equation,

- the dependent variable is the natural log of annual salary;
- W_i is a vector of characteristics of worker *i*;
- O_i is an indicator variable for worker *i*'s occupation;
- I_i is an indicator variable for worker *i*'s industry;
- R_i is an indicator variable for the region that worker *i* lives in; and
- ε_i is an idiosyncratic error term.

The resulting coefficients are then used to predict a wage in each region for a worker with average characteristics (that is, average values of all worker characteristics).

Estimation of this model requires data on individual worker characteristics as well as industry, occupation, wages, and location. These variables are all available in the American Community Survey, which is administered annually.[4] The American Community Survey (ACS) is an ongoing national survey administered by the U.S. Census Bureau, sent to 3.5 million people each year, collecting information on income, housing, education, and migration, as well as the employment variables already mentioned. The ACS replaced the long form of the decennial Census and thus, is the only national source of this type of information. Data with the individual responses necessary to compute a CWI are available in the ACS Public Use Microdata Sample for areas with at least 100,000 residents (called PUMAs or Public Use Microdata Areas). A CWI for any PUMA is therefore relatively straightforward to create and can easily be updated on an annual basis. A CWI also has the advantage of being clearly beyond the control of local districts; it does not use any school-generated data. It can also be used, or easily adjusted for use, for all labor costs (e.g. certified staff, non-certified staff, teachers, administrators, or classified staff).

On the other hand, a CWI assumes comparability of workers. The CWI captures average preferences for a location among all non-teacher workers, so using a CWI to adjust for district wage costs assumes teachers have similar preferences as other workers and therefore require similar wage adjustments. This assumption could be strengthened by estimating the CWI with a sample of workers more closely aligned with teachers (e.g. workers with college degrees or workers in industries that require education levels and/or job responsibilities similar to teaching). However, if teacher preferences are systematically different than other worker preferences – an unlikely possibility – then a CWI may not be appropriate.

A CWI is also intended to capture variation across labor markets, generally measured at a broad geographical level (e.g. across a metropolitan area). The smallest area for which a CWI value can be calculated using the ACS data is a PUMA (areas with at least 100,000 residents); in densely populated

[4] In 2000 and earlier, the relevant variables were collected on the long form of the decennial Census. Taylor and Fowler (2006) discuss how to use Occupational Employment Statistics data from the Bureau of Labor Statistics to update a CWI in the years between Censuses; thus, annual adjustments can still be made between Census years prior to 2005 when the relevant variables became available annually as part of the American Community Survey.

regions, a PUMA may represent one part of a city or county but in sparsely populated regions, a PUMA may span multiple counties. A CWI cannot measure cost variations across districts within the measured geographical area, so all districts within that area would necessarily have the same index value.[5] This drawback is related to another potential concern about CWI: A CWI does not measure variation in wages across districts due to school-specific working conditions. As discussed in the previous section, it is not clear that the state *should* make adjustments for the impact of student characteristics on wages. That said, if a state decided to make such adjustments anyway, a CWI measure would not include variation in wages because of school-specific conditions.

Hedonic Wage Index

Hedonic wage indices are calculated by breaking down variation in current wages due to a number of different identifiable variables. Thus, hedonic wage indices can capture variation due to both geographic location characteristics and student characteristics. Following Chambers (1998), a hedonic wage index for teachers is created by estimating the following equation:

$$LnTeacherSalary_i = \beta_T T_i + \beta_D D_S + \beta_C C_S + \beta_G G_i + \varepsilon_i$$

In this equation,

- the dependent variable is the natural log of a teacher's annual salary;
- T_i is a vector of characteristics of teacher *i* (the most commonly included are gender, race, education, certifications, experience, and any other available measures of teacher quality such as measures of effectiveness or test scores);
- D_S is a vector of discretionary cost/working condition variables in district *S* (such as class size);
- C_S is a vector of uncontrollable cost/working condition variables in district *S* (the most commonly included are the percentages of high-need or at-risk students);
- G_S is a vector of characteristics for the region that teacher *i* lives and works in (such as housing prices and area amenities like weather, crime or population density); and
- ε_i is an idiosyncratic error term.

The resulting coefficients are then used to predict a wage for an average teacher (with state average values of the variables in T_i) in each district, holding constant the discretionary cost variables.

The data required to estimate this model will depend on the specific variables included. Though the most commonly included variables have been noted above, it is important to recognize that the specific choice of variables to include is ultimately up to the analyst. This can have some benefits, as the model can generate estimates of the impact of specific variables that may be of particular interest to the state. For example, the hedonic method can reveal how much of locational variation is coming from housing costs, versus how much locational variation is coming from preferences for area amenities (e.g. low

[5] This is likely to be less important in states with geographically large districts and/or districts that line up with established municipal boundaries, such as Maryland where school district boundaries coincide with county lines.

crime or desirable weather). Additionally, the hedonic approach explicitly captures and controls for the impact of student characteristics on teacher wages, and thus can generate a distinct value for each district.

On the other hand, there may be some variables (e.g. measures of teacher quality or area amenities) that should theoretically be included (because theory and previous research suggest that they impact teacher wage costs), but that are excluded in practice due to lack of data. This creates a potential concern: Because the model uses directly-observed teacher salaries, which are subject to district control, any variation in teacher salaries due to variables that are not specifically included in the model will either (1) be relegated to the error term (and thus left out of the resulting index values) or (2) create bias (potentially of unknown direction and size) in the coefficients of included variables. In both cases, the resulting index will provide a potentially biased measure of true cost variations. Of particular concern is that, to the extent that unobserved/excluded variables are correlated with included cost factors, the hedonic index may overestimate or underestimate true costs. For example, if districts with more special needs students are also less efficient than districts with fewer special needs students, then the coefficients on student variables may be biased upward, rewarding districts with extra revenue for their inefficiency.

It is tempting to try to make up for missing data by including as many specific cost and control variables as possible. However, doing this creates some issues. Including additional variables can reduce the precision with which all the coefficients are estimated; this is particularly salient in states with relatively few districts, such as Maryland. (That is, smaller samples restrict the number of variables that can be included in the model.) It is also particularly salient when the additional variables are correlated with other variables already in the model. Furthermore, a larger and more complex model becomes increasingly difficult to update over time. That last point is perhaps the largest drawback of the hedonic approach in general, especially for generating a measure to be used in state policy. The data requirements and statistical complexity of the hedonic approach make calculating and updating even a relatively simple hedonic wage index significantly more difficult and time-consuming than either of the alternative approaches.

Comparable Wage Index versus Hedonic Wage Index

Economic theory clearly suggests that the cost of living approach is inferior to the other two approaches; although all three methods can account for the impact of housing and other costs on wages, the cost of living approach fails to capture the impact of area amenities that affect wages. With that in mind, this analysis focuses on the relative merits of a comparable wage index and a hedonic wage index.

When attempting to capture variation in the impact of geographic location on district salaries, the comparable wage approach has multiple benefits over the hedonic approach. First, unlike a hedonic model, a comparable wage model does not require an analyst to decide which specific area costs and amenities to include. With the comparable wage approach, the overall impact of all relevant variables is simply captured by the regional indicator variables. This decreases the chance that the results will be systematically biased and reduces the “noise” in the estimates. Second, the data needed to estimate a comparable wage model are easily accessible on public government websites maintained by federal agencies. By contrast, the hedonic approach requires data on all the specific variables an analyst chooses to include. Generally, these data must be gathered from multiple sources. Sometimes, they can only be gathered through individual data requests, making updates to the index much more cumbersome. There is also a higher chance that data will either stop being collected or that specific variables will change or be defined differently by the collecting agency. Finally, because the comparable wage approach relies on data that are completely outside the control of local school districts, it cuts out any possibility of districts manipulating the system to receive additional revenue (e.g. offering inefficiently high salaries).

One aspect of the hedonic model that may seem advantageous is that it specifically includes student characteristics. Research shows that, as variables, student characteristics do have an influence on teacher salaries. However, if the intention is to use the resulting model to generate a funding adjustment, then the inclusion of student characteristics may provide little benefit. As discussed above, it is unclear whether it is appropriate to compensate districts for the higher wage costs associated with factors like the share of special needs students, because there are many ways for districts to address teacher preferences about student characteristics other than offering higher salaries. Although these variables need to be included as controls in any model using actual teacher salaries as the dependent variable, it may not be appropriate to incorporate variation in those variables when calculating the aid adjustment for wage costs. But if that variation is not going to be included anyway, then the comparable wage approach is preferable for the reasons stated above.

If for some reason a state wants to include student characteristics, it is important to recognize that an index based on a hedonic model is no longer a clean measure of the impact of geographic location. Instead, an index based on a hedonic model conflates the impact of both geographic location and district characteristics on wages. Although there are situations where this might be desirable (such as analyses investigating the relative impacts of different variables), it is likely to be problematic in the context of school funding formula adjustments because most states – including Maryland – have separate adjustments for those same district characteristics. Typically, analysts estimate the costs of a student characteristic, like poverty, by looking at the characteristic's impact on *total* expenditures, since student characteristics are likely to require districts to hire more teachers, or buy higher levels of other inputs, in addition to offering higher wages. These costs are then included in state aid formulas separately from adjustments for geographic location, which primarily impact wages. If a state has these separate adjustments for student characteristics (such as the pupil weights in Maryland for free and reduced price meals (FARM) students, ELL students, and students with disabilities), then it may be problematic to include the same student characteristics in an adjustment primarily intended to capture the impact of geographic location on wages. Including student characteristics in such an adjustment may lead to overall revenue adjustments that are larger than necessary for districts with higher concentrations of special needs students.

Finally, one potential benefit of the hedonic approach relative to a CWI is that a hedonic model includes individual area variables. This means a distinct value can be calculated for each individual district, even if student characteristics are held constant. In contrast, a CWI generates the same value for all districts in the same labor market or population center. In practice, this is likely to have relatively little impact because many area variables will have similar values within labor markets. Still, the identical values generated under the CWI could be more difficult to explain politically.

IV. The Maryland Geographic Cost of Education Index (GCEI)

The previous section highlighted methods of measuring variation in education costs due to geographic location. To the extent that Maryland's current formula accounts for these costs, it does so through the Geographic Cost of Education Index (GCEI). This section of the report reviews how the GCEI is calculated.

Calculation of the Maryland GCEI

The Maryland GCEI is a weighted index of four components: (1) an index of uncontrollable wage variation for professional employees (both teaching and non-teaching); (2) an index of uncontrollable wage variation for non-professional employees; (3) an index of uncontrollable energy costs; and (4) a fixed amount for other expenditures (e.g. supplies, materials, equipment, and miscellaneous expenditures, all of which are assumed to remain constant across districts). In 2003, the weights for these four components were 80.5 percent, 10.5 percent, 2.0 percent, and 7.0 percent, respectively. The three sub-indices are each constructed using the hedonic methodology described above. In addition, one of the variables within the wage models, average housing prices, is constructed from a separate hedonic model of the housing market. See Duncombe and Goldhaber (2003) (referred to hereafter as DG2003) for a full discussion of the index estimation. At the time of Duncombe and Goldhaber's analysis, the hedonic approach would have been preferred, given that the data to estimate a Comparable Wage Index was only available once a decade in the long form of the decennial Census.[6] Table 1, below, lists the specific variables that are included in the three models of the Maryland GCEI. To calculate the indices, the geographic location and district cost factors are allowed to vary (set at each district's actual values), while all other variables are held constant at state average values.

Table 1: Variables Included in the Maryland GCEI Sub-Indices

	Professional Cost Index (PPCI)	**Non-Professional Cost Index (NPCI)**	**Energy Cost Index (ECI)**
Dependent Variable	Employee salary	Employee salary	District total energy expenditures
Location Cost Factors	• Measure of violent crime • Proportion of working population that commutes > 60 minutes • Constructed regional average house value**	• Unemployment rate • Constructed regional average house value	• Heating degree days (cold days) • Cooling degree days (hot days)
District Cost Factors	Percent of students receiving Free and Reduced-Price Lunch	Percent of students receiving Free and Reduced-Price Lunch	Enrollment

[6] In comparison, that data is now available on an annual basis in the American Community Survey.

Employee Control Variables*	• Race (indicators for Native American, African American, Asian) • Gender • Education • Years of Experience • Licensure status • Licensure test performance (NTE, Praxis) • Non-teaching position (indicators for principal, vice principal, counselor, library media specialist)	• Race (indicators for Native American, African American, Hispanic) • Gender • Age • Position (indicators for technical personnel, crafts and trade personnel, manual laborer, service worker)	**NA**
Other Time, District, and/or Area Control Variables*	• Year indicators • Per capita income • Percent of designated commercial land	• Year indicators • District wealth	• District wealth • Percent of cost in electric/gas • Average square foot per pupil • School building size (indicators for under 10,000 square feet; over 190,000 square feet) • Adjusted age of school (indicators for over 70 years old; between 50 and 70 years)

*Held constant to calculate index.
**Duncombe and Goldhaber first estimated a hedonic model of housing prices, controlling for house characteristics such as age, size, construction type, and condition, then calculated an average housing price for each county.

Analysis of the GCEI

It is important to note that the GCEI captures both (1) variation due to cost factors associated with the geographic location of a district (e.g. housing costs, commute time, and crime) and (2) variation due to cost factors associated with district characteristics (e.g. student poverty). Furthermore, while the wage indices attempt to isolate variation in input prices, the energy index and other expenditures components capture variation in overall costs (both prices and input levels) associated with those inputs. Because it combines these various factors into one number, the GCEI is really a hybrid cost adjustment; it is more than just an adjustment for the impact of geographic location on wages but it does not fully account for all of the possible variation in costs across districts. Given the overall structure of Maryland's funding formula, which includes pupil weights for special needs students, this creates some issues that are discussed in Section V, below.

As noted earlier, one of the disadvantages of the hedonic approach is that it requires significant data to calculate and update any index. The Maryland GCEI is no exception: To estimate the original indices, the research team compiled data from Maryland State Department of Education (MSDE) district demographic files; MSDE staff data files; MSDE certification data files and certification testing files; the Bureau of Labor Statistics; Maryland Department of Labor; National Oceanic and Atmospheric Administration; Maryland State Police; Public School Construction Program; decennial Census of Population and Housing; State Department of Assessment and Taxation; and individual districts. Re-estimating the full GCEI requires collecting updated data from all of these different sources, some of which are difficult to access or require submission of individual requests for data (which may be time-consuming for districts to respond to).

DG2003 noted that the coefficients in the GCEI models should remain fairly stable over time. Therefore, annual updates can be calculated by plugging in updated data for cost factors. In practice, the State has only implemented this simpler approach once: In 2009, Duncombe and Goldhaber updated the GCEI using more recent data for the cost factors in the three hedonic models (hereafter DG2009). For that analysis, DG2009 re-estimated the housing model used to generate the housing price variable (one of the cost factors in the PPCI and NPCI); they also were forced to make some changes to the Energy Cost Index (ECI) based on changes in available data. The resulting changes in the overall GCEI are relatively minor; the correlation between the original 2003 GCEI and the GCEI with the updated cost factors is 0.961, although some individual districts saw changes in their values of up to four percentage points. The authors note that changes in the GCEI values were primarily driven by changes in housing prices.

One notable difference between the Maryland GCEI and geographic cost adjustments used in other states is that the Maryland GCEI includes the ECI. Almost all other states that include geographic cost adjustments in their funding formulas use measures based on wage costs, using one of the three methods discussed in the previous section.[7] Energy costs are not often explicitly addressed in state funding programs, but may be considered part of other physical or maintenance costs. This may be because energy costs are such a small share of total district budgets (less than three percent in Maryland). Another reason it may be so rare to see energy addressed separately is the challenge of accurately measuring variation in energy costs. As noted in DG2003, energy markets can be incredibly complex. This is reflected in the fact that Maryland's hedonic ECI model only captures about 30 percent of the variation in energy costs. Energy costs per pupil are only weakly correlated with any of the individual variables in the model.

V. Incorporating Geographic Costs into Maryland's School Funding Formula

Base Foundation Formula

The current Maryland school finance formula is a version of a traditional foundation state-aid formula.[8] Typically, in a foundation system, the state assumes (or requires) that each district satisfy certain requirements for raising revenue locally, such as levying a minimum tax rate. If a district meets the

---

[7] Alaska's current formula – based on a 2005 study by the Institute of Social and Economic Research (ISER) at the University of Alaska Anchorage – has a geographic cost adjustment that includes a measure of energy costs based on actual district energy expenditures.

[8] The analysis in this section draws heavily on descriptions of the school finance program provided by the Department of Legislative Services (2014).

state's requirement but still raises less than the foundation amount, then state aid makes up the difference. Thus, basic state aid is defined as:

*State aid = Foundation amount per pupil*pupil count – (required tax rate*assessed property wealth)*

One reason the majority of states use foundation formulas, either solely or in combination with other systems, is that foundation formulas result in total district revenues unrelated to local property wealth. In a "pure" foundation system, every district would have exactly the same per pupil revenue (though not the same amount of state aid), equal to the per pupil foundation amount. This lack of relationship between revenues and wealth was a key requirement of many school finance equity court cases of the 1970s and 80s.[9]

The simple formula above leaves out the recognition that, if the goal is for all students to achieve at some minimum level, then the cost to achieve that minimum level of performance will not be the same in every district. Thus, as states have turned their focus from revenue equity to revenue adequacy, foundation aid formulas have been modified to account for these variations in costs between districts. Specifically, the foundation amount and the pupil counts are adjusted to account for the higher costs associated with geographic location and district characteristics, as discussed in Section II. The following formula allows for such adjustments:

*State aid = Foundation amount per pupil*geographic cost index*weighted pupil count –*
*(required tax rate*assessed property wealth)*

This type of formula still breaks the connection between total revenue and local wealth. However, in addition to providing more revenue for low-wealth districts, it also provides more revenue for high-cost districts.

Maryland's foundation formula has some adjustments for adequacy, including the GCEI and the use of weights for special needs pupils. However, Maryland's implementation of these adjustments differs from a traditional adequacy-focused foundation formula in a few significant ways. In particular, the GCEI and the weighted pupil count are not actually integrated into the base formula, but are instead treated as separate add-ons. Thus, Maryland's base formula can be described as:

*State aid = Foundation amount per pupil*pupil count –*
*(local contribution rate*local wealth)*

Incorporating the GCEI

The GCEI is not part of the base foundation formula. Instead, it is treated as a separate add-on. Districts with a GCEI less than or equal to one receive no change in state aid. Districts with a GCEI above one receive an adjustment that equals the "foundation amount per pupil" times the pupil count times the difference between the GCEI and 1.0. One important aspect of Maryland's current formula is that

[9] The equity of Maryland's school finance formula is analyzed in the companion report by Glenn, Griffith, Picus, and Odden (2015).

districts with GCEI values below one (meaning costs below the state average) are treated as if their GCEI is equal to one. Setting a minimum value of one for the GCEI ensures that such districts will not receive any additional revenue but will not lose any revenue either. This significantly reduces the variation in the GCEI values and puts high-cost districts at a relative disadvantage. Ensuring that no district's funding is reduced may be connected to the fact that the GCEI-based revenue is calculated as a separate add-on, rather than being calculated as part of the base foundation formula. In practice (i.e. in implementation), any reduction in revenue would take away funds that had been allocated elsewhere in the program, which is politically difficult. At the same time, because the GCEI is treated as separate from the base formula, it is also potentially more politically vulnerable. For example, the GCEI was not fully funded for the first several years after its creation and was only funded at fifty percent for fiscal year 2016. Senate Bill 183, passed in the 2015 session of the General Assembly, requires the resumption of full funding of the GCEI beginning in fiscal year 2017.

There is one aspect the current GCEI calculation that is especially problematic within Maryland's overall funding program. A separate piece of the formula uses pupil weights to calculate additional aid for students who are low-income or FARMs students (0.97), ELL students (1.0), and special education students (0.74). These types of weights are common fixtures in school funding formulas, as they reflect the overall higher costs associated with educating these students. But, as discussed in Section III, using an adjustment for geographic location that is based on a hedonic wage model and *also* including pupil weights based on their impact on total expenditures may over-estimate the costs associated with special needs students. That is, although it is widely recognized that low-income, ELL, and special education students do require additional expenditures, the additional spending is due partly to teachers demanding higher salaries to teach these students (for reasons that the State may not actually want to compensate) and partly to schools and districts hiring more teachers and using more of other inputs to achieve similar performance levels. Since these student characteristics are included in the hedonic model used to calculate the 2003 GCEI, the wage costs are *already included* in the variation captured in the GCEI. Thus, adjusting the foundation amount for a hedonic-based GCEI and then *also* using weights for special needs students will lead to an overestimation of at least some of the higher costs associated with these students.

VI. Recommendations

Given the discussion and analysis outlined in previous sections, the study team has three specific recommendations for modifying and updating the GCEI.

1. The current wage indices within the GCEI should be replaced with indices estimated using comparable wage methodology.
2. The ECI and the other expenditures (which do not vary significantly) should be removed so that the GCEI cleanly isolates the wage costs associated with geographic location. The wage costs could still consist of a combination of professional and non-professional wages, weighted for budget shares.
3. The GCEI should not be truncated, and should also be integrated into the base foundation formula rather than treated as a separate add-on program.

Comparable Wage to Replace Hedonic Model

As noted earlier, the current GCEI is a hybrid cost adjustment: It does not isolate the impact of geographic location because it also incorporates variation due to district characteristics. Some of these district characteristics are already accounted for elsewhere in Maryland's school funding program. Moreover, one could argue that student need variables should not be included in revenue intended to augment teacher salaries. A CWI does not have this problem, as it cleanly isolates geographic wage costs and does so with data that districts cannot manipulate.

From a policy perspective, a CWI that captures geographic wage costs alone is simple to explain; it clearly captures a cost that is outside district control. Perhaps even more importantly, the data requirements for a CWI are far less onerous than the requirements for a hedonic model; a CWI is simply much easier and quicker to estimate and update annually. At the time of the original analysis (DG2003), comparable wage methods were not as commonly used. This was in part because the data needed to estimate the full model were only collected as part of the long form on the decennial Census. Thus, although there were ways to update a CWI in intervening years, such methods were not as accurate as re-estimating the full model with the appropriate data each year. Now, the data are collected continuously through the American Community Survey, so annual updates are easily accomplished. This is an important benefit because, although any GCEI is unlikely to change dramatically within the time frame of a few years, the longer the time between updates, the larger (and more politically contentious) the changes are likely to be. Annual updates, in which the change for any individual district will be relatively small, allow the State to make incremental adjustments in aid that may be more politically palatable than larger adjustments.

The one potential disadvantage of a CWI relative to the hedonic-based GCEI is that a CWI generates a single value for all districts within an established area. As discussed in section III, the smallest geographic areas for which ACS data are available at the individual level are the Public Use Microdata Areas (PUMAs) which are areas with approximately 100,000 residents. So a CWI value can only be estimated down to the level of a PUMA. This is less of a problem in Maryland than other states because Maryland school districts line up with counties; thus, a unique value could still be estimated for half of the districts. It is only the less populated counties that are combined within one PUMA. For example, Wicomico, Worcester, and Somerset are all in one PUMA and would therefore have a common value in a CWI (see Table 2). However, given how the GCEI has been implemented over the last decade, the use of a common index across counties is potentially moot in all but four districts. Because the state has truncated all GCEI values at 1.0, several low-cost districts already are treated as if they have the same value; for example, the three districts named above already all receive aid as if they have the same GCEI value of 1.0 because their actual index values are below that.

Table 2: Maryland Districts by PUMA

PUMA	Districts
100	Allegany, Garrett
200	Washington
300	Frederick

400	Carroll
700	Cecil
1300	Caroline, Dorchester, Kent, Queen Anne's,
1400	Somerset, Wicomico, Worcester
1500	Calvert, St. Mary's
1600	Charles
1001-1007	Montgomery
1101-1107	Prince George's
1201-1204	Anne Arundel
501-506	Baltimore
601-602	Harford
801-806	Baltimore City
901-902	Howard

Although some districts would 'share' a CWI value, it is also important to keep in mind that the purpose of the CWI is to capture the variation in the wages necessary to attract and retain employees that is due to location characteristics. Thus, the appropriate unit of measurement is the regional labor market, not necessarily just the boundaries of a given district, and a common CWI value for multiple districts may still be appropriate as long as workers can commute within the overall area with relative ease.

Given the small number of districts that would be affected by this aspect of switching to a comparable wage approach, and given the numerous other advantages, particularly in terms of simplifying estimation and actually capturing geographic costs cleanly, it is the recommendation of the research team that the hedonic wage indices in the current GCEI be replaced with CWIs.

Take Energy and Other Costs Out of the Maryland GCEI

In the school finance adequacy literature, almost all discussions of geographic location costs focus on how to measure the impact of location on wages (see Taylor and Fowler, 2006, for summary). Geographic location *can* also affect total costs if other input prices or levels vary systemically from location to location; however, it is unlikely that prices for physical inputs would vary systematically across districts (barring discrimination on the part of suppliers). Therefore, most of this variation is likely to come through impacts on input levels. For example, districts located in rural, sparsely populated locations may need to use more buses for student transportation, or districts in very hot or very cold locations may use more electricity for cooling and heating. However, there are two problems with using the ECI within the GCEI as is currently done. First, the benefits of measuring variation in energy costs with a hedonic index seem outweighed by the disadvantages. The hedonic ECI model only captures about 30 percent of the variation in energy costs, which in turn are less than three percent of district budgets. Thus, the ECI represents a very small amount (approximately one percent) of the overall variation in total district costs. At the same time, it is more time consuming to collect the data needed to estimate the ECI, as these data must be collected directly from districts instead of from some central source. Furthermore, the data needed to estimate the ECI are subject to change over time (DG2009), making updates problematic. Second, it is unclear why total energy costs are combined with wage costs in the GCEI. Another physical input cost that could also vary with location is transportation and that is funded through a separate program, rather than embedded in the foundation formula. To the extent that the State wants to compensate districts separately and explicitly for these costs, the research team recommends that approach for energy as well.

In their original report, DG2003 warned that, "the results of the energy analysis should be used cautiously, and the issue of whether to include an energy cost index in the GCEI should be explored in a couple of years…" (DG2003, 66). Given the complexity of the energy market, and the relatively small share of district budgets that energy represents, it does not seem worth the time and effort required to try to capture and compensate explicitly for variation in these costs. If further investigation of these costs is desired, then the State should consider the approach discussed in Rose, et al. (2008), in which variation in residential energy consumption is considered as an external measure of the local climate-related energy costs.

The GCEI also holds constant the seven percent (on average) of district budgets spent on "other instructional costs." Given that these do not vary, it is unclear why they are explicitly included. Removing this component would have no impact on the resulting index.

Use the Full Variation in the Maryland GCEI and Integrate into Base Foundation Formula

As discussed in Section V, truncating the GCEI values at 1.0 puts high-cost districts at a relative disadvantage, regardless of how the GCEI is calculated. Presumably, the decision to truncate the index was a political one – either to avoid the problem of some districts "losing" revenue or to reduce the overall revenue needed to fund the program. To avoid districts "losing" revenue, one alternative is simply to re-value the index so that the base value is the lowest-cost district, rather than the average. (That is, the value for the lowest-cost district would be moved up to 1.0 and all other districts adjusted accordingly.) However, this could be costly for the state.

Another option that would preserve the full variation in the index would be to integrate the GCEI into the base foundation formula but to phase in implementation with a Hold Harmless provision. That is, districts with current values of the GCEI below 1.0 (that have been receiving more revenue than warranted, given their costs), would have revenue calculated with their appropriate index value. At the same time, their allocation would be maintained at the level of the previous year. Over time, as the formula's foundation amount per pupil is increased for inflation, lower-cost districts would not receive the same increases in revenue as higher-cost districts; eventually, the index would be fully implemented with the appropriate values.[10] Integrating the GCEI into the base formula, rather than as a separate add-on, potentially has the advantage of making the funding less politically vulnerable.

[10] This same approach could be used with the index normed to a minimum base value of 1.0 so that even when the index is fully implemented, it will not appear that any district is ever receiving less aid than they "should" be.

VII. Conclusion

This report has reviewed methods for estimating the variation in educational costs associated with geographic location in order to evaluate the current Maryland Geographic Cost of Education Index and make recommendations for possible revisions. The focus has been primarily on the geographic variation in wage costs, given that the main impact of location on district costs is through wages, which in turn comprise the largest share of district budgets. The three methods that analysts use to capture this geographic variation in wage costs are cost of living, CWI, and hedonic wage models. While each has strengths and weaknesses, the CWI approach has become commonly used in state policy because of the relative simplicity of the model and the availability of data. A CWI is relatively straightforward to create and update on an annual basis; it also has the advantage of being clearly beyond the control of local districts, as there are no data used that are generated by schools. In contrast, the data requirements and statistical complexity of the hedonic approach make calculating and updating even a fairly simple hedonic wage index more difficult than either of the alternative approaches. A hedonic model also conflates variation due to geographic location with costs associated with student characteristics, such as poverty; this may be particularly problematic when those costs are already accounted for elsewhere in the funding system.

The current Maryland GCEI is based on two hedonic indices for professional and non-professional district workers, a hedonic index of energy costs, and a non-varying measure of other instructional expenditures. It is included in the Maryland school finance program as an add-on to the base foundation formula and the index is truncated at 1.0. (That is, districts with values less than 1.0 are treated as if their value is 1.0.) Given the advantages that the CWI provides over hedonic methods, it is recommended that Maryland replace the wage indices within the current GCEI with CWIs. These indices can then be easily updated each year; annual changes in the index are likely to be quite small, and certainly smaller than if there are several years between updates.

It is also recommended that the ECI and the other expenditures should be removed so that the GCEI cleanly isolates the wage costs associated with geographic location. Finally, the GCEI should not be truncated, but should also be integrated into the base foundation formula, since truncating the index removes much of the variation in the index and puts high-cost districts at a relative disadvantage. Thus, incorporating the full range of cost differentials is more consistent with Maryland's stated goals of funding an adequate education for all students.

References

Andrews, M., Duncombe, W., & Yinger, J. (2002). Revisiting economies of size in American education: are we any closer to a consensus? *Economics of Education Review*, *21*(3), 245-262.

Baker, B. D. (2005). The emerging shape of educational adequacy: From theoretical assumptions to empirical evidence. *Journal of Education Finance*, 259-287.

Baker, B. D., Taylor, L. & Vedlitz, A. (2008). Measuring Educational Adequacy in Public Schools (Report to the National Research Council). Retrieved 8/11/15 from http://www.educationjustice.org/assets/files/pdf/Resources/Policy/Funding%20Systems/Adequacy%20estimates%20and%20the%20implications%20of%20common%20standards%20for%20the%20cost%20of%20instruction.pdf.

Betts, J. R., Zau, A., & Rice, L. (2003). *Determinants of student achievement: New evidence from San Diego* (1-5821). San Francisco, CA: Public Policy Institute of California.

Chambers, J. G. (1998). *Geographic variations in public schools' costs*. US Department of Education, Office of Educational Research and Improvement, National Center for Education Statistics.

Department of Legislative Services (2014). *Education in Maryland*, Legislative Handbook Series, Vol. IX. Annapolis, MD.

Duncombe, W. & Goldhaber, D. (2003). *Adjusting for Geographic Differences in the Cost of Educational Provision in Maryland*, Report Prepared for the State of Maryland, December 31, 2003.

Duncombe, W. & Goldhaber, D. (2009). *Adjusting for Geographic Differences in the Cost of Educational Provision in Maryland, Revisions to the Original Report*, Prepared for the Maryland State Department of Education, August 1, 2009.

Fowler, W. J., Jr. & Monk, D. H. (2001). *A Primer for Making Cost Adjustments in Education* (NCES 2001–3230). Washington, D.C.: U.S. Department of Education, National Center for Education Statistics.

Glenn, W., Griffith, M., Picus, L.O., Odden, A. (2015). *Analysis of School Finance Equity and Local Wealth Measures in Maryland*. Denver, CO: Augenblick, Palaich & Associates.

Hirsch, E. (2008). Key Issue: Identifying Professional Contexts to Support Highly Effective Teachers. *National Comprehensive Center for Teacher Quality*. Retrieved 8/11/15 from http://www.gtlcenter.org/sites/default/files/docs/ProfessionalContexts.pdf

Imazeki, J., & Goe, L. (2009). The Distribution of Highly Qualified, Experienced Teachers: Challenges and Opportunities. TQ Research & Policy Brief. *National Comprehensive Center for Teacher Quality*.

Imazeki, J., & Reschovsky, A. (2003). Financing adequate education in rural settings. *Journal of Education Finance*, 137-156.

Maryland State Department of Education. (2014). Selected Financial Data Maryland Public Schools 2012-2013, Part 2--Expenditures. MSDE-LFRO 12/2014. Baltimore, MD.

McMahon, W. W. (1996). Intrastate Cost Adjustments. *Selected Papers in School Finance*, 89.

Monk, D. H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of education review 13*(2), 125-145.

Odden, A.R. & Picus, L.O. (2014). *School Finance: A Policy Perspective 5th Edition*, McGraw-Hill Education.

Reschovsky, A., & Imazeki, J. (1997). The development of school finance formulas to guarantee the provision of adequate education to low-income students. *Developments in school finance*, *124*.

Rose, H., & Sengupta, R. (2007). *Teacher compensation and local labor market conditions in California: implications for school funding*. Governor's Committee on Education Excellence.

Rose, H., Sengupta, R., Sonstelie, J., & Reinhard, R. (2008). *Funding Formulas for California Schools: Simulations and Supporting Data*. Public Policy Institute of California.

Taylor, L. L., & Fowler Jr, W. J. (2006). A Comparable Wage Approach to Geographic Cost Adjustment. Research and Development Report. NCES-2006-321. *National Center for Education Statistics*.