Updating the Wyoming Hedonic Wage Index

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Submitted by:

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Executive Summary

Some school districts must pay a premium to attract the same high quality teachers available to other districts at lower cost. A regional cost index captures this effect by indicating how much more or less it costs each school district to recruit and employ equivalent school personnel.

Wyoming is one of the few states that explicitly incorporate a regional cost index into their school finance formulas. The regional cost adjustment (RCA) used in the Wyoming school funding model (funding model) is designed to provide additional resources to school districts with higher labor costs.

The RCA is an amalgam of two alternative regional cost indices. The first is the Wyoming Cost of Living Index (WCLI). The second is the 2005 Wyoming Hedonic Wage Index (HWI). Both indices are centered on 100 and have a similar interpretation. An index value of 100 indicates that labor costs are equal to the state average. An index value of 110 indicates that labor costs are 10 percent above the state average, whereas an index value of 90 indicates that labor costs are 10 percent below the state average.

During both the 2005 and 2010 recalibrations of the funding model, state consultants recommended that the RCA be based solely on the Wyoming HWI. However, the Legislature decided that each district's RCA would be the larger of the WCLI, the 2005 Wyoming HWI or 100. Thus, the RCA only applies to school districts where labor costs are above average. Districts where labor costs are below the state average receive no adjustment, and are therefore treated as if their costs were higher than they are measured to be. As a result, from a strict equity perspective, the RCA overfunds districts with below average costs.

The RCA may also overfund districts where the RCA is based on the WCLI. Researchers have long argued that the cost of living overstates the cost of hiring in locations that have both a high cost of living and attractive amenities that make it a desirable place to live and work. In addition, there is reason to believe that the WCLI overstates the cost of living in Wyoming counties with relatively high housing costs. As a general rule, the residents of Wyoming spend a smaller share of their budgets on housing than the residents of any other state except Iowa and North Dakota, yet the WCLI is constructed assuming that consumers in Wyoming spend a much larger share of their budget on housing than the typical city-dweller in the rest of the United States. This assumption gives too much weight to housing costs in the construction of the WCLI, making the WCLI artificially high in areas where housing costs are high.

The WCLI is updated annually in the funding model, but the HWI is only updated as part of the funding model recalibration that occurs every five years. This report contributes to the 2010 recalibration effort by updating the 2005 Wyoming HWI in five important ways:

1. The update uses more recent data and a much longer time series. Using a longer time series allows for a richer specification of discretionary and uncontrollable cost factors and should lead to more precisely measured regional cost adjustments.[1]
2. This analysis estimates a hedonic model of total salary, not just base salary. Teachers are likely to consider their total salary not just their base salary when deciding whether to accept a new position or stay in their existing one, so it is appropriate to treat supplemental salary as just another part of an individual's compensation package.
3. This analysis uses a much richer set of discretionary factors. Broadening the set of teacher characteristics included in the model strengthens the argument that the resulting regional cost index reflects only factors that are outside of school district control.
4. This analysis includes an extended version of the National Center for Education Statistics' Comparable Wage Index (CWI) as one of the uncontrollable costs factors. The CWI, which was not available for the previous analysis, provides a direct measure of the labor market alternatives available to Wyoming school teachers. The CWI lacks the geographic detail needed to make it a good substitute for the WCLI or the HWI in the construction of the RCA. Embedding it in the hedonic wage model is the best available strategy for incorporating the information from the CWI into Wyoming's RCA.
5. This analysis revises and expands the set of uncontrollable cost factors to improve the predictive power of the hedonic wage model.

Using the updated hedonic wage model, this analysis generates four alternative updates to the 2005 Wyoming HWI. All of the alternatives are highly correlated with one another, and with the exception of a few cases, yield similar cost adjustments. Differences among the alternatives arise from differences in statistical technique.

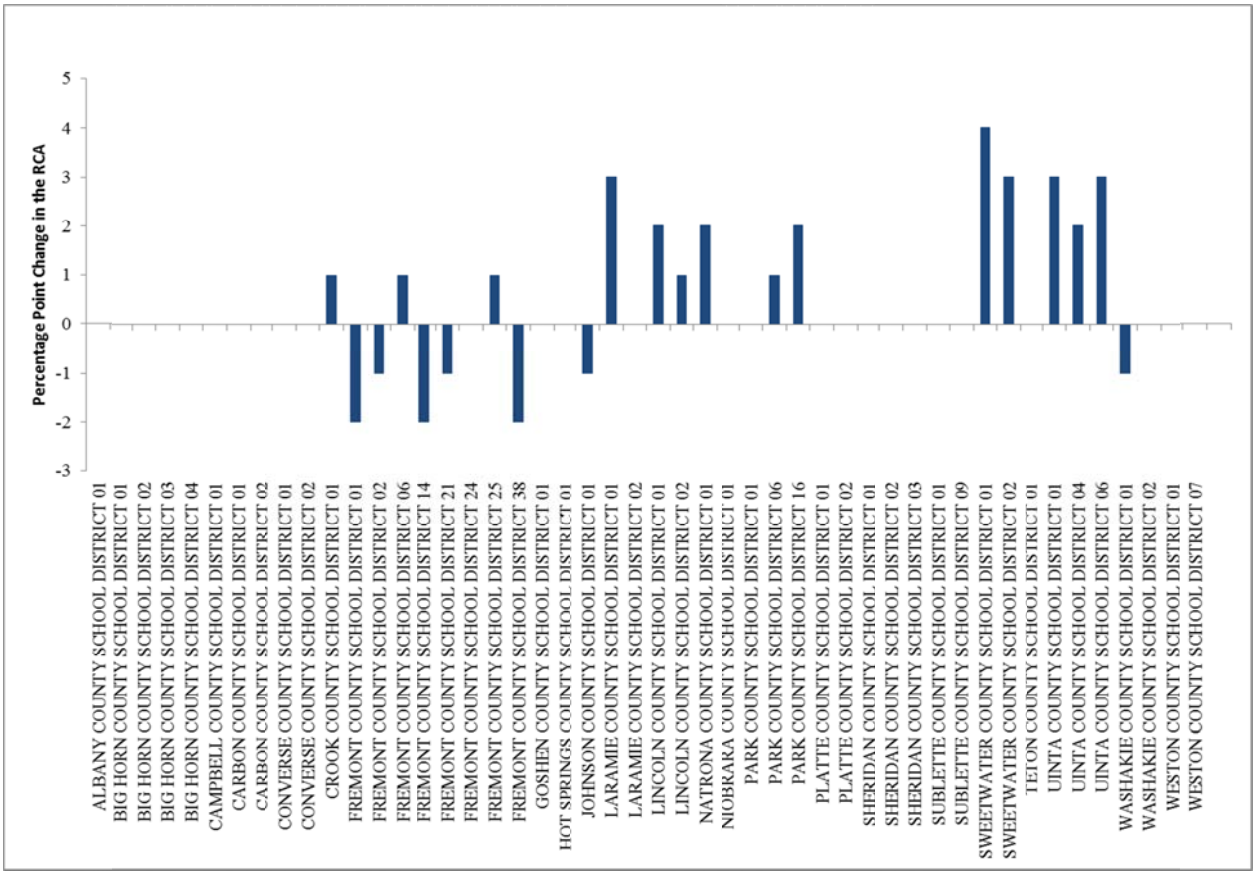
Of the four alternatives, the AR Random Effect HWI is the best choice for updating the 2005 Wyoming HWI. It incorporates all of the available information about teacher salaries and some information about persistent but unmeasured teacher characteristics without losing the ability to measure the impact of the stable cost factors like a high cost of living or geographic isolation. It indicates that the cost of hiring teachers is 23 percent higher in the highest-cost Wyoming school district (Teton County School District #1) than in the lowest-cost Wyoming school district (Niobrara School District #1).

Figure E.1 illustrates how updating would change the RCA, assuming that the AR Random Effects HWI would simply replace the 2005 Wyoming HWI in the calculation of the RCA. Thus, the updated RCA would be the larger of the WCLI, the updated HWI or 100. As the figure illustrates, most Wyoming school districts would have the same RCA after updating as they do

[1] Discretionary factors are those that are generally considered to be within the control of local school districts, at least over the long run. Factors typically categorized as discretionary include teacher demographics, teaching assignments, and the length of the school year. Uncontrollable factors typically include some measure of the cost of living, the degree of geographic isolation and student demographics.

today. No school district would experience more than a 2 percentage point decline in the RCA, but school districts in Laramie, Sweetwater and Uinta County would experience more than a 2 percentage point gain. The RCA for nine school districts (including Teton County School District #1) would continue to be based on the WCLI and therefore would be unaffected by the updating.

Figure E1: The Changes in the Statutory RCA Arising From Updating the HWI



Source: Author's calculations.

The updated HWI is a direct measure of regional variations in the cost of educator labor. If the RCA were working as intended, then the cost adjustments that school districts receive would be highly correlated with the uncontrollable costs that they incur. Instead, because of the three-way design of the RCA, only 22 of the 48 school districts in Wyoming will receive the regional cost adjustment indicated by the updated HWI. The remaining districts will receive a larger adjustment. Equity goals in Wyoming would be better served if the Legislature replaced the three-way design of the RCA, and simply used the updated HWI as the sole source of regional cost adjustments.

Introduction

Some school districts must pay a premium to attract the same high quality teachers available to other districts at lower cost. Districts in urban areas must pay more than other districts to compensate for the higher cost of living and districts in isolated areas may need to pay a premium to compensate for the lack of local amenities. Districts with large numbers of students who are English language learners may find that they need to pay more than other districts to compensate for the more challenging teaching environment. A regional cost index captures this effect by indicating how much more or less it costs each school district to recruit and employ equivalent school personnel.

Wyoming is one of the few states that explicitly incorporate a regional cost index into their school finance formulas.[2] The regional cost adjustment (RCA) in the Wyoming school funding model (funding model) is designed to provide additional resources to school districts with higher labor costs. As such, the RCA applies only to the salary components of the funding model.

The RCA is an amalgam of two alternative regional cost indices. The first is a three-year moving average of the Wyoming Cost of Living Index (WCL).[3] The second is the 2005 Wyoming Hedonic Wage Index (HWI).[4] Both indices are centered on 100 and have a similar interpretation. An index value of 100 indicates that labor costs are equal to the state average. An index value of 110 indicates that labor costs are 10 percent above the state average, whereas an index value of 90 indicates that labor costs are 10 percent below the state average.

During both the 2005 and 2010 recalibrations of the funding model, state consultants recommended that the RCA be based solely on the HWI. However, the Legislature decided that each district's RCA would be the larger of the WCLI, the HWI or 100. Thus, the regional cost adjustment only applies to school districts where labor costs are above average. Districts where labor costs are below the state average receive no adjustment, and are therefore treated as if their costs were higher than they are measured to be using the WCLI and the HWI. From a strict equity perspective, the RCA overfunds districts with below average costs.

The WCLI is updated annually in the funding model, but the HWI is only updated as part of the funding model recalibration that occurs every five years. This report contributes to the 2010 recalibration effort by updating the 2005 Wyoming HWI using data on school district costs that were not available at the time of the 2005 recalibration, and by exploring the implications of updating the HWI for the RCA. The analysis suggests that most Wyoming school districts

[2] Other states that have regional cost adjustments in their funding models include Florida and Texas.

[3] The WCLI used in the RCA is the average of the six consecutive semi-annual index reports completed by January 1 of the immediately preceding school year. For more on the Wyoming Cost of Living Index, visit http://eadiv.state.wy.us/WCLI/Cost.html

[4] For more on the Hedonic Wage Index, see Baker (2005).

would be unaffected by any update to the HWI, but that districts in Laramie, Sweetwater and Uinta counties would particularly benefit from the change.

Regional Cost Adjustments in Theory and Practice

Three basic strategies have been used to develop most regional cost adjustments— hedonic wage indices (also known as teacher cost indices), cost of living indices and comparable wage indices.[5] The funding model RCA already incorporates two of the three strategies. This section discusses the theoretical foundations, advantages and disadvantages of each approach.

Hedonic Wage Indices

There are three basic reasons why average teacher salaries differ from one school district to the next. First, differences in teacher characteristics will drive differences in wages. All other things being equal, experienced teachers with advanced degrees earn higher wages than other teachers. Second, differences in working conditions and teaching assignments drive differences in salaries. Like all other types of workers, teachers demand a premium to accept jobs that are relatively unattractive or arduous, but may be willing to accept a lower salary from a school district where the job is particularly fulfilling or the working conditions are unusually pleasant. Finally, locational characteristics drive differences in wages. Teachers in areas with a low cost of living or an abundance of local amenities will accept a lower nominal wage than otherwise equal teachers in a less attractive locale.

Hedonic wage models use regression analysis to divide the observed variation in teacher salaries into that which is attributable to teacher characteristics, that which is attributable to working conditions and that which is attributable to locational characteristics. Hedonic wage models have a long history in labor economics, and have been used in education finance contexts for more than 30 years. [6]

To construct a regional cost index from a hedonic wage model, researchers categorize the explanatory factors in the model as either discretionary or uncontrollable. Discretionary factors are those that are generally considered to be within the control of local school districts, at least over the long run. Factors typically categorized as discretionary include teacher demographics, teaching assignments, and the length of the school year. Uncontrollable factors typically include some measure of the cost of living, the degree of geographic isolation and student demographics.

The regional cost index is then constructed by predicting the full-time-equivalent salary in each school district, holding constant the influence of the discretionary factors. In other words, a

[5] For more on regional cost adjustments, see Taylor, Chambers and Robinson (2004), Baker (2005), Fowler and Monk (2001), Duncombe and Yinger 2008, or Taylor and Keller (2003).

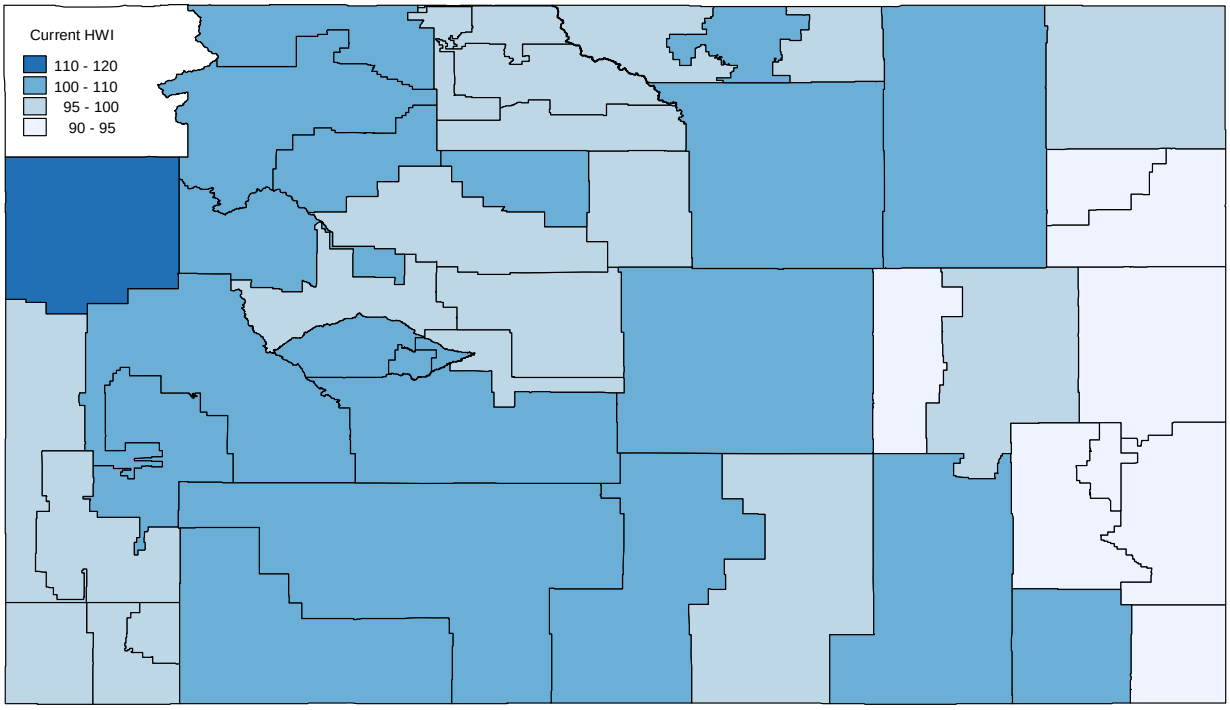
[6] For more on the use of hedonic wage models in education, see Chambers (1995, 1997, 1998), Goldhaber (1999), or Taylor (2010, 2008a and 2008b).

regional cost index reflects how much more or less it costs each school district to recruit and employ equivalent school personnel.

The 2005 Wyoming HWI is based on a hedonic wage model of base salaries estimated by Bruce Baker using data from the 2003-04 and 2004-05 school years. The uncontrollable cost factors that drive differences in the 2005 Wyoming HWI are: the WCLI, four measures of geographic isolation[7], three measures of student demographics,[8] and the district average supplemental salary. The supplemental salary variable was included on the grounds that "some districts have the advantage of being able to provide more supplemental earnings opportunities not solely as a function of budgetary discretion but as a function of uncontrollable conditions," (Baker 2005, p 230). The index values used in the current RCA are based on the values of the uncontrollable cost factors in 2004-05.

Figure 1 illustrates the geographic distribution of the 2005 Wyoming HWI. Darker colors indicate higher index values.

Figure 1: The 2005 Wyoming Hedonic Wage Index



Source: Baker (2005).

[7] The four measures of geographic isolation are the population density, the distance to Yellowstone, the distance to a city with a population of at least 15 thousand, and the distance to a city with a population of at least 50 thousand.
[8] The student demographic variables are the school-level unduplicated "at risk" counts, the percent of special education students, and the percent of mobile students. For construction of the index, all three variables were averaged across 2003-04 and 2004-05.

As the figure illustrates, according to the 2005 Wyoming HWI there is substantial variation in the teacher salary cost from one part of Wyoming to the next. The lowest index values are found in the rural and eastern parts of the state, while the highest index values are in Teton County. The 2005 HWI for Teton County School District #1, the school district with the highest index value, is 118 while the 2005 HWI for Platte County School District #2, the school district with the lowest index values, is 93. Thus, the 2005 HWI indicates that labor costs differ by as much as 27 percent (118/93) from one part of Wyoming to the next.

Advantages and Disadvantages

The hedonic wage approach to regional cost adjustment has a number of attractive features. Instead of using indirect measures of labor cost, an HWI is based directly on teacher salaries, making it clearly relevant to educational costs. The hedonic wage approach goes beyond the direct comparison of district salaries, however, by using regression analysis to control for differences across districts in the mix of school district personnel. HWIs are constructed from data at the school or school district level, allowing the resulting index to pick up systematic differences in cost from one district to another within the same labor market.

There are also a number of potential disadvantages to the hedonic wage approach. HWIs rely on statistical technique and researcher judgment to distinguish between discretionary factors and uncontrollable costs. Statistical models and judgment calls are inherently subject to criticism. Important aspects of teacher quality may not be captured by the data used in the estimation, raising the risk of bias in the resulting cost index (Goldhaber 1999). Cost indices that are based on school expenditure data have also been criticized as subject to school district manipulation (McMahon 1994), biased by the noncompetitive nature of the teacher labor markets (Hanushek 1999), and likely to misidentify high-spending districts as high-cost districts (Rothstein and Smith 1997).

The inclusion of the district's average supplemental salary in the construction of the 2005 Wyoming HWI makes the index particularly vulnerable to criticism. As Baker acknowledges, the extent to which a school district provides supplemental earnings opportunities is at least partially discretionary. Basing the 2005 Wyoming HWI on a variable that can be so easily manipulated by school districts makes it harder to argue that the 2005 Wyoming HWI reflects only cost variations that are outside of school district control.

Cost-of-Living Indices

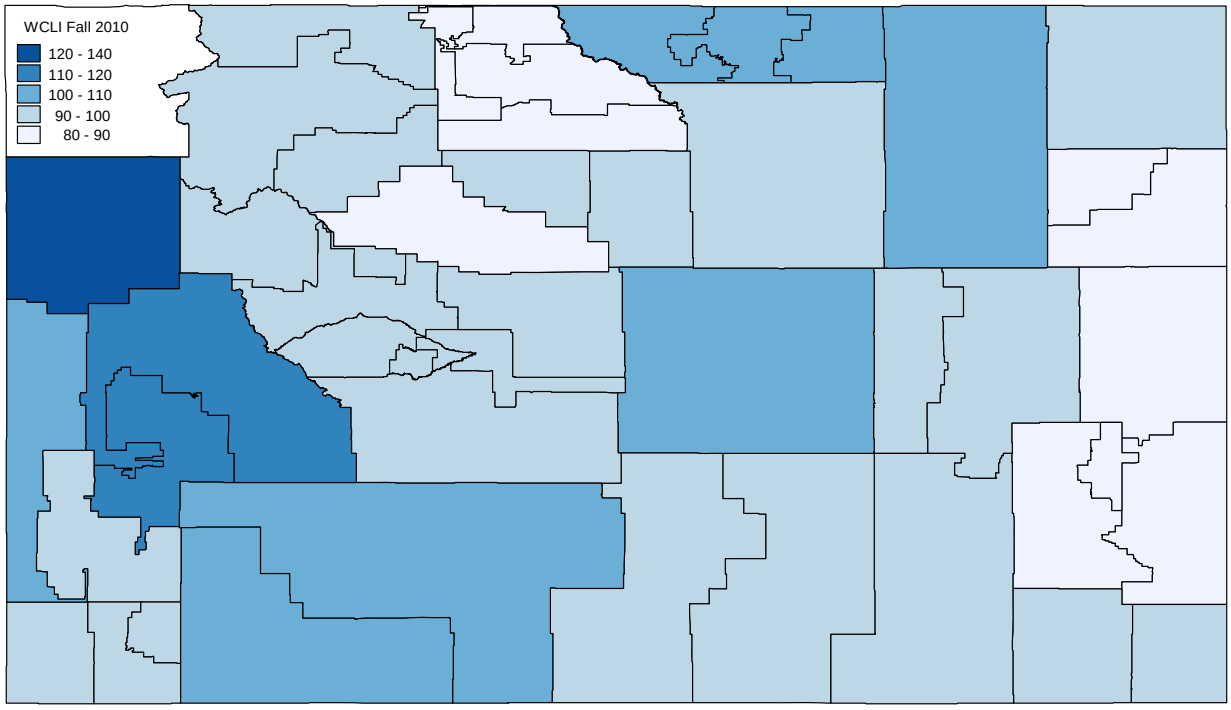
The basic premise underlying the cost-of-living approach is that districts in areas with a high cost of living will need to pay higher salaries to attract school employees, and therefore will need more funding than other districts just to be able to provide the same level of services. Typically, cost of living indices are constructed by tabulating the cost of a specified collection of goods and services used by consumers in each community in a method called the "market-basket"

approach. Differences among communities in the cost of a basket of consumer goods and services capture differences in the cost of living.

The WCLI is modeled after the U.S. Bureau of Labor Statistics' Consumer Price Index for urban consumers (CPI-U). It is produced bi-annually by the Wyoming Department of Administration & Information's Economic Analysis Division. Twice a year, the Division collects data on prices for food, housing, apparel, transportation, medical services, and recreation and personal care. The WCLI is a weighted average of the prices for each of these components, where the weights reflect the share of the typical consumer's budget devoted to each component.

Figure 2 illustrates the geographic distribution of the WCLI for fall 2010. Again, darker colors indicate higher index values.

Figure 2: The Wyoming Cost of Living Index, Fall 2010



Source: Wyoming Department of Administration & Information's Economic Analysis Division.

Clearly, the WCLI also indicates that there is substantial variation in the cost of living from one part of Wyoming to the next. The WCLI for Teton County School District #1, the school district with the highest index value in fall 2010, was 132 while the WCLI for Platte County School Districts #1 and #2, the school districts with the lowest index values in fall 2010, was 85. Thus, the WCLI indicates that labor costs differ by as much as 55 percent from one part of Wyoming to the next. The range of the WCLI is roughly twice as much as the range of labor costs indicated by the 2005 Wyoming HWI.

The wide range of index values across the state and the particularly high index values in Teton County are almost exclusively attributable to the housing component of the WCLI. Regional differences in housing cost explain 95.9 percent of the regional variation in the WCLI.

Advantages and Disadvantages

There are a number of advantages to using a cost-of-living index to adjust for regional variations in labor cost. The clearest advantage is that cost-of-living indices measure cost factors that are beyond the control of school administrators. There is no risk that this cost adjustment will confuse high spending districts with high cost districts. The cost-of-living approach is also straightforward. While there are many complex measurement issues involved in the development of price indices (Rothstein and Smith 1997, Wynne and Sigalla 1993), the approach produces cost measures that are familiar and can be easily understood.

There are also a number of disadvantages to the cost-of-living approach. McMahon (1994) argues that teachers may live outside the district in which they teach, so the cost-of-living index values for districts may not accurately reflect the actual cost of living for the teachers they employ. Education cost adjustments based on a market basket may also over-compensate districts in locations that have both a high cost of living and attractive amenities that make it a desirable place to live and work (Rothstein and Smith 1997, Stoddard 2005).

Furthermore, a market-basket approach relies on comparability. For it to work reliably, people in various locations must fill their baskets with a similar mix of goods and services. If people in urban areas buy a different mix of items than do people in rural areas, then comparability breaks down and the index may become disconnected from the actual variations in the cost of living (Rothstein and Smith 1997).

The WCLI was designed to use roughly the same market basket as the CPI-U (Wyoming Department of Administration and Information, Division of Economic Analysis 1999). However, over the years, the two indices have drifted apart. In fall 2010, the CPI-U was constructed assuming that housing represented 41.5 percent of the budget for a typical urban consumer[9] while the WCLI was constructed assuming that housing represented 48.0 percent of the budget.[10] In other words, the market basket used in the construction of the current WCLI presumes that consumers in Wyoming spend more on housing than the typical urban consumer in the rest of the United States. They don't. As a general rule, the residents of Wyoming spend a smaller share of their budgets on housing than the residents of any other state except Iowa and North Dakota.[11] Thus, the WCLI's current market basket gives too much weight to housing

[9] See http://stats.bls.gov/cpi/cpiri2010.pdf.

[10] See http://eadiv.state.wy.us/wcli/NewsRelease-4Q10.pdf

[11] In the nation as a whole, 40 percent of households spend more than 30 percent of their incomes on housing; in Wyoming, Iowa and North Dakota, less than 29 percent of households spend so much on housing. The share of households spending more than 30 percent of their incomes on housing was calculated by taking a weighted average of the share of owner-occupants spending more than 30 percent of their incomes on housing and the share of renters

costs in the construction of the WCLI, and overstates the cost of living in Wyoming counties with relatively high housing costs.

For most Wyoming counties, reducing the weight on housing in the Wyoming market basket would have little impact on the WCLI, but for a handful of counties such a change would be substantial. If the WCLI were constructed using the same market basket as the CPI-U (an assumption that arguably still gives too much weight to housing in the Wyoming market basket) then the fall 2010 WCLI for Goshen, Hot Springs and Niobrara Counties would have been 92 rather than 90, and the fall 2010 WCLI for Teton County would have been 128 rather than 132.

Comparable Wage Indices

The third approach to regional cost adjustment is to recognize that teachers are not the only workers who are sensitive to the cost of living and the general attractiveness of the community. All types of workers demand a higher salary where the price of a home is high, the climate is inhospitable, or the closest movie theater is many miles away. A comparable wage index measures regional variations in the price that school districts must pay to attract high quality teachers by observing regional variations in the salaries of comparable professionals who are not teachers (Taylor and Fowler 2006, Rothstein and Smith 1997, Guthrie and Rothstein 1999). Intuitively, if the butcher, the baker and the candlestick maker all earn 10 percent more than the state average for their professions in Laramie, then the cost of hiring teachers in Laramie should also be 10 percent higher than the state average.

The National Center for Education Statistics' Comparable Wage Index (CWI) was designed specifically to capture regional wage differences for college graduates who are not educators.[12] The baseline estimates come from a regression analysis of the individual earnings data from the 2000 U.S. Census. Annual updates to that baseline come from regression analyses of occupational earnings data provided by the U.S. Bureau of Labor Statistics (BLS).[13] The CWI is not available from NCES for the years after 2005, but I have updated it through 2010 using the methodology I used to construct the NCES CWI. (See Appendix A for details on the update to the CWI.) The CWI is centered on the national average wage in 1999. A CWI of 100 indicates that the wage level is equal to the national average for 1999. A CWI of 110 indicates that the wage level is 10 percent above the wage level that was the national average in 1999.

The updated CWI measures the relative cost of labor for each state and for 800 U.S. labor markets—including four in Wyoming—Western Wyoming (Park, Teton, Sublette, Sweetwater, Lincoln and Uinta counties), Central Wyoming (Fremont, Natrona and Carbon counties), Eastern

spending more than 30 percent of their incomes on housing. The weights were the shares of housing units in each type. The data come from the 2011 Statistical Abstract of the United States. For the data tables, visit http://www.census.gov/compendia/statab/cats/construction_housing/homeownership_and_housing_costs.html

[12] Educators are individuals who are employed in the elementary and secondary education industry (regardless of occupation) or who are employed in an elementary or secondary education occupation (regardless of employer).

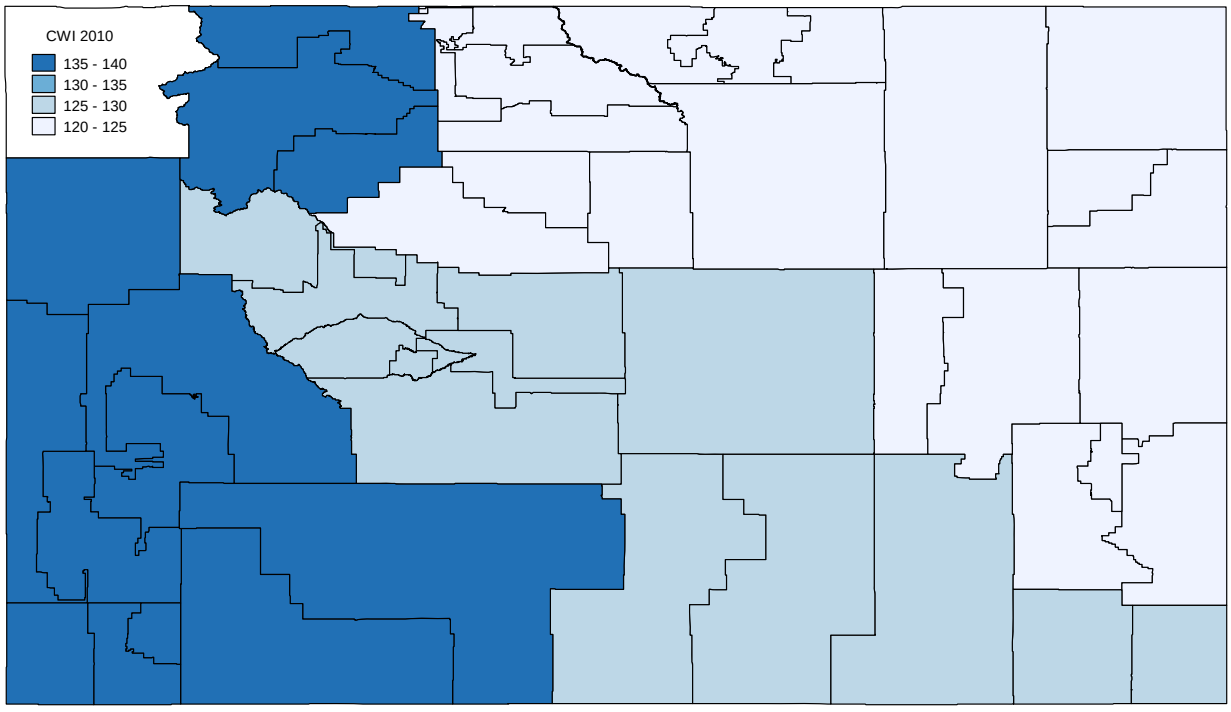
[13] For more on the estimation of the NCES CWI, see Taylor and Fowler (2006).

Wyoming (Big Horn, Hot Springs, Washakie, Sheridan, Johnson, Campbell, Crook, Converse, Niobrara, Platte, Goshen and Weston counties) and the Cheyenne and Laramie metropolitan areas (Albany and Laramie counties).[14]

Each Wyoming school district has been matched to the CWI for its county of record. Figure 3 illustrates the updated CWI for each Wyoming school district in 2010. Again, darker colors indicate higher index values.

The figure demonstrates that the CWI is substantially higher in Western Wyoming than in other parts of the state. The 2010 CWI ranges from 123 in Eastern Wyoming, to 137 in Western Wyoming. Once again, Teton County School District #1 has the highest index value in the state, and Platte County School District #2 has the lowest value. However, the difference between the two is only 11 percent for the CWI, where it was 55 percent for the WCLI. A smaller variation in comparable wages than in the cost of living implies that the relatively high-rent parts of the state must also boast local amenities that make people willing to accept a lower real wage than they would otherwise require. In other words, the attractions of living in Teton County make people willing to accept salaries that are not high enough to fully offset the higher cost of living. The smaller range to the CWI may also reflect the lack of geographic variation in this index.

Figure 3: The Wyoming CWI, 2010



Source: Author's calculations using OES data and the NCES CWI.

[14] These geographic areas are based on place-of-work areas as defined by the Census Bureau. See Appendix Table A.1 for the index values for each of the four Wyoming labor markets.

Advantages and Disadvantages

The principal advantage of a comparable-wage index is that it avoids the difficult problems associated with distinguishing variations in school district expenditures that are discretionary from those that are uncontrollable. Like the WCLI, the CWI is completely outside of school district control. After all, it is unlikely that school districts will be able to manipulate the general labor market. Furthermore, unlike a WCLI, the CWI reflects not only differences in the cost of purchased goods and services (like housing) but also differences in amenities (like the climate or access to health care).

The disadvantages of a comparable-wage index are threefold. As with the WCLI, comparability is always a concern. If the non-educator population differs substantially from the educator population in terms of age, educational background, or tastes for local amenities, then the CWI may overstate (or understate) the wage differentials that teachers will require. By focusing on college graduates and controlling for demographic and occupational characteristics, the CWI largely addresses demographic differences, but the methodology cannot control for possible differences in tastes. Second, by design, the CWI cannot pick up district-level variations in the price of labor. Every school district in a labor market receives the same index value as every other district in the market. This may be particularly problematic in a sparsely populated state like Wyoming, where the CWI's labor markets cover large geographic areas. Finally, the CWI reflects labor cost differentials only when labor is mobile. If moving costs prevent workers from moving into (or out of) a particular location, then labor cost in that location may temporarily diverge from what would be expected given local amenities and the local cost of living. For example, employers in fast-growing industries and school districts in fast-growing areas may need to pay a temporary premium to attract workers. The CWI cannot capture this effect.

Updating the Hedonic Wage Index

The first step in updating the 2005 Wyoming HWI is to update the underlying hedonic wage model. This analysis updates that model in five important ways.

1. This analysis uses more recent data and a much longer time series. The 2005 HWI was estimated using two years of data covering the 2003-2004 and 2004-05 school years. This analysis covers the six school years from 2005-06 through 2010-11.[15] All 9,489 individuals with complete data who taught full time in a Wyoming public school during that six-year period are included in the analysis.[16] Using a longer time series allows for a richer

[15] Data for this analysis were provided by the Wyoming Department of Education (WDE). Data on earnings, teacher characteristics and job assignments were drawn from the WDE602 fall data collection files for the six school years from 2005-2006 through 2010-2011.

[16] Due to data quality concerns, teacher records with full-time-equivalent (FTE) total salaries greater than $120,000 or less than 80 percent of the first step on the district's salary schedule were excluded from the analysis, as were individuals with a reported FTE less than 0.9 or greater than 1.1, or an FTE in teaching greater than 110 percent of the individual's total FTE.

specification of discretionary and uncontrollable cost factors and should lead to more precisely measured regional cost adjustments.

2. Where the previous analysis treated the prospects for supplemental pay as an uncontrollable cost factor that could influence the base salary a teacher was willing to accept from a district, this analysis takes a different tack. Teachers are likely to consider their total salary not just their base salary when deciding whether or not to accept a new position or stay in their existing one, and school districts have great discretion over the size of the supplements they offer for coaching, tutoring after school or advising the debate team. Therefore, this analysis treats most forms of supplemental salary as just another part of an individual's compensation package, and estimates a hedonic model of total salary, not just base salary.
   The lone exception is stipends for coaching. Coaching stipends in Wyoming vary a lot from district to district. For example, the supplemental salary for being a football coach during the 2010-11 school year ranged from $3,243 to $9,200. Because there is little reason to believe that this variation in coaching stipends reflects regional differences in labor cost (and we have no way of controlling for differences in coaching quality that might successfully explain the differences in salary) all supplemental pay for coaching has been excluded from the measure of total salary.
3. This analysis uses a much richer set of discretionary factors (see Table 1). In addition to the number of contract days and the teacher demographic characteristics included in the previous analysis (indicators for gender, race, advanced degrees, total teaching experience, secondary school assignment) this analysis also includes indicators for the subject matter of the teaching assignment;[17] for whether or not the teacher was assigned to a school with more than 1,000 students; for whether or not the teacher was assigned to a middle school, elementary school or K-12 school; and for whether or not the teacher was assigned to a number of non-teaching activities such as coaching or advising. (Because all of the teachers under analysis were, by definition, assigned to the teaching activity full time, there is no need for an indicator for teaching.) This analysis includes district-level teaching experience and an indicator for first-year teachers to add further richness to the specification of teacher characteristics.
   Broadening the set of teacher characteristics included in the model strengthens the argument that the resulting regional cost index reflects only factors that are outside of school district control.
4. This analysis includes the extended CWI as one of the uncontrollable costs factors. The CWI, which was not available for the previous analysis, provides a direct measure of the labor market alternatives available to Wyoming school teachers. The CWI lacks the geographic detail needed to make it a substitute for the WCLI in the design of the regional cost index. Embedding it in the hedonic wage model is the best available strategy for incorporating the information from the CWI into Wyoming's regional cost adjustment.

[17] The teaching assignments indicators include English, Social Science, Math, Health and P.E., Foreign Language, Vocational Education, Bilingual/ ESL, Fine Arts, Science, Special Education, and Elementary Education. Any teacher could have one or more teaching assignments.

5. This analysis replaces the unduplicated-at-risk percent and the percent mobile students with two alternative measures of student need—the percent of students who are English language learners and the percentage of students who qualify to receive free school lunches. These two variables better explain salaries over the analysis period than do the original student demographic indicators.[18] The list of uncontrollable cost factors also now includes an additional measure of geographic isolation (the population density of the county). The addition of this variable also improves the predictive power of the hedonic wage model.

Table 1: Explanatory Factors from the Hedonic Wage Model for Wyoming Teachers

Discretionary Factors	**Uncontrollable Cost Factors**
Contract days	WCLI
Years of experience in the school district	CWI
Years of experience, total	Miles to Yellowstone
Highest Degree held	Geographic isolation
Teaching Assignment	Miles to nearest city of 50,000[19]
Subject matter indicators (math, science, etc.)	Miles to nearest city of 15,000
Large school (enrollment > 1,000)	Five-mile radius population density
School type (elementary, middle, etc.)	County Population density
Non-Teaching Assignment	Student demographics
Advisor/Sponsor	Percent Free Lunch
Assistant coach	Percent Special Ed.
Coach	Percent English language learners
Classified staff position	
Head teacher	
Principal	
Support staff position	
Tutor	
Other administrator	

Given the list of discretionary and controllable cost factors, attention now turns to choosing the most appropriate estimation strategy. There are a number of reasonable alternatives. Table 2 presents selected results from four alternative estimates of the hedonic wage model of total teacher salaries in Wyoming. (Appendix Table B.1 presents the complete set of regression

[18] The conclusion that the new variables better explain salaries is based on researcher judgment and a series of likelihood ratio tests. The student demographics are lagged one year, so that student demographics in 2008-09 are used to predict teacher salaries in 2009-10.

[19] The distance to the nearest city with a population of 50,000 and the nearest city with a population of 15,000 were calculated as-the-crow-flies using the U.S. Census Bureau's 2009 population estimates and latitude and longitude files for places. For both measures, the nearest city need not be within the state of Wyoming. Indeed, half of the school districts in Wyoming are closer to a city of 50,000 in another state than they are to a city of that size within Wyoming.

coefficients and standard errors.) In all four cases, the dependent variable is the log of total teacher salaries, and there are 39,988 observations.

Table 2: Alternative Specifications of the Hedonic Wage Model

	Pooled Cross Section Model	Between Teachers Model	Teacher Fixed Effects Model	AR Random Effects Model
WCLI	0.4034	0.4311	-0.0043	0.1366
	(0.0110)***	(0.0124)***	(0.0177)	(0.0083)***
Wyoming CWI	0.1739	0.1482	0.3263	0.3577
	(0.0172)***	(0.0185)***	(0.0455)***	(0.0153)***
Five-mile density	0.0108	0.0099	0.0192	0.0153
	(0.0006)***	(0.0006)***	(0.0021)***	(0.0005)***
County population	0.0372	0.0377	0.0164	0.0211
density (log)	(0.0021)***	(0.0020)***	(0.0084)*	(0.0017)***
Distance to 15,000	0.0002	0.0003	-0.0004	-0.0003
population city	(0.0000)***	(0.0000)***	(0.0002)**	(0.0000)***
Distance to50,000	0.0008	0.0007	0.0009	0.0007
population city	(0.0000)***	(0.0000)***	(0.0002)***	(0.0000)***
Distance to	-0.0001	-0.0001	-0.0001	-0.0002
Yellowstone	(0.0000)***	(0.0000)***	(0.0001)	(0.0000)***
Percent free lunch	0.0221	0.0296	0.0386	0.0062
	(0.0064)***	(0.0086)***	(0.0067)***	(0.0035)*
Percent ELL	-0.0131	-0.0243	-0.0212	0.0290
	(0.0077)*	(0.0120)**	(0.0067)***	(0.0042)***
Percent special ed.	-0.0639	-0.1109	0.0298	0.0159
	(0.0151)***	(0.0219)***	(0.0112)***	(0.0068)**
Includes year indicators?	yes	yes	yes	yes
Includes discretionary factors?	yes	yes	yes	yes
Includes teacher fixed effects	no	no	yes	no
Includes teacher random effects?	no	no	no	yes
Observations	38,988	38,988	38,988	38,988
R-squared	0.85	0.83	0.92	0.83
Number of teachers	9,489	9,489	9,489	9,489

Note: Robust standard errors are in parentheses. The asterisks indicate that the coefficient is significantly different from zero at the 10-percent level (*), the 5-percent level (**) or the 1-percent level (***).

All four new HWI models do a good job of capturing variations in teacher salaries. As expected, salaries increase with teaching experience and educational attainment. Teachers with administrative duties earn more than other teachers, all other things being equal, as do teachers with advisory responsibilities and teachers who tutor. Teachers who are assigned to large schools tend to earn more than other teachers, while social science teachers tend to earn less.

Teacher salaries are higher where the CWI is higher, where the population density is higher, and where the share of free-lunch students is higher. All told, the models explain between 83 and 92 percent of the variation in full-time-equivalent teaching salaries in the state of Wyoming over the last six years, depending on the specification.

The first model, the pooled cross-section model, is the simplest. It uses all six years of data, but does not exploit the fact that most teachers and all school districts are observed more than once. The model is estimated using ordinary least squares (OLS) regression. It is presented largely as a baseline for comparison purposes.

The second model, the between-teachers model, uses the same between-effects estimation strategy as was used in the construction of the 2005 Wyoming HWI. The between-teachers model uses only information about differences between teachers, and largely ignores information about the changing experiences and earnings of individual teachers over time. A between-effects model is particularly attractive when there is little variation across time, as is the case when the analysis is based on only two years of data. In such situations, the cross-time variation is as likely to be noise as information. The between-effects estimation strategy is less attractive in analyses, like this one, that incorporate many years of data because it fails to exploit all of the available information about salaries.

The third model is a fixed effects model. The fixed effects methodology adjusts for any variation in salaries that might arise from persistent, but unmeasured teacher characteristics such as intelligence or communication skills. As such, it goes further than any of the other specifications to control for differences in salary that can be attributed to discretionary factors. Unfortunately, in doing so, it also removes much of the variation in cost that is driven by stable characteristics of school districts. Stable district characteristics—such as geographic remoteness or a persistently high cost of living—will only register for teachers who change districts. If teachers who change districts are not representative of the teaching population as a whole, the fixed-effects model can be misleading. During the period under analysis, only 5 percent of the teachers in Wyoming changed school districts, and they were disproportionately inexperienced teachers who did not have an advanced degree.

The last model is the autoregressive (AR) random effects model. A random effects model is a weighted average of the between-effects and fixed-effects models. In this case, the random effects model has been estimated allowing the residuals to follow the autoregressive pattern found in the data.[20] (An autoregressive pattern to teacher salaries means that if a teacher earns more than the model predicts in one year, he or she will probably earn more than the model predicts the next year too.) Like the fixed effects model, the AR random effects model incorporates all of the information in the data and (partially) adjusts for persistent but

[20] A Wald test for the absence of autocorrelation was rejected at the 1 percent level. See Drukker (2003) and Wooldridge (2002).

unmeasured differences in teacher quality. Unlike the fixed effects model, the AR random effects model captures the influence of cost factors that are relatively stable over time using data from all teachers, not just the teachers who move.

Comparing the Cost Indices

Each of the four hedonic wage models was used to generate a corresponding HWI. Those HWIs were estimated by predicting the salary for each Wyoming school district using the state average values in Appendix Table B.2 for all of the discretionary factors and the local values for all of the cost factors. This approach treats the specified cost factors as uncontrollable; all other factors that influence salaries—including any relevant omitted factors—are treated as discretionary. A district's index value is the district's predicted salary in 2010-11 divided by the average predicted salary in the state and then multiplied by 100. Table 3 illustrates the range of the resulting index values and compares the updated HWIs with the 2005 Wyoming HWI. Appendix Table B.3 compares the index values for each Wyoming school district with the 2005 Wyoming HWI.

Table 3: Comparing the 2005 Wyoming HWI with the 2010-11 Cost Indices Implied by Each Hedonic Wage Model

	Mean	Std. Deviation	Minimum	Maximum	Maximum Excluding Teton County
Pooled Cross-Section HWI	100	6.33	89	118	108
Between Teachers HWI	100	6.39	89	119	108
Teacher Fixed Effects HWI	100	4.96	91	111	111
AR Random Effects HWI	100	5.37	90	111	109
2005 Wyoming HWI	100.3	4.6	93	118	107

As the table illustrates, all of the potential updates to the HWI indicate that there are substantial regional cost differences in Wyoming. The Pooled HWI and the Between Teachers HWI have the largest range. They indicate that labor cost is 33 to 34 percent higher in the highest cost district (Teton County School District #1) than it is in the lowest-cost district (Niobrara County School District #1). The Teacher Fixed Effects HWI has the smallest range. It indicates that labor cost is 22 percent higher in the highest-cost district (Laramie County School District #1) than in the lowest-cost district ((Niobrara County School District #1).

Like the 2005 Wyoming HWI, the Pooled Cross-Section and the Between Teachers indices have a maximum values of 118 or higher, indicating that labor cost is at least 18 percent higher than the state average in the highest-cost district. In contrast, both the Teacher Fixed Effects index and the AR Random Effects index have maximum values of 111, indicating that labor cost is only 11 percent higher than the state average in the highest cost district.

The apparent compression in the latter two indices arises from differences in the index value assigned to Teton County School District #1. The 2005 Wyoming HWI assigns Teton County School District #1 an index value 12 percentage points higher than the next highest school district. Similarly, the Pooled Cross-Section and Between Teachers indices each assign Teton County School District #1 an index value at least 10 percentage points higher than the next highest district. In contrast, the gap between the highest-cost district and the next-highest-cost district is no more than 2 percentage points for the Teacher Fixed Effects and AR Random Effects indices. Furthermore, the Teacher Fixed Effects index doesn't even identify Teton County School District #1 as the highest-cost district in the state. According to the Teacher Fixed Effects HWI, there are eight school districts where labor costs are higher than they are in Teton County.

This break in pattern arises because the WCLI has a much smaller marginal effect in the Teacher Fixed Effects and AR Random Effects models than it does in the other two models. Recall that the Teacher Fixed Effects and the AR Random Effects models at least partially adjust for persistent, but unmeasured teacher characteristics while the Pooled Cross-Section and Between Teachers models do not. Differences between the Teacher Fixed Effects and AR Random Effects models and the other specifications therefore suggest that there are unmeasured aspects of teacher quality that are positively correlated with the WCLI (so that unmeasured quality is higher in areas with a higher WCLI) and/or that the subset of teachers who move between districts are less sensitive than other Wyoming teachers to differences in the cost of living.

Table 4 illustrates the correlations among the various cost indices. As the table illustrates, the Pooled Cross-Section HWI and the Between-Teachers HWI are nearly perfectly correlated with one another. Despite the differences in estimation strategy, these two alternative specifications yield essentially the same cost index. None of the other indices are so highly correlated with one another, but all of the indices are reasonably well correlated.

Table 4: The Correlations Among the Cost Indices Implied by Each Model

	Pooled Cross Section HWI	Between Teachers HWI	Teacher Fixed Effects HWI	AR Random Effects HWI
Pooled Cross-Section HWI	1.000			
Between Teachers HWI	0.996	1.000		
Teacher Fixed Effects HWI	0.850	0.822	1.000	
AR Random Effects HWI	0.937	0.919	0.950	1.000
2005 Wyoming HWI	0.854	0.846	0.762	0.833

Note: There are 48 observations and all of the correlations are statistically significant at the 1-percent level.

On purely statistical grounds, the fixed effects model fits the data better than the other three. Statistical tests reject the AR Random Effects model, the Between Teachers model and the

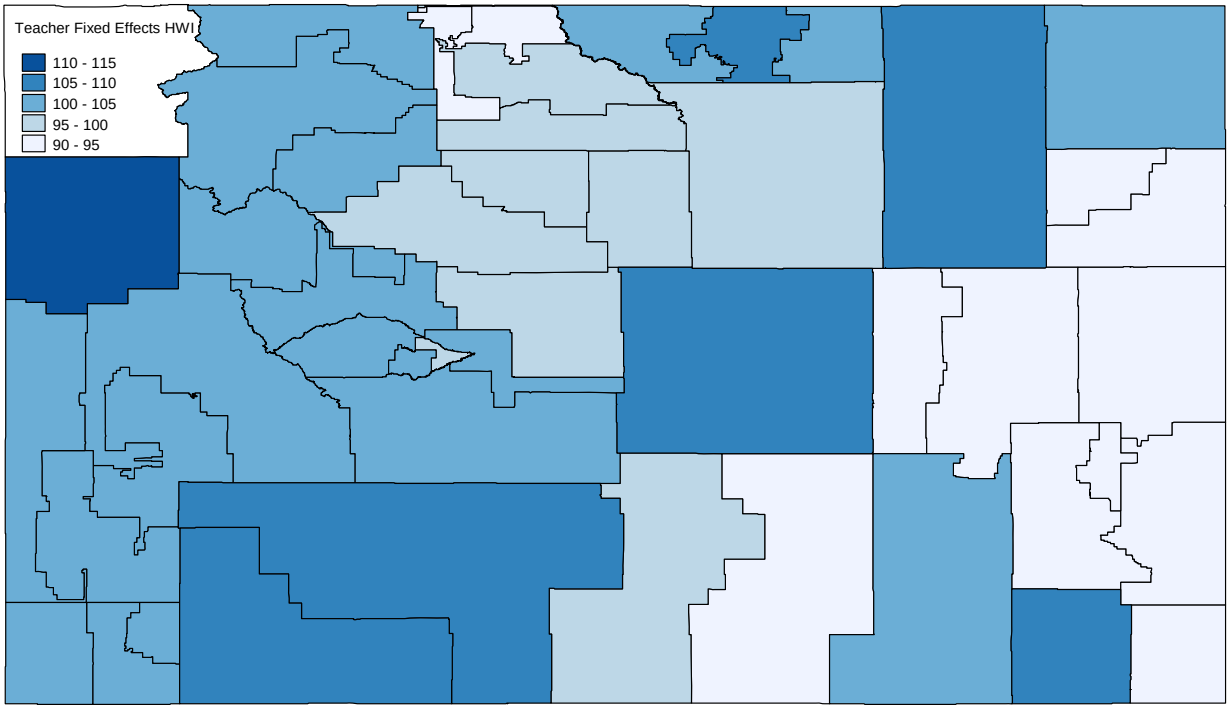
Pooled Cross-Section model in favor of the fixed effects model.[21] Relying on the Teacher Fixed Effects Index rather than one of the other indices would also largely address concerns about the potential for bias arising from an incomplete specification of teacher characteristics. On the other hand, the fixed effects modeling strategy may also strip from the index much of the information about important, quasi-fixed district characteristics like a relatively low cost of living.

Because the Teacher Fixed Effects model may be overcorrecting for individual characteristics and failing to pick up important cost factors, the AR Random Effects model is the best option for updating the Wyoming HWI. The AR Random Effects model incorporates all of the available information about the distribution of teacher salaries and some of the information about unmeasured teacher characteristics without losing the ability to capture the impact of the stable cost factors. Furthermore, the list of discretionary characteristics is quite extensive. The additional detail incorporated into this update greatly reduces the risk that there are important teacher characteristics that have been omitted from the model.

Figure 4 illustrates the geographic pattern to the AR Random Effects HWI. Once again, darker colors indicate higher index values.

[21] The R-squared is highest for the Teacher Fixed Effects model. The Pooled Cross-Section model is a special case of the Teacher Fixed Effects model in which the coefficients on the teacher fixed effects are all set equal to zero. An F-test rejects this restriction at the 1-percent level. Hausman tests of model specification reject the Between Effects and AR Random Effects models in favor of the Teacher Fixed Effects model at the 1 percent level, but these tests are only suggestive because the difference in variances is not positive definite.

Figure 4: The AR Random Effects HWI



Source: Author's calculations.

As the figure illustrates, the AR Random Effects HWI indicates that labor costs are lowest in Niobrara County and the vicinity and highest in Laramie, Sweetwater and Teton Counties.

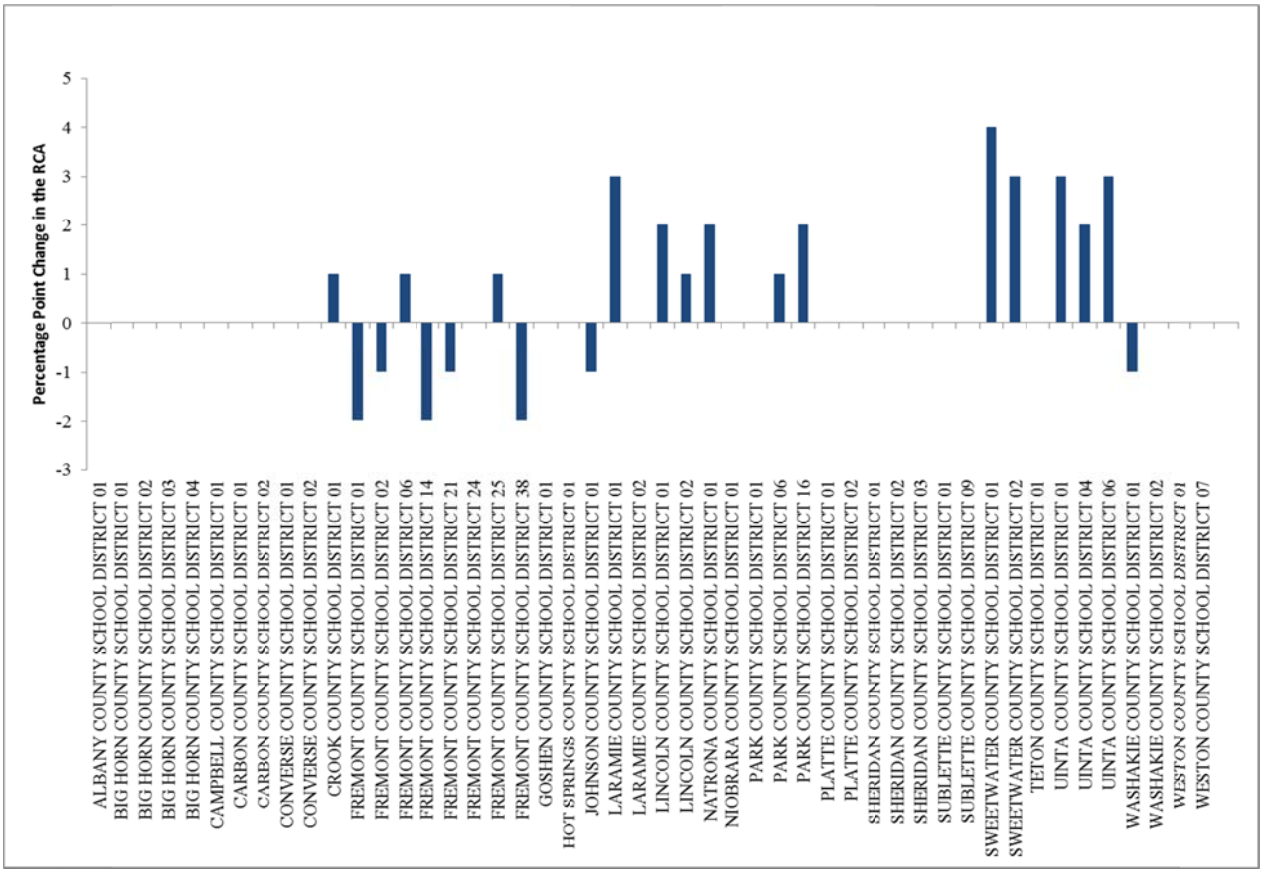
Exploring the Distributional Effects

Updating the HWI could substantially alter Wyoming's regional cost adjustments, and therefore the distribution of state aid to school districts. The analysis in this section explores the implications of updating the Wyoming RCA using the AR Random Effects HWI. In so doing, we presume that the updated HWI would simply replace the existing HWI in the calculation of the RCA. Thus, the updated RCA would be the larger of the WCLI, the updated HWI or 100.

Figure 5 illustrates how updating the HWI would change the RCA.[22] Appendix Table B4 lists the current and updated RCA for each Wyoming district.

[22] The WCLI used in these calculations is the average of the six consecutive semi-annual index reports from fourth-quarter 2007 though second-quarter 2010.

Figure 5: The Changes in the Statutory RCA Arising From Updating the HWI



Source: Author's calculations.

As the figure illustrates, most Wyoming school districts would be completely unaffected by updating the 2005 Wyoming HWI with the AR Random Effects HWI. Seven school districts would experience a decrease in their RCA, 14 school districts would experience an increase and 27 districts would remain unchanged.

Laramie, Sweetwater and Uinta counties would experience the largest increases in the RCA. Sweetwater County School District #1 would see its RCA increase by 4 percentage points if the HWI were updated. Johnson County School District #1, Washakie County School District #1 and many of the school districts in Fremont County would experience declines in the RCA, but no district would experience more than a 2 percentage point decline.

After updating, only 22 of the 48 school districts in Wyoming would have their RCA based on the HWI. (See Table 5.) Seventeen districts would have their RCA set to 100 despite below average labor costs. The RCA for eight school districts (including Teton County School District #1) would continue to be based on the WCLI, and therefore would be unaffected by the updating. A ninth school district (Johnson County School District #1) would switch from a RCA based on the 2005 Wyoming HWI to an RCA based on the WCLI because the AR Random Effects HWI is substantially lower than the 2005 Wyoming HWI.

Table5: The Number of School Districts Receiving Each Type of Regional Cost Adjustment

	HWI	WCLI	100
AR Random Effects HWI	22	9	17
2005 Wyoming HWI	20	10	18

Source: Author's calculations.

Conclusions

Wyoming is one of the few states in the nation to adjust its school finance formula to reflect regional variations in the cost of education. This analysis suggests that the cost of education varies widely within the state, offering strong support for continuing such adjustments.

Based on the analysis presented above, which updates the 2005 Wyoming HWI in a number of key dimensions, it is recommended that the Wyoming Legislature consider replacing the 2005 Wyoming HWI with the AR Random Effects HWI. The AR Random Effects HWI incorporates all of the available information about the distribution of teacher salaries without losing the ability to measure the impact of the stable cost factors like the cost of living and geographic isolation.

Most Wyoming school districts would have the same statutory RCA after updating as they do today. No school district would experience more than a 2 percentage point decline in the RCA, but school districts in Laramie, Sweetwater and Uinta County would experience more than a 2 percentage point gain. Sweetwater County School District #1 would see its RCA increase by 4 percentage points if the 2005 Wyoming HWI were replaced with the AR Random Effects HWI.

Defining the RCA as the greater of three alternatives—the WCLI, the HWI or 100—has unintended consequences for school funding equity in Wyoming that will not be resolved simply by updating the 2005 Wyoming HWI. From a strict equity perspective, continuing to apply the regional costs index only to districts with above-average costs will overfund more than a third of the school districts in Wyoming. Continuing to offer the WCLI option will also overfund some districts, not only because any cost of living overstates the cost of hiring in locations that have attractive amenities, but also because the WCLI overstates the cost of living in Wyoming counties with relatively high housing costs.

The HWI is a direct measure of regional variations in the cost of educator labor. If the RCA were working as intended, then the cost adjustments that school districts receive would be highly correlated with the uncontrollable costs that they incur. Instead, only 22 of the 48 school districts in Wyoming will receive the regional cost adjustment indicated by the updated HWI. Wyoming would be better served if the Legislature replaced the three-way design of the RCA, and simply used the updated HWI as the sole source of regional cost adjustments.

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Appendix A: Updating the NCES Comparable Wage Index

The basic premise of the CWI is that all types of workers demand higher wages in areas with a higher cost of living or a lack of amenities. One should be able to measure the effect of teacher wages of differences in amenities and the cost of living by observing systematic variations in the earnings of comparable workers who are not educators. If Laramie construction workers are paid 5 percent less than the national average construction wage, Laramie engineers are paid 5 percent less than the national average engineering wage, Laramie nurses are paid 5 percent less than the national average nursing wage, and so on, then the cost of hiring teachers in Laramie should also be 5 percent less than the national average.

The NCES CWI measures the prevailing wage for college graduates in 800 U.S. Labor markets. The baseline estimates (for 1999) come from a regression analysis of the individual earnings data from the 2000 U.S. Census. Annual updates to that baseline come from regression analyses of occupational earnings data provided by the U.S. Bureau of Labor Statistics (BLS).[23]

The baseline analysis yields predicted wages in each labor market, adjusted for regional differences in worker characteristics and the mix of industries and occupations in each location. As such, the NCES CWI does not indicate that the wage level is low in an area simply because most of the workers are young and inexperienced, nor does it indicate that the wage level is low in an area simply because there are a disproportionate number of low-skill jobs. Rather, the NCES CWI isolates the regional variation in wages that is attributable specifically to differences in location.

The labor markets in the NCES CWI are based on "place-of-work areas" as defined by the Census Bureau for the 2000 Census. Census place-of-work areas are geographic regions designed to contain at least 100,000 persons. The place-of-work areas do not cross state boundaries and generally follow the boundaries of county groups, single counties, or census-defined places (Ruggles et al. 2003). Counties in sparsely-populated parts of a state are clustered together into a single Census place-of-work area. Each labor market in the NCES CWI is either a single place of work, or a cluster of the places-of-work that comprise a metropolitan area. There are four NCES CWI labor markets in the state of Wyoming—Western Wyoming (Park, Teton, Sublette, Sweetwater, Lincoln and Uinta counties), Central Wyoming (Fremont, Natrona and Carbon counties), Eastern Wyoming (Big Horn, Hot Springs, Washakie, Sheridan, Johnson, Campbell, Crook, Converse, Niobrara, Platte, Goshen and Weston counties) and the Cheyenne and Laramie metropolitan areas (Albany and Laramie counties).

Taylor and Fowler (2006) used data from the Bureau of Labor Statistics' Occupational Employment Survey (OES) to extend the baseline estimates of the NCES CWI and provide annual index values for 1997 through 2005. The OES is a BLS database that contains average annual earnings by occupation for states and metropolitan areas. Each year, the BLS samples

[23] For more on the estimation of the NCES CWI, see Taylor and Fowler (2006).

and contacts approximately 400,000 civilian, nonfarm establishments for the OES survey.[24] Survey respondents in the 2010 OES dataset employed 74.4 percent of the civilian, nonfarm workers in the United States.

When extending the baseline CWI, Taylor and Fowler used the OES data to estimate an occupationally adjusted wage in each labor market area, and then adjusted the baseline NCES CWI to reflect the annual growth in those wage estimates in each location.[25] For example, if their analysis of the OES data indicated that the wage level in Laramie increased by 5 percent between 1999 and 2001, they revised the baseline CWI for Laramie upward by 5 percent to generate an estimate of the Laramie CWI in 2001.

Following the same methodology as in that earlier work, I have updated the NCES CWI through 2010. Thus, I have used OES data for 2006, 2007, 2008, 2009 and 2010 to estimate the occupationally adjusted wage level in each state and major metropolitan area in the United States. Using those estimates, I have also calculated the implied average wage level in the non-metropolitan remainder of each state. I then calculated the annual rate of change in the OES wage estimates and adjusted the baseline CWI accordingly. Table A.1 presents the updated values of the NCES CWI for the 4 labor market areas in Wyoming.

Table A.1: Comparable Wage Index Values

	NCES CWI 2005	Updated CWI 2006	Updated CWI 2007	Updated CWI 2008	Updated CWI 2009	Updated CWI 2010
Cheyenne and Laramie	0.999	1.035	1.086	1.155	1.196	1.257
Eastern Wyoming	0.983	1.023	1.069	1.134	1.183	1.228
Central Wyoming	1.010	1.080	1.135	1.202	1.238	1.279
Western Wyoming	1.096	1.141	1.191	1.265	1.319	1.369
State average	1.024	1.072	1.122	1.191	1.237	1.285
National average	1.265	1.313	1.355	1.408	1.437	1.464

Source: Author's calculations using OES data and the NCES CWI.

[24] Details on the OES survey come from Bureau of Labor Statistics (2003).

[25] The local wage level is a weighted average of the local predicted wages by occupation, where the weights are each occupation's share of total employment among the national sample of college graduates in the census database. Thus, occupations that are held only rarely by college graduates are given little weight in the construction of the OES wage levels, while occupations that employ college graduates intensively are given greater weight. See Appendix A of Taylor and Fowler (2006) for details.

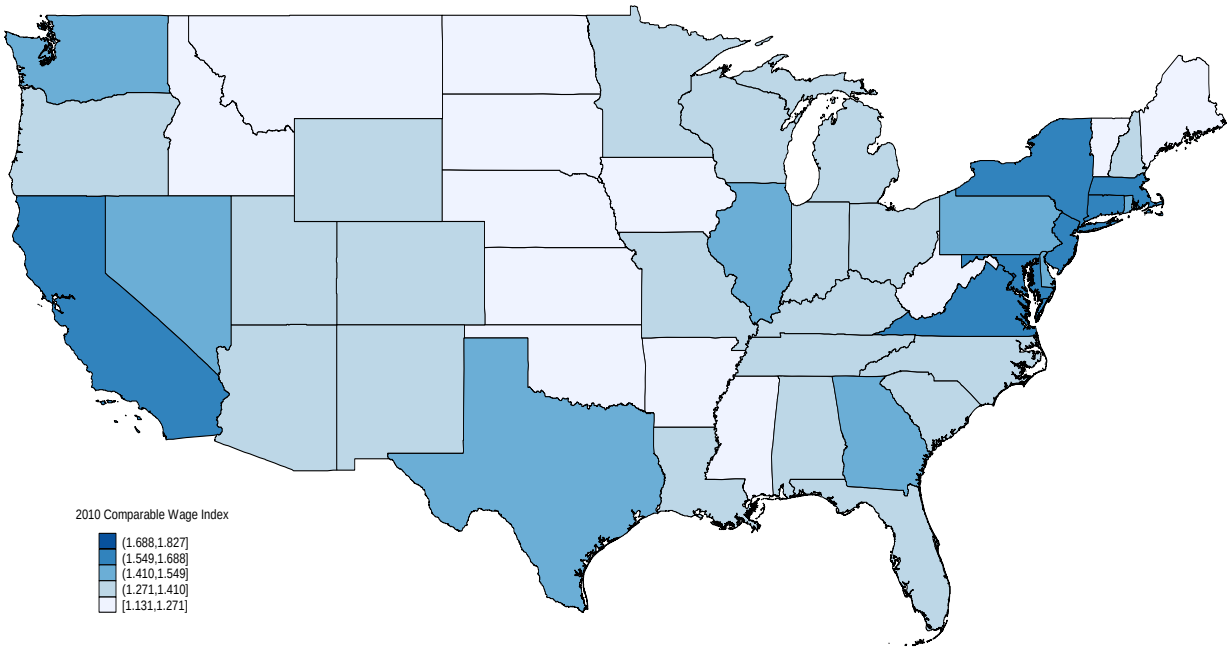
As the table illustrates, the wage differences among Wyoming labor market areas have remained remarkably stable over the last six years. For example, wages in Cheyenne and Laramie were 2.4 percent lower than the state average in 2005 and 2.2 percent lower than the state average in 2010. Similarly, wages in Western Wyoming were 7 percent higher than the state average in 2005 and 6.5 percent higher than the state average in 2010.

The updated CWI also indicates substantial increases in the cost of college educated labor between 2005 and 2010. On average, wages for college graduates in Wyoming increased 4.6 percent per year over the five-year period.

Because wage growth in Wyoming has exceeded the national average for a number of years, the difference between Wyoming and the national average has narrowed substantially. In 2005, the prevailing wage for college graduates in Wyoming was 81 percent of the national average; in 2010, it was 88 percent. Thus, the CWI suggest that the cost-of-living advantage enjoyed by Wyoming school districts is slowly eroding

Figure A.1 illustrates the state-to-state variation in the CWI. As the figure illustrates, the prevailing wage for college graduates is highest in California and along the eastern seaboard. It is lowest in the Great Plains and Mountain West. The CWI for Wyoming is among the lowest in the nation, but slightly higher than those in most of the surrounding states.

Figure A.1: The Updated CWI for 2010



Source: Author's calculations using OES data and the NCES CWI

Appendix B: Supplemental Tables

Table B.1: Alternative Specifications of the Hedonic Wage Model

	Pooled Cross Section Model	Between Teacher Model	Teacher Fixed Effects Model	AR Random Effects Model
MA	0.0959	0.1027	0.0521	0.0639
	(0.0016)***	(0.0017)***	(0.0022)***	(0.0011)***
PhD	0.1474	0.1695	0.0355	0.0722
	(0.0114)***	(0.0128)***	(0.0103)***	(0.0078)***
District experience, log	0.0255	0.0291	0.0152	0.0167
	(0.0014)***	(0.0012)***	(0.0024)***	(0.0008)***
Total experience, log	0.1160	0.1123	0.1072	0.1160
	(0.0017)***	(0.0015)***	(0.0045)***	(0.0011)***
Experience unknown	0.3291	0.3347	0.2972	0.3121
	(0.0137)***	(0.0078)***	(0.0290)***	(0.0060)***
New teacher	0.1156	0.1294	0.0625	0.0626
	(0.0026)***	(0.0046)***	(0.0031)***	(0.0014)***
Non-teaching assignments				
Administration	0.0465	0.0502	0.0209	0.0222
	(0.0045)***	(0.0058)***	(0.0034)***	(0.0020)***
Advisor/Sponsor	0.0338	0.0377	0.0218	0.0245
	(0.0019)***	(0.0024)***	(0.0013)***	(0.0008)***
Assistant Coach	-0.0079	-0.0087	-0.0063	-0.0051
	(0.0022)***	(0.0030)***	(0.0018)***	(0.0011)***
Classified	0.0312	0.0314	0.0349	0.0325
	(0.0076)***	(0.0136)**	(0.0051)***	(0.0032)***
Coach	-0.0122	-0.0154	-0.0010	-0.0042
	(0.0029)***	(0.0037)***	(0.0023)	(0.0014)***
Head teacher	0.0293	0.0247	0.0479	0.0442
	(0.0137)**	(0.0159)	(0.0099)***	(0.0062)***
Principal	0.2591	0.2923	0.0950	0.1552
	(0.0646)***	(0.0393)***	(0.0207)***	0.0215)***
Support	-0.0007	0.0020	0.0123	0.0108
	(0.0058)	(0.0067)	(0.0035)***	(0.0023)***
Tutor	0.0271	0.0361	0.0261	0.0462
	(0.0106)**	(0.0187)*	(0.0067)***	(0.0037)***
Teaching assignments				
Arts	0.0027	0.0024	-0.0157	0.0057
	(0.0044)	(0.0044)	(0.0114)	(0.0031)*
Elementary grades	-0.0032	-0.0073	-0.0017	-0.0016
	(0.0037)	(0.0041)*	(0.0036)	(0.0019)
English/language arts	0.0013	-0.0010	-0.0046	-0.0001
	(0.0036)	(0.0039)	(0.0037)	(0.0019)
Bilingual/ ESL	-0.0118	-0.0177	0.0156	0.0122
	(0.0083)	(0.0088)**	(0.0091)*	(0.0052)**
Fine Arts	-0.0098	-0.0091	0.0176	0.0016
	(0.0055)*	(0.0055)*	(0.0088)**	(0.0040)
Health & P.E.	-0.0036	-0.0060	0.0068	-0.0013
	(0.0042)	(0.0044)	(0.0076)	(0.0028)

	Pooled Cross Section Model	Between Teacher Model	Teacher Fixed Effects Model	AR Random Effects Model
Math	-0.0088	-0.0112	0.0007	-0.0031
	(0.0035)**	(0.0040)***	(0.0049)	(0.0021)
Science	-0.0078	-0.0080	-0.0069	-0.0030
	(0.0040)**	(0.0043)*	(0.0074)	(0.0028)
Special Education	-0.0049	-0.0062	-0.0023	-0.0024
	(0.0038)	(0.0041)	(0.0059)	(0.0023)
Social science	-0.0147	-0.0167	-0.0009	-0.0107
	(0.0040)***	(0.0044)***	(0.0043)	(0.0026)***
Vo-tech	0.0024	0.0021	-0.0078	0.0013
	(0.0045)	(0.0044)	(0.0062)	(0.0026)
Contract days	0.0031	0.0033	0.0012	0.0013
	(0.0002)***	(0.0003)***	(0.0002)***	(0.0001)***
Elementary / middle school	-0.0256	-0.0290	-0.0059	-0.0152
	(0.0067)***	(0.0061)***	(0.0121)	(0.0043)***
High school	0.0046	0.0017	0.0031	0.0045
	(0.0027)*	(0.0030)	(0.0042)	(0.0018)**
K-12 school	-0.0078	-0.0231	0.0225	0.0241
	(0.0050)	(0.0064)***	(0.0054)***	(0.0032)***
Middle (Jr. High) school	0.0066	0.0043	0.0117	0.0107
	(0.0025)***	(0.0028)	(0.0037)***	(0.0017)***
Large School(enrollment > 1,000)	0.0161	0.0189	0.0110	0.0097
	(0.0031)***	(0.0033)***	(0.0029)***	(0.0019)***
Black	-0.0068	0.0041		0.0026
	(0.0110)	(0.0126)		(0.0139)
Hispanic	-0.0053	-0.0070		-0.0025
	(0.0203)	(0.0188)		(0.0217)
Indian	-0.0060	-0.0024		-0.0138
	(0.0082)	(0.0089)		(0.0093)
Female	-0.0084	-0.0089		-0.0075
	(0.0019)***	(0.0018)***		(0.0019)***
WCLI	0.4034	0.4311	-0.0043	0.1366
	(0.0110)***	(0.0124)***	(0.0177)	(0.0083)***
Wyoming CWI	0.1739	0.1482	0.3263	0.3577
	(0.0172)***	(0.0185)***	(0.0455)***	(0.0153)***
Five-mile density	0.0108	0.0099	0.0192	0.0153
	(0.0006)***	(0.0006)***	(0.0021)***	(0.0005)***
County population density (log)	0.0372	0.0377	0.0164	0.0211
	(0.0021)***	(0.0020)***	(0.0084)*	(0.0017)***
Distance to a 15,000 city	0.0002	0.0003	-0.0004	-0.0003
	(0.0000)***	(0.0000)***	(0.0002)**	(0.0000)***
Distance to a 50,000 city	0.0008	0.0007	0.0009	0.0007
	(0.0000)***	(0.0000)***	(0.0002)***	(0.0000)***
Distance to Yellowstone	-0.0001	-0.0001	-0.0001	-0.0002
	(0.0000)***	(0.0000)***	(0.0001)	(0.0000)***
Percent free lunch	0.0221	0.0296	0.0386	0.0062
	(0.0064)***	(0.0086)***	(0.0067)***	(0.0035)*
Percent English language learners	-0.0131	-0.0243	-0.0212	0.0290
	(0.0077)*	(0.0120)**	(0.0067)***	(0.0042)***

	Pooled Cross Section Model	Between Teacher Model	Teacher Fixed Effects Model	AR Random Effects Model
Percent special education	-0.0639	-0.1109	0.0298	0.0159
	(0.0151)***	(0.0219)***	(0.0112)***	(0.0068)**
School year 2005-6	-0.1846	-0.2116		-0.1717
	(0.0021)***	(0.0065)***		(0.0041)***
School year 2006-7	-0.0346	-0.0647	0.1518	-0.0238
	(0.0011)***	(0.0071)***	(0.0024)***	(0.0034)***
School year 2007-08		-0.0432	0.1817	0.0021
		(0.0081)***	(0.0046)***	(0.0026)
School year 2008-09	0.0231		0.1954	0.0116
	(0.0014)***		(0.0076)***	(0.0016)***
School year 2009-10	0.0366	0.0248	0.2025	0.0162
	(0.0021)***	(0.0079)***	(0.0097)***	(0.0009)***
School year 2010-11	0.0298	0.0223	0.1881	
	(0.0030)***	(0.0062)***	0.0118)***	
Constant	9.1924	9.1881	9.6743	9.6667
	(0.0469)***	(0.0612)***	(0.0785)***	(0.0331)***
Observations	38,988	38,988	38,988	38,988
R-squared	0.85	0.83	0.92	0.83
Number of individual teachers	9,489	9,489	9,489	9,489

*Note: The dependent variable for all models is the log of total annual salary. Robust standard errors are in parentheses. The robust standard errors for the Pooled Cross-Section model and the Teacher Fixed Effects model have been clustered by teacher; clustering is not appropriate for the other specifications. The AR Random effects model is a random-effects model estimated using REML and an AR1 error structure. . The asterisks indicate a coefficient that is * significant at 10%; ** significant at 5%; *** significant at 1%.*

Table B.2: The Characteristics of the Average Wyoming Teacher, 2010-11

	Mean	Standard Deviation
FTE Total Salary	57,010.590	9,042.669
MA	0.389	0.488
PhD	0.003	0.055
District experience, log	2.070	1.004
Total experience, log	2.393	0.927
Experience unknown	0.007	0.083
New teacher	0.034	0.181
Non-teaching assignments		
Administration	0.021	0.143
Advisor/Sponsor	0.191	0.393
Assistant Coach	0.122	0.327
Classified	0.004	0.065
Coach	0.065	0.246
Head teacher	0.002	0.050
Principal	0.000	0.017
Support	0.009	0.094
Tutor	0.006	0.079
Teaching assignments		
Arts	0.075	0.263
Elementary grades	0.377	0.485
English/language arts	0.090	0.286
Bilingual/ ESL	0.008	0.089
Fine Arts	0.023	0.149
Health & P.E.	0.067	0.251
Math	0.066	0.249
Science	0.058	0.233
Special Education	0.136	0.343
Social science	0.056	0.230
Vo-tech	0.063	0.243
Contract days	185.048	3.751
Elementary / middle school	0.016	0.126
High school	0.271	0.445
K-12 school	0.030	0.171
Middle (Jr. High) school	0.188	0.391
Large School(enrollment > 1,000)	0.093	0.291
Black	0.003	0.055
Hispanic	0.000	0.000
Indian	0.007	0.086
Female	0.708	0.455

Table B.3: Comparing the HWI with the Cost Indices Implied by Each Model, by District

	Current HWI	Pooled Cross Section Model	Between Teacher Model	Teacher Fixed Effects Model	AR Random Effects Model
Albany County School District 01	101	100	100	102	101
Big Horn County School District 01	98	94	94	96	95
Big Horn County School District 02	100	92	92	96	95
Big Horn County School District 03	99	94	93	98	97
Big Horn County School District 04	99	95	94	99	97
Campbell County School District 01	106	108	108	107	107
Carbon County School District 01	101	98	98	97	97
Carbon County School District 02	98	94	95	95	95
Converse County School District 01	96	92	92	93	93
Converse County School District 02	94	90	90	91	92
Crook County School District 01	97	96	96	101	101
Fremont County School District 01	103	102	102	101	101
Fremont County School District 02	102	103	103	100	101
Fremont County School District 06	100	105	105	101	101
Fremont County School District 14	104	104	104	103	102
Fremont County School District 21	103	106	106	105	102
Fremont County School District 24	99	99	100	97	98
Fremont County School District 25	100	102	102	101	101
Fremont County School District 38	102	104	104	102	100
Goshen County School District 01	95	93	93	94	93
Hot Springs County School District 01	100	97	97	98	97
Johnson County School District 01	102	96	96	96	96
Laramie County School District 01	106	107	106	111	109
Laramie County School District 02	95	97	98	94	95
Lincoln County School District 01	97	101	101	100	102
Lincoln County School District 02	98	103	103	101	103
Natrona County School District 01	106	106	105	108	108
Niobrara County School District 01	94	89	89	91	90
Park County School District 01	103	101	101	102	103
Park County School District 06	104	105	104	104	105
Park County School District 16	101	104	105	103	103
Platte County School District 01	95	90	90	93	91
Platte County School District 02	93	91	91	93	92
Sheridan County School District 01	98	104	104	99	101
Sheridan County School District 02	107	108	107	107	107
Sheridan County School District 03	99	107	107	103	103
Sublette County School District 01	106	108	108	101	105
Sublette County School District 09	103	107	107	102	105
Sweetwater County School District 01	105	107	106	110	109
Sweetwater County School District 02	104	105	105	109	108
Teton County School District 01	118	118	119	104	111

	Current HWI	Pooled Cross Section Model	Between Teacher Model	Teacher Fixed Effects Model	AR Random Effects Model
Uinta County School District 01	99	101	101	102	103
Uinta County School District 04	99	101	101	102	102
Uinta County School District 06	100	102	101	103	103
Washakie County School District 01	101	98	98	100	99
Washakie County School District 02	96	96	96	95	96
Weston County School District 01	94	91	90	93	92
Weston County School District 07	94	91	91	94	93

Table B.4: The Prospective RCAs, by School District

	Current RCA	AR Random Effects RCA
Albany County School District 01	101	101
Big Horn County School District 01	100	100
Big Horn County School District 02	100	100
Big Horn County School District 03	100	100
Big Horn County School District 04	100	100
Campbell County School District 01	110	110
Carbon County School District 01	102	102
Carbon County School District 02	102	102
Converse County School District 01	100	100
Converse County School District 02	100	100
Crook County School District 01	100	101
Fremont County School District 01	103	101
Fremont County School District 02	102	101
Fremont County School District 06	100	101
Fremont County School District 14	104	102
Fremont County School District 21	103	102
Fremont County School District 24	100	100
Fremont County School District 25	100	101
Fremont County School District 38	102	100
Goshen County School District 01	100	100
Hot Springs County School District 01	100	100
Johnson County School District 01	102	101
Laramie County School District 01	106	109
Laramie County School District 02	100	100
Lincoln County School District 01	100	102
Lincoln County School District 02	102	103
Natrona County School District 01	106	108
Niobrara County School District 01	100	100
Park County School District 01	103	103
Park County School District 06	104	105
Park County School District 16	101	103
Platte County School District 01	100	100
Platte County School District 02	100	100
Sheridan County School District 01	105	105
Sheridan County School District 02	107	107
Sheridan County School District 03	105	105
Sublette County School District 01	115	115
Sublette County School District 09	115	115
Sweetwater County School District 01	105	109
Sweetwater County School District 02	105	108
Teton County School District 01	133	133
Uinta County School District 01	100	103
Uinta County School District 04	100	102
Uinta County School District 06	100	103

	Current RCA	AR Random Effects RCA
Washakie County School District 01	101	100
Washakie County School District 02	100	100
Weston County School District 01	100	100
Weston County School District 07	100	100

Updating the Wyoming Hedonic Wage Index: Addendum

Submitted to:

The Joint Appropriations Committee and
The Joint Education Committee

Submitted by:

Dr. Lori L. Taylor
Texas A&M University

January 2012

A data error was discovered after completion of the fall 2011 legislative report, "Updating the Wyoming Hedonic Wage Index." The information provided by the Legislative Service Office on the distance to Yellowstone National Park from Crook County School District #1 was not correct. This addendum presents the coefficient estimates and hedonic wage index values that result from replicating the AR random effects analysis using the corrected data. In addition, to facilitate annual updates to the hedonic wage index, the comparable wage index (CWI) used in this corrected analysis was divided by the Wyoming state average CWI for 2010.[1] (Because the state average CWI for 2010 is a constant, such rebasing has no effect on the wage predictions or the resulting hedonic wage index.)

Table 1: Selected Coefficients from the Corrected Hedonic Wage Model

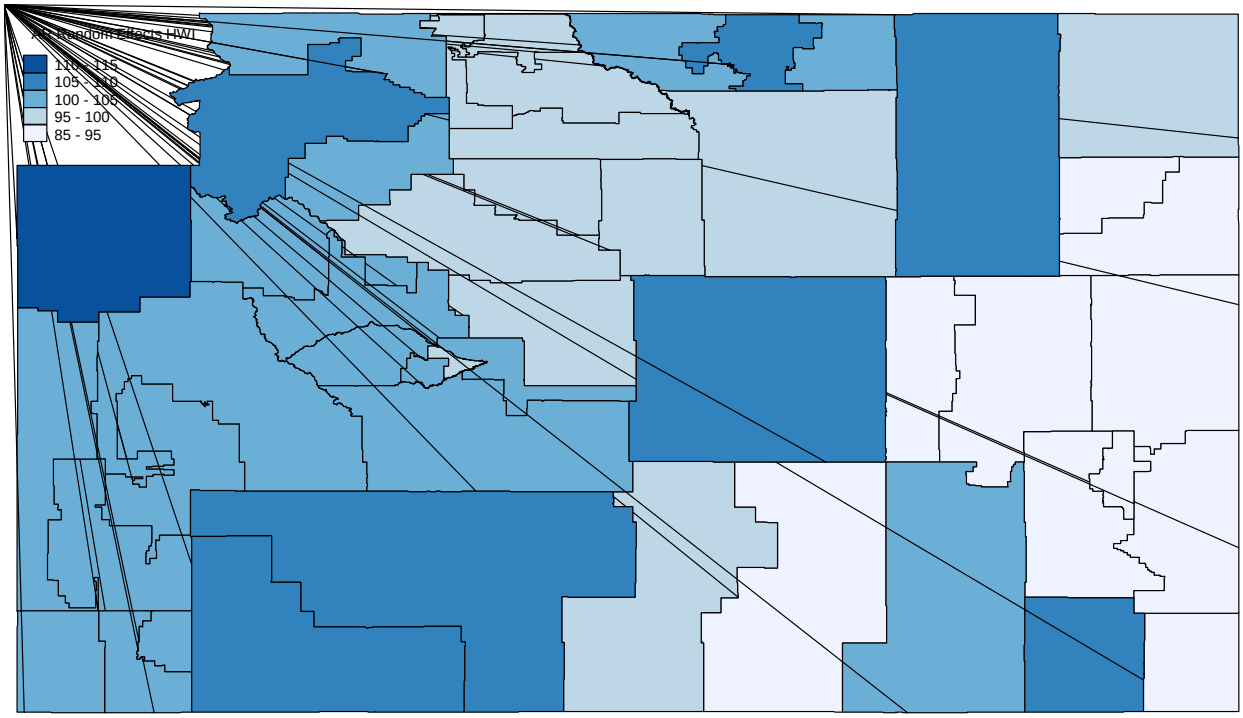
	AR Random Effects Model
WCLI	0.1170
	(0.0083)***
Wyoming CWI	0.4285
	(0.0197)***
Five-mile density	0.0158
	(0.0005)***
County population density (log)	0.0174
	(0.0017)***
Distance to 15,000 population city	-0.0004
	(0.00004)***
Distance to50,000 population city	0.0006
	(0.00003)***
Distance to Yellowstone	-0.0003
	(0.00001)***
Percent free lunch	0.0060
	(0.0035)*
Percent ELL	0.0289
	(0.0042)***
Percent special ed.	0.0175
	(0.0068)***
Includes year indicators?	yes
Includes discretionary factors?	yes
Includes teacher fixed effects	no
Includes teacher random effects?	yes
Observations	38,988
R-squared	0.8326
Number of teachers	9,489

Note: Robust standard errors are in parentheses. The asterisks indicate that the coefficient is significantly different from zero at the 10-percent level (*), the 5-percent level (**) or the 1-percent level (***).

[1] The state average CWI for 2010 was 1.2853. When updating the HWI using 2011 data, the regional CWI values should be divided by the Wyoming state average CWI in 2011 before multiplying by the coefficients in Table 1.

Figure 4 illustrates the geographic pattern to the corrected AR Random Effects HWI. Darker colors indicate higher index values.

Figure 1: The Corrected AR Random Effects HWI



Source: Author's calculations.

Table 2: Corrected AR Random Effects Hedonic Wage Model

	AR Random Effects Model
MA	0.0633
	(0.0011)***
PhD	0.0719
	(0.0078)***
District experience, log	0.0166
	(0.0008)***
Total experience, log	0.1161
	(0.0011)***
Experience unknown	0.3116
	(0.006)***
New teacher	0.0627
	(0.0014)***
Non-teaching assignments	
Administration	0.0226
	(0.002)***
Advisor/Sponsor	0.0245
	(0.0008)***
Assistant Coach	-0.0050
	(0.0011)***
Classified	0.0325
	(0.0032)***
Coach	-0.0039
	(0.0014)***
Head teacher	0.0439
	(0.0062)***
Principal	0.1566
	(0.0214)***
Support	0.0108
	(0.0023)***
Tutor	0.0475
	(0.0036)***
Teaching assignments	
Arts	0.0059
	(0.0031)*
Elementary grades	-0.0016
	(0.0019)
English/language arts	-0.0001
	(0.0019)
Bilingual/ ESL	0.0123
	(0.0052)**
Fine Arts	0.0017
	(0.0040)
Health & P.E.	-0.0010
	(0.0028)
Math	-0.0033
	(0.0021)
Science	-0.0029
	(0.0028)

	AR Random Effects Model
Special Education	-0.0025
	(0.0023)
Social science	-0.0108
	(0.0026)***
Vo-tech	0.0015
	(0.0026)
Contract days	0.0014
	(0.0001)***
Elementary / middle school	-0.0141
	(0.0043)***
High school	0.0052
	(0.0018)***
K-12 school	0.0252
	(0.0031)***
Middle (Jr. High) school	0.0103
	(0.0017)***
Large School(enrollment > 1,000)	0.0096
	(0.0018)***
Black	0.0050
	(0.0138)
Hispanic	0.0022
	(0.0216)
Indian	-0.0132
	(0.0093)
Female	-0.0071
	(0.0019)***
WCLI	0.1170
	(0.0083)***
Wyoming CWI	0.4285
	(0.0197)***
Five-mile density	0.0158
	(0.0005)***
County population density (log)	0.0174
	(0.0017)***
Distance to a 15,000 city	-0.0004
	(0.00004)***
Distance to a 50,000 city	0.0006
	(0.00003)***
Distance to Yellowstone	-0.0003
	(0.00001)***
Percent free lunch	0.0060
	(0.0035)*
Percent English language learners	0.0289
	(0.0042)***
Percent special education	0.0175
	(0.0068)***
School year 2005-6	-0.1781
	(0.0041)***

	AR Random Effects Model
School year 2006-7	-0.0292
	(0.0034)***
School year 2007-08	-0.0020
	(0.0026)
School year 2008-09	0.0092
	(0.0016)***
School year 2009-10	0.0150
	(0.0009)***
School year 2010-11	
Constant	9.7442
	(0.0333)***
Observations	38,988
R-squared	0.8326
Number of individual teachers	9,489

*Note: The dependent variable is the log of total annual salary. Robust standard errors are in parentheses. The AR Random effects model is estimated using REML and an AR1 error structure. The asterisks indicate a coefficient that is * significant at 10%; ** significant at 5%; *** significant at 1%.*

Table 3: Comparing the 2005 HWI with the Updated HWI, by District

	2005 Wyoming HWI	Corrected AR Random Effects Model
Albany County School District 01	101	100
Big Horn County School District 01	98	97
Big Horn County School District 02	100	97
Big Horn County School District 03	99	98
Big Horn County School District 04	99	99
Campbell County School District 01	106	107
Carbon County School District 01	101	96
Carbon County School District 02	98	95
Converse County School District 01	96	93
Converse County School District 02	94	93
Crook County School District 01	97	96
Fremont County School District 01	103	101
Fremont County School District 02	102	101
Fremont County School District 06	100	101
Fremont County School District 14	104	102
Fremont County School District 21	103	102
Fremont County School District 24	99	98
Fremont County School District 25	100	101
Fremont County School District 38	102	100
Goshen County School District 01	95	92
Hot Springs County School District 01	100	97
Johnson County School District 01	102	97
Laramie County School District 01	106	108
Laramie County School District 02	95	94
Lincoln County School District 01	97	101
Lincoln County School District 02	98	103
Natrona County School District 01	106	109
Niobrara County School District 01	94	89
Park County School District 01	103	104
Park County School District 06	104	106
Park County School District 16	101	104
Platte County School District 01	95	91
Platte County School District 02	93	91
Sheridan County School District 01	98	102
Sheridan County School District 02	107	107
Sheridan County School District 03	99	102
Sublette County School District 01	106	105
Sublette County School District 09	103	105
Sweetwater County School District 01	105	109
Sweetwater County School District 02	104	108
Teton County School District 01	118	111
Uinta County School District 01	99	102

	2005 Wyoming HWI	Corrected AR Random Effects Model
Uinta County School District 04	99	102
Uinta County School District 06	100	103
Washakie County School District 01	101	100
Washakie County School District 02	96	96
Weston County School District 01	94	92
Weston County School District 07	94	93