

Student Achievement in the Appalachian Region: Analyzing the 2013 NAEP Eight Grade Mathematics Assessment

Study Objectives

The purpose of this study is to explore factors associated with eighth grade student achievement in the Appalachian region. Specifically, this study aims to answer the following research questions:

1. What are the characteristics of eighth grade students in the Appalachian region among key demographic variables?
2. How are eighth grade students in the Appalachian region performing in comparison to the rest of the nation?
3. Within Appalachia, and as compared to the rest of the nation, what are the factors that may be associated with performance differences?

Introduction and Background

Following the spine of the Appalachian Mountains from southern New York to northern Mississippi, the Appalachian region spans across 13 states and is home to more than 25 million people (Appalachian Regional Commission, 2015). It comprises 420 counties including all of West Virginia and parts of Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, and Virginia (see Figure 1). The region used to depend highly on resource-based industries such as mining, forestry, and agriculture. While still resource-intensive, in the recent decades its economy has become more diverse and now includes a base of manufacturing and professional services industries. With these changes, the poverty rate in the Appalachian region has dropped from 31 percent in 1960 to 17 percent in 2013 (Fester et al., 2014).

In spite of the gains in economic status of the overall region over the years, many communities within the region still suffer from poverty and lack of economic opportunities. Understanding and improving the academic performance of Appalachian students can be one of the more effective means to increase the economic status of people living the region (Pollard & Jacobsen, 2014). For example, Ziliak (2007) found that communities within the Appalachian region with a higher level of high school and college completion showed greater gains in median household income. Educational achievement has been shown to be highly correlated to improvement of income and employment in Appalachia (Black, Pollard, & Sanders, 2007).

Although the importance of educational attainment in relation to the region's economic improvement is well demonstrated in the literature, much of the prior research is focused on high school and college completion with little attention focused on the elementary and middle school grades. The absence of research on pre-high school outcomes may be due in part to the lack of easily accessible large-scale data from the region. Our study aims to address this gap in the literature. In this study, using the 8th grade mathematics data from the National Assessment of Educational Progress (NAEP), the academic

performance of the Appalachian students are compared to the rest of the nation, and investigated to determine factors associated with differences in educational performance.

Methods and data

The first two research questions were answered by examining significant differences in the proportions of students assessed by subcategories of major demographic variables, and differences in average NAEP scale scores between students in the Appalachian region and the rest of the nation. The third research question was answered by conducting an OLS regression analysis with the average scale scores of NAEP mathematics assessment as the dependent variable.

This study uses data from the NAEP mathematics assessment administered to eighth graders in 2013. The study combined NAEP data and county-level data from the U.S. Census Bureau to identify educational performance of Appalachian students. Average scale scores for student groups were estimated using the twenty plausible values provided in the NAEP restricted-use data set. To account for the design effects of NAEP's complex sampling strategy, the study estimated variance using the Jackknife repeated replication technique. Standard errors were calculated using the STATA survey module and the appropriate weights and design variables included in the NAEP data set. Because NAEP is traditionally designed to describe educational trends and characteristics for individual states or the nation as a whole, not for individual regions of the country, sampling weights for student in Appalachia have been adjusted to the region's population control totals using a three-way raking procedure.

Because there is no geographic identifier in NAEP that identifies the Appalachian region, an Appalachian "flag" variable was created from the county definitions provided by ARC. Then, we identified the county FIPS codes of each NAEP school using the 2013 Common Core of Data (CCD) and then flagged any schools located in the Appalachian region. NAEP schools were then linked to information on county-level economic status from the American Community Survey of the U.S. Census Bureau (2011).

Results

Research Question 1: What are the characteristics of students in the Appalachian region among key demographic variables?

Results for the first research question are shown in Tables 1 and 2. Results showed that Appalachian students make up 8.5 percent of all eighth graders in the nation (Table 1). Significant differences¹ were examined for six student characteristics: gender, race/ethnicity, eligibility for the National School Lunch Program (NSLP), parental education, disability status, and English-language learner status. Differences were also examined for five school characteristics, disaggregated to the level of students: public school type (charter or non-charter), percentage of school enrollment that was non-white (divided into four categories), percentage of school enrollment that was eligible for NSLP (divided into four categories), school locale, and county economic status (as defined by the US Census Bureau).

There were a number of significant differences in the percentage distribution of Appalachian eighth grade students vs. their peers in the rest of the nation. Although most of the differences in the percentages of students in subcategories of demographic variables were statistically significant, such differences were mostly minimal, ranging from 0.2 (gender) to 4.0 ("I don't know" category of the parental education

¹ Significant differences were tested in two ways: using chi-square analysis, and using independent samples two-tailed t-tests without adjustments for multiple comparisons. Only results for t-tests are presented in the tables. Nearly all variables showed a significant chi-square coefficient between the region vs the rest of the nation. Significant differences are reported at the .05 alpha level.

variable) percent difference (see Table 1). Notably, the percentage of White students in the Appalachian region (78 percent) was substantially higher compared to the rest of the nation (51 percent). Additionally, while the percentages of Black and Asian students were similar between the Appalachian region and the rest of the nation, the percentage of Hispanic students in the Appalachian region was significantly smaller (6 percent) compared to the rest of the nation (25 percent). About half the students in the Appalachian region had at least one parent with a college degree, and about half were eligible for the national student lunch program. Both of these estimates were about the same compared to the rest of the nation. The number of English language learners in the Appalachian region was smaller than the rest of the nation.

A similar pattern was observed regarding the percentage of non-White students enrolled in the Appalachian schools compared to the rest of the nation (see Table 2). While approximately 70 percent of Appalachian students attended mostly-white schools (less than 25 percent of non-White enrollment), only 30 percent of students in the rest of the nation attended mostly-white schools. In contrast, only 6 percent of Appalachian students attended schools with more than 75 percent of non-White students, in contrast to about 27 percent of students in the rest of nation attending such schools.

Most of students (approximately 79 percent) in the Appalachian region attended schools with an average level of student poverty (26 to 50 percent of NSLP eligible students). However, the percentage of Appalachian students attending schools with a high concentration of poverty (more than 75 percent NSLP eligible students) was much smaller compared to the rest of the nation. About a half of students in the Appalachian region attended schools located in the town or rural areas while a majority of students in the rest of nation attended schools located in the urban or suburban areas.

Research Question 2: How are students in the Appalachian region performing in comparison to the rest of the nation?

The average NAEP mathematics scores of eighth-grade Appalachian students were similar to the average of eighth-grade students in the rest of the nation (see Table 3). Across student demographic characteristics of gender, parental education, NSLP eligibility status, and disability status, the average scale scores of Appalachian students did not differ greatly from their peers in the rest of the nation. The differences ranged from 0.2 (male student performance) to 2 (performance of students whose parents graduated from college) scale score points.

However, when comparing academic performance by race/ethnicity, there were notable differences between Appalachia and the rest of the nation. White students in the Appalachian region performed substantially lower (7 scale score points) compared to White students in the rest of the nation. On the other hand, Hispanic students in this region performed substantially higher (6 scale score points) compared to Hispanic students in the rest of the nation. Lastly, English language learners (ELL) in the Appalachian region performed 9 scale score points higher than their peers in the rest of the nation.

Among school demographic characteristics (see Table 4), there was no significant difference in the academic performance of students in the Appalachian region and the rest of nation regarding the percentage of NSLP-eligible students enrolled in schools. In contrast, Appalachian students attending charter schools performed 15 points lower than charter school students in the rest of the nation. Also, Appalachian students attending schools with fewer non-White students performed lower compared to similar students in the rest of the nation. Lastly, Appalachian students attending schools located in rural areas performed approximately 5 points lower than rural students in the rest of the nation.

Research Question 3: What are the factors that may be associated with the performance differences?

To determine the factors associated with the achievement of Appalachian students, an OLS regression analysis was conducted for students in the Appalachian region, with eighth grade NAEP mathematics scores as the dependent variable and selected demographic variables as independent variables (see Table 5). For comparison purposes, a similar regression model was analyzed for students in the rest of the country. Independent variables included gender, race/ethnicity, eligibility for NSLP, parental education, locale, disability status, and ELL status. The reference group is a White male student living in a suburban area, who is not eligible for NSLP, attends a non-charter public school, is not designated as ELL and not having a disability, and whose parent graduated from college. The r-square estimate indicated that approximately 31 percent of the variance in the outcome variable was explained by the selected demographic variables included in the model for the Appalachian region, whereas approximately 36 percent of the variance in the outcome was explained by the same set of variables for the rest of the nation. The average scale score for the reference group in Appalachia was 308; this score was about the same as the score of similar students in the rest of the nation (309).

Relationships between the NAEP mathematics scores and many of the student demographic variables were similar between the Appalachian region and the rest of the nation. For instance, the magnitude of the coefficients was similar between the two regions for the following predictors: female, White and Black students, NSLP eligible students and NSLP non-eligible students, and parental education. In contrast, while Hispanic students in the rest of nation performed approximately 8 points lower compared to their White peers, Hispanic students in the Appalachian region did not show a significant achievement gap compared to their White peers. Additionally, while Asian students performed significantly higher compared to their White peers in both the Appalachian region and the rest of the nation, the magnitude of difference was larger for the Appalachian region (approximately 21 points) compared to the rest of the nation (approximately 14 points).

Regarding the school level demographic variables, after controlling for other variables, attending a charter school has a positive association with student achievement for students in the rest of the nation, but a similar positive association was not observed for students in the Appalachia region. Another school level variable which appeared to show a differential effect between the Appalachian region and the rest of the nation was school locale. While attending school in a town or rural area showed significant disadvantage compared to those in the suburban area for students in both Appalachian region and the rest of the nation after controlling for other variables, such negative effect was more severe for students in the Appalachian region compared to the rest of the nation.

Discussion and Implications for Policy

The Appalachian region shares unique characteristics compared to the rest of the nation. While the average scores of eighth graders NAEP mathematics assessment did not differ significantly between students in the Appalachian region and the rest of the nation, the academic achievement of White students in the region is significantly lower than White students in the rest of the nation. Perhaps this may be related to the fact that the majority of students in the Appalachian region live in more rural areas compared to the rest of the nation. Regression results showed that the most substantial predictors of achievement were typically the same in both Appalachia and the rest of the nation. From these results, we conclude that factors related to educational achievement tended to have more or less the same relationship on outcomes regardless of the region. However, the prevalence of certain conditions in Appalachia (such as the large percentage of white students, or students living in rural areas) would necessitate differential interventions from other regions of the nation where such conditions are not as prevalent. Given the large

population in the rural areas in the Appalachian region, and the fact that performance of students living in rural areas in the Appalachian region tended to be lower compared to similar students in the rest of the nation, policymakers may need to consider ways to improve educational outcomes for students living in rural areas.

As always, there were limitations to the study. First, the NAEP student sample was not designed to be used for non-state regional analysis, and there may be bias for some student groups due to non-coverage. Despite our effort to address this issue methodologically, readers should be cautioned when making generalizations of findings from this study. Second, the current study did not include any interaction effects among the demographic variables included in the regression model. For future research, it would be informative to include an interaction effect between race/ethnicity and the locale variable and compare academic achievement of White students living in the Appalachian rural areas and White students living in the Appalachian urban areas. Researchers may find it worth investigating the academic performance of White students in the rest of the nation living in rural areas and white students in the rest of nation living in urban areas to further explain why White students in the Appalachia region perform much lower than White students in the rest of the nation.

Additionally, the Appalachian region covers a large area with a wide range of economic status within the region. Therefore, assuming that all Appalachian students demonstrate similar academic performance and the factors associated with their performance would be similar may not be reasonable. Future study should investigate academic performance of Appalachian students by its subregions to determine whether the distributions and effects of key variables may differ across geographic areas of Appalachia.

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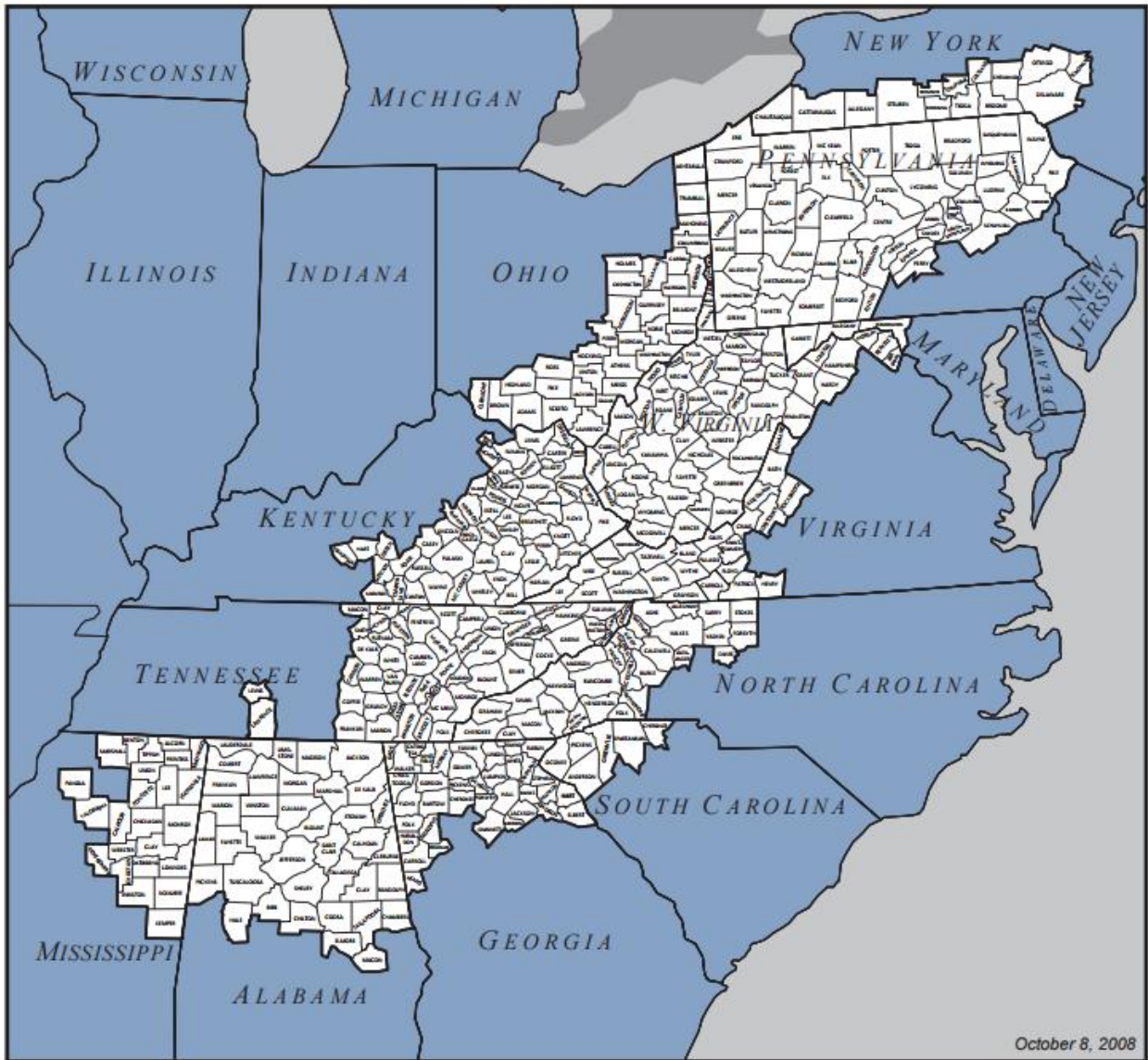
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Figure 1. Counties in Appalachia



Source: Appalachia Regional Commission, 2015 www.arc.gov

Table 1. Percentage distribution of 8th grade public school students, by Appalachia region and select student characteristics: 2013

| | Appalachia Region | | Rest of Nation | |
|----------------------|-------------------|----------------|----------------|----------------|
| | Estimate | Standard Error | Estimate | Standard Error |
| Proportion of nation | 8.5 | 0.06 | 91.5 | 0.06 |
| Gender | | | | |
| Male | 50.9 | 0.46 | 51.1 | 0.13 |
| Female | 49.1 | 0.46 | 48.9 | 0.13 |
| Race/Ethnicity | | | | |
| White | 77.6* | 0.00 | 50.7 | 0.34 |
| Black | 12.6* | 0.00 | 15.3 | 0.27 |
| Hispanic | 6.1* | 0.00 | 25.2 | 0.35 |
| Asian | 1.6* | 0.00 | 5.5 | 0.18 |
| Other | 0.3* | 0.00 | 1.2 | 0.05 |
| Eligibility for NSLP | | | | |
| Eligible | 51.2* | 0.00 | 49.8 | 0.46 |
| Non-eligible | 48.8* | 0.00 | 50.2 | 0.46 |
| Parental Education | | | | |
| Did not finish H.S. | 7.0* | 0.31 | 7.7 | 0.15 |
| Graduated H.S. | 19.0* | 0.44 | 16.2 | 0.21 |
| Some college | 16.3* | 0.47 | 14.9 | 0.18 |
| Graduated college | 48.5 | 0.67 | 48.1 | 0.41 |
| Don't know | 9.1* | 0.34 | 13.1 | 0.17 |
| SD | | | | |
| SD, yes | 12.1 | 0.44 | 11.6 | 0.13 |
| SD, no | 87.9 | 0.44 | 88.4 | 0.13 |
| ELL | | | | |
| ELL, yes | 1.7* | 0.19 | 5.5 | 0.16 |
| ELL, no | 98.3* | 0.19 | 94.5 | 0.16 |

* Significantly different from rest of nation at $p < .05$.

NOTE: Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress NAEP, 2013 Eighth Grade Mathematics Assessment.

Table 2. Percentage distribution of 8th grade public school students, by Appalachia region and select school characteristics: 2013

| | Appalachia Region | | Rest of Nation | |
|---|-------------------|----------------|----------------|----------------|
| | Estimate | Standard Error | Estimate | Standard Error |
| Public school type | | | | |
| Charter | 1.6* | 0.69 | 3.2 | 0.41 |
| Not charter | 98.4* | 0.69 | 96.8 | 0.41 |
| Percent non-white enrollment | | | | |
| Up to 25% | 69.1* | 1.84 | 30.2 | 0.51 |
| From 25 through 50% | 19.0 | 1.93 | 22.3 | 0.66 |
| From 50 to 75% | 5.5* | 1.17 | 20.3 | 0.75 |
| More than 75% | 6.4* | 0.99 | 27.2 | 0.69 |
| Percent NSLP-eligible enrollment | | | | |
| Up to 25% | 11.4* | 1.52 | 20.4 | 0.61 |
| From 25 through 50% | 37.4* | 2.47 | 28.8 | 0.87 |
| From 50 to 75% | 41.4* | 2.40 | 28.0 | 0.97 |
| More than 75% | 9.8* | 1.40 | 22.7 | 0.77 |
| Locale | | | | |
| Urban | 11.5* | 0.00 | 28.9 | 0.33 |
| Suburban | 30.7* | 0.00 | 36.2 | 0.42 |
| Town | 20.1* | 0.00 | 12.1 | 0.33 |
| Rural | 37.7* | 0.00 | 22.7 | 0.40 |
| County economic status | | | | |
| Attainment | 2.4* | 0.74 | 13.5 | 0.54 |
| Competitive | 13.4* | 1.58 | 18.3 | 0.63 |
| Transitional | 64.3* | 1.81 | 57.2 | 0.87 |
| At-Risk | 12.5* | 1.45 | 7.4 | 0.57 |
| Distressed | 7.4* | 0.62 | 3.6 | 0.35 |

* Significantly different from rest of nation at $p < .05$.

NOTE: Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress NAEP, 2013 Eighth Grade Mathematics Assessment. U.S. Census Bureau, 2010 American Community Survey ACS.

Table 3. Average mathematics scale scores of 8th grade public school students, by Appalachia region and select student characteristics: 2013

| | Appalachia Region | | Rest of Nation | |
|----------------------|-------------------|----------------|----------------|----------------|
| | Estimate | Standard Error | Estimate | Standard Error |
| Overall Mean | 283.4 | 0.55 | 283.7 | 0.26 |
| Gender | | | | |
| Male | 283.7 | 0.73 | 283.9 | 0.31 |
| Female | 283.0 | 0.63 | 283.4 | 0.32 |
| Race/Ethnicity | | | | |
| White | 287.0* | 0.56 | 294.0 | 0.27 |
| Black | 260.8 | 1.43 | 263.0 | 0.43 |
| Hispanic | 277.0* | 2.41 | 270.9 | 0.43 |
| Asian | 308.0 | 3.86 | 305.8 | 1.10 |
| Other | 286.9* | 6.51 | 270.2 | 1.28 |
| Eligibility for NSLP | | | | |
| Eligible | 271.6* | 0.77 | 269.9 | 0.28 |
| Non-eligible | 295.7* | 0.68 | 297.3 | 0.32 |
| Parental Education | | | | |
| Did not finish H.S. | 267.1 | 1.63 | 266.8 | 0.53 |
| Graduated H.S. | 270.5 | 1.07 | 270.4 | 0.40 |
| Some college | 285.1 | 0.87 | 285.0 | 0.46 |
| Graduated college | 293.4* | 0.70 | 295.4 | 0.34 |
| Don't know | 266.0 | 1.35 | 265.6 | 0.51 |
| SD | | | | |
| SD, yes | 250.1 | 1.55 | 248.2 | 0.52 |
| SD, no | 287.9 | 0.56 | 288.4 | 0.26 |
| ELL | | | | |
| ELL, yes | 254.2* | 4.00 | 245.2 | 0.80 |
| ELL, no | 283.8* | 0.54 | 285.9 | 0.26 |

* Significantly different from rest of nation at $p < .05$.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress NAEP, 2013 Eighth Grade Mathematics Assessment.

Table 4. Average mathematics scale scores of 8th grade public school students, by Appalachia region and select school characteristics: 2013

| | Appalachia Region | | Rest of Nation | |
|---|-------------------|----------------|----------------|----------------|
| | Estimate | Standard Error | Estimate | Standard Error |
| Public school type | | | | |
| Charter | 266.6* | 5.01 | 281.5 | 2.87 |
| Not charter | 283.6 | 0.56 | 283.8 | 0.26 |
| Percent non-white enrollment | | | | |
| Up to 25% | 285.8* | 0.60 | 293.7 | 0.37 |
| From 25 through 50% | 282.1* | 1.77 | 289.8 | 0.61 |
| From 50 to 75% | 281.1 | 4.75 | 282.5 | 0.75 |
| More than 75% | 262.3* | 2.60 | 268.5 | 0.68 |
| Percent NSLP-eligible enrollment | | | | |
| Up to 25% | 301.3 | 2.27 | 304.2 | 0.51 |
| From 25 through 50% | 289.4 | 1.24 | 289.1 | 0.50 |
| From 50 to 75% | 277.8 | 0.78 | 277.4 | 0.44 |
| More than 75% | 262.8 | 1.89 | 266.3 | 0.48 |
| Locale | | | | |
| Urban | 277.2 | 2.71 | 277.7 | 0.64 |
| Suburban | 291.4* | 1.37 | 287.5 | 0.33 |
| Town | 279.0 | 1.26 | 281.6 | 0.75 |
| Rural | 281.0* | 1.00 | 286.3 | 0.60 |

* Significantly different from rest of nation at $p < .05$.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress NAEP, 2013 Eighth Grade Mathematics Assessment. U.S. Census Bureau, 2010 American Community Survey ACS.

Table 5. OLS Regression analysis of mathematics performance of 8th grade public school students, by Appalachia region: 2013

| | Appalachia Region | | Rest of Nation | |
|----------------------|-------------------|----------------|----------------|----------------|
| | Coefficient | Standard Error | Coefficient | Standard Error |
| Intercept | 308.4*** | 1.198 | 309.1*** | 0.416 |
| Female | -2.545*** | 0.712 | -2.971*** | 0.292 |
| Black | -20.16*** | 1.313 | -22.81*** | 0.481 |
| Hispanic | 2.326 | 2.127 | -8.345*** | 0.489 |
| Asian | 20.70*** | 3.603 | 13.64*** | 0.907 |
| Other | 1.174 | 7.008 | -12.22*** | 1.201 |
| Eligibility for NSLP | -13.14*** | 0.713 | -11.88*** | 0.395 |
| Parental Education | | | | |
| Did not finish H.S. | -13.99*** | 1.560 | -13.12*** | 0.603 |
| Graduated H.S. | -14.45*** | 1.079 | -14.06*** | 0.397 |
| Some college | -3.272*** | 1.046 | -4.477*** | 0.440 |
| Don't know | -14.85*** | 1.455 | -15.44*** | 0.494 |
| Urban | -4.163* | 2.304 | -2.000*** | 0.481 |
| Town | -8.349*** | 1.292 | -4.389*** | 0.621 |
| Rural | -7.656*** | 1.281 | -2.311*** | 0.579 |
| Charter | -1.577 | 3.586 | 3.423** | 1.561 |
| SD | -31.94*** | 1.271 | -34.34*** | 0.531 |
| ELL | -24.84*** | 3.524 | -27.08*** | 0.757 |
| R Square | 0.314 | | 0.363 | |

* Significant at $p < .05$.

** Significant at $p < .01$.

*** Significant at $p < .001$.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress NAEP, 2013 Eighth Grade Mathematics Assessment.