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Does Place Influence Mathematics Achievement Outcomes? An Investigation of the Standing of Appalachian Ohio School Districts

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Abstract

In Appalachian Ohio, districts are 2.5 times more likely than other districts to earn "deficiency" ratings from the state education agency (SEA). District accountability performance is not adjusted for poverty or other structural threats, and affluent suburban districts are permitted to address the same standards as impoverished rural and urban districts. The SEA calls this "accepting no excuses." This study, arguing that poverty (and other threats) are not irrelevant temporizations but powerful threats, investigates the charge of deficiency in the case of district-level mathematics performance, holding all else equal. The analysis theorizes the influence of 10 independent variables on three dependent measures (mathematics pass rates, mathematics achievement efficiency, and number of accountability indicators passed). All else equal, the results suggest that Appalachian locale and rural locale exert significant influences on the dependent variables, and that, most particularly, (a) the charge of deficiency is inapt and (b) Appalachian districts are more efficient in the production of mathematics achievement than other districts. In short, Appalachian districts do more with less in cultivating the mathematics learning of their students. One of several surprising results is that the proportion of expenditures devoted to instruction (i.e., teacher salaries), particularly among lower-spending districts, exerts a positive a positive influence on achievement. Recommendations include the need for (a) a value-added accountability model in Ohio and (b) resource levels adequate to sustain smaller schools and districts and to fund competitive teacher salaries in rural and Appalachian districts.

Does Place Influence Mathematics Achievement Outcomes? An Investigation of the Standing of Appalachian Ohio School Districts

Introduction

During the past two decades, state legislatures in the United States have adopted a wide variety of systems that represent to the public (and perhaps most critically to state and federal politicians) the quality of the work accomplished by schools and districts. The judgments are authoritative in the sense that they derive from the ultimate authority of states, under the reserved rights provision of the U.S. constitution, to operate systems of schools. The schemes for assessing such work exhibit great variety, as the provisions of the reauthorized Elementary and Secondary Education Act (NCLB) attest.

Linking funding and achievement in law. This movement is in fact a partial reaction to the numerous funding suits that began with *Serrano* (first decided in 1971), *all* of them instigated by distressed rural and urban districts. Rural Appalachia, in particular, has been the origin of a number of cases, including those in Ohio, Pennsylvania, West Virginia, Kentucky, Tennessee, and Virginia (cf. Dayton, 1998).

When rural school districts in the United States turn to the courts to hold states accountable for educational funding, legislatures might logically be expected to hold such districts accountable for the "results" of any additional funding subsequently provided. Despite the problematic relationship between funding and achievement identified by researchers (e.g., Greenwald, Hedges, & Laine, 1996; Hanushek, 1989), both plaintiffs and defendants, and often the judiciary, behave as if the influence of funding is an established and largely indisputable fact.

Not surprisingly, therefore, the determination of accountability ratings is usually quite straightforward—far more straightforward than most of the formulas under which states govern the flow of funds to school districts in the U.S. Given the ease of accounting for money and the difficulty of accounting for achievement, the practice harbors considerable irony. These systems of public reporting are undergoing change at present, with many changes contingent on the requirements of NCLB, and the effects of these changes remain to be seen. It is not clear, however, that the distribution of blame and praise will differ sharply from the current distribution. Understanding the way matters stand at present is, at the very least, important to providing a baseline for future comparisons.

Recent accountability standings in Appalachian Ohio. In Appalachian Ohio about 47 percent of districts were placed in the troubled categories of "academic emergency" and "academic watch," versus 19 percent of the rest of the state's districts.[1] On the terms of the Ohio accountability system, Appalachian districts are widely troubled and deficient. *None* of these 125 districts, for example, was considered effective (in the year in question, 2000-2001). Is such an implication of deficiency fair? Is the state getting its money's worth in Appalachia?

Perhaps the implication is not fair; perhaps the state is getting a good deal. This speculation is possible because the accountability playing field in Ohio is not merely out of level, it is sharply tilted. District-level socioeconomic status (SES) and accountability success are strongly correlated.

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[1] Data in our analyses come from the 2000-2001. Ohio operates 611 regular school districts, of which 125 are located in counties designated "Appalachian" by the Appalachian Regional Commission (ARC).

For 2000-2001 (the year of our data set), all districts were placed by the state into one of four categories based predominately on percentages of students passing "proficiency tests" (based on success or failure on 27 indicators): academic emergency, academic watch, continuous improvement, effective.[2] The zero-order correlation of our measure of socioeconomic status and number of accountability indicators met is r = .84 ($\underline{p}$<.0001). With median family incomes of about $25,000 (Appalachian districts) v. $32,000 (other districts), Appalachian districts are substantially poorer than those located elsewhere in the state.

In the Ohio accountability system for 2000-2001, the proportion of the district's students passing a test, unadjusted for threats and challenges faced by those students, is the basis of most judgments. Extremely affluent districts with highly experienced and credentialed teaching forces are permitted to address the same standard as extremely impoverished districts with inexperienced staff with a high proportion of "emergency" credentials. The result, as shown above, is predictable: impoverished districts are usually judged to be deficient. In 2000-2001, no districts in the top quartile of the SES measure used in this study were placed on "academic emergency" or "academic watch," whereas 109 districts from the lowest SES quartile were. Moreover, in comparing the top and bottom quartile of districts on SES, all the districts categorized as "effective" (n=27) came from the top SES quartile (again, none was Appalachian).

On the basis of these data, an objective observer might make the claim that the Ohio accountability game was "rigged." The state, by contrast, maintains that all districts

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[2] For 2001-2002 and later, the legislature added a fifth category: "excellent." Beginning in 2003-2004, the Ohio accountability system was realigned with the requirements of NCLB. Speculation about the implications of this change is included in our discussion of results.

are held to the same standards and that the state is not accepting poverty and other threatening conditions imposed by the political economy as "excuses"; as we have seen, however, the standard is not growth or improvement—and affluent districts are permitted to stagnate and to receive public praise for stagnation. Poverty should not excuse failure, but, we ask in this study, what are the terms of the judgment used in Ohio?

From a value-added perspective on student performance, Appalachian districts might actually *not* be less successful than other districts. They might even be discovered to outperform other districts, though this result seems unlikely in view of long-established impressions of Appalachian deficiency. The possibility is worth investigating, particularly in view of the state's representations that the accountability game is played on a level field ("no excuses").

Presumptions and Imputations of Appalachian Deficiency

The arguable unfairness of the Ohio accountability system might be an accident of poor design, but it might represent the influence of a tacit legacy under which designers may have operated unaware of its influence on them. Evidence for this tacit legacy addresses three realms (1) cultural and educational deficiency, (2) mathematics deficiency, and (3) deficiencies of Appalachian Ohio in particular.

Cultural and educational deficiency. Appalachia was difficult to reach until the penetration of the railroads, and especially the interstate highways. Indeed, until the East Coast industrialized following the Civil War, few people found any reason to come here, much less settle here. The Appalachian mountains and the plateau to the west of the mountains were "isolated" regions so far as the imagination of Easterners was concerned

(DeYoung, 1995; Pudup, Billings, & Waller, 1995). As the East boomed after the war, however, it coveted the timber, coal, and (as manufacturers disseminated the automobile) petroleum products found in abundance in Appalachia. The culture of small agriculture—of self-provisioning (described prejudicially as "subsistence" farming)—gave way before the onslaught. The population swelled, particularly in the steepest, most "isolated" parts of Appalachia in which coal was mined.

As employment in natural resource extraction has mechanized, population has declined in Appalachia, but not to the extent that it once swelled. Appalachians exhibit strong devotion to place and are reluctant to move, and when they do move, exhibit a storied—and sung—longing for home.

Appalachia, then, has a century-old reputation in the national mindset as a dark, dangerous, isolated, and deeply impoverished place. In the United States, the only places as bad as Appalachia are the Mississippi Delta and Indian Reservations. The only places as bad, and more feared, are urban neighborhoods where the neighbors' skins are dark. Jim Goad, in the opening of *The Redneck Manifesto*, parodies the hatefulness uniquely directed at Appalachians:

> Their stunted, subhuman minds are mesmerized by cheap alcohol, Lotto fever, and the asinine superstitions of poor-folks' religion. They stop beating their wives just long enough to let [them bear] another deformed rug rat.... They really bring down their race. (Goad, 1997, p. 15)

His point is that, in an age of care about hate-venom, Appalachians remain the only ethnic minority about whom such venomous speech is routinely and widely practiced. Young African American males are to be feared; Indians spurned but wondered at; and “hillbillies” mocked and ridiculed (the recently cancelled “Real Beverly Hillbillies” reality TV program seems to affirm the point), not to mention misrepresented.

The nation’s newspaper of record frequently finds reason to be gratuitously condescending when Appalachia figures in the news. According to a recent *New York Times* story, “The fact remains that very poor people still live along the back roads of Appalachia, in houses that look like abandoned barns. Some of them even live right on the roads for all the world to see” (Nieves, September 26, 2000, p. A1). The entire lineage of alienation for the poor is summed up in the stereotypes ascribed to Appalachia. They are consistent with the concepts critiqued by Gans (1995): feeble-mindedness, lawlessness, culture of poverty, underclass. In Appalachia, these sins are compounded by the un-American devotion to a remote place, to extended kinship networks, and to discredited ways of engaging the world.

The stereotype of the feeble-minded (and therefore ignorant) hillbilly has been sharpened to the point of caricature over the previous several decades by products such as *The Beverly Hillbillies, Hee-Haw* and movies such as *Deliverance*. For instance, Jethro Bodine in *Hillbillies*, received the frequent congratulations of family and friends for completing the sixth grade. Given the prevalent misrepresentations, combined with lack of first-hand experience of Appalachia, the deployment of deficiency models to study and judge Appalachian schooling should surprise no one.

In fact, the misconstruction of Appalachian reality is rooted in misconstructions of rural life that have a long history (Theobald, 1997; Williams, 1973). This deep-seated and increasingly popular view has generated a corresponding belief in the inherent inadequacy of educational opportunities in rural places (i.e., those who are ignorant and feeble-minded must suffer educationally). Herzog and Pittman (1995) observe that rural schools have long suffered from prejudicial attitudes about country people. Edington and Koehler (1987) suggest that this belief is common not only to the general public, but among many educators, legislators, and members of state boards of education. Confounding the attempts of professionals and policy makers, again, is the coincidence of poverty and rural place. Campbell and Silver (1999), to no one's surprise, observe that mathematics achievement of students in poor communities is significantly lower than the achievement of their more affluent peers—regardless of whether the poverty is urban or rural. Because of massive residential segregation and sorting in the US, of course, poverty and *rural*, and poverty and *race* are easily conflated, confused, and misinterpreted in law and policy.

Mathematics deficiency as a case in point. The imputation of deficiency thus trickles down many centuries from high culture, to popular opinion, to education professionals and policy makers, to provisions for accountability, and to professional development in Appalachian Ohio (and all places, actually).

Ohio won one of the first of the National Science Foundation's State Systemic Initiative (SSI) Grants. Related to the SSI work, a 1996 investigation evaluated the equity of mathematics and science reform, focusing on "Ohio's urban and isolated rural districts where there may be fewer opportunities to learn quality science and mathematics" (Kahle, Meese, & Damnjanovic, 1999, ¶ 4). In general, when the problem is *poverty*, NSF generously ascribes lower levels of achievement to poor curriculum or poor instruction rather than to poor children's deficient mental apparatus. The Rural

Systemic Initiative, for instance, targeted the most impoverished rural locales for special interventions in curriculum and instruction.

There is a sense in which this approach might be considered high-minded: the Foundation chose not to concentrate its efforts in affluent suburban districts. Moreover, educators and the public need not to blame the poor for the challenges that make life (and schooling) difficult—and they need to refrain from distinguishing the "undeserving" from the "deserving poor" (e.g., Gans, 1995).

The trouble arises when accountability systems misconstrue poverty as "an excuse" (an irrelevant temporization). To the contrary, poverty is *real*, and the threats contingent on poverty really do make life and learning difficult. (We advise those who have not tried poverty to do so.) Further, U.S. systems of schooling have often been constructed to compound the threats: We permit public schools serving affluent communities to access the most and best resources, and those serving the "underclass" (i.e., the undeserving poor) the fewest and shabbiest resources (e.g., Kozol, 1991).

No amount of high-quality inservice on mathematics curriculum and instruction will change this circumstance—worthy though such activity may be. Overcoming the real threats that come with poverty through inservice (professional development) is much the same as litigating school funding cases with a strategy of *prayer*. Both strategies have value, and both may be necessary. They are, however, remote from sufficiency.

Substantial empirical evidence exists, however, that rural achievement in mathematics is not deficient as compared to national averages—whether the influence of SES is statistically controlled or not (see Howley, 2003, for a recent synthesis). With respect to the mathematics achievement of Appalachian students in particular, Winters, controlling for achievement in this case, recently reported that the mean scores of rural schools (in Tennessee) equaled or exceeded those of other schools (Winters, 2003).

Appalachian deficiency and district accountability in Ohio. As noted in the introduction, Appalachian districts are poorer and are about 2.5 times more likely to be judged as deficient by the Ohio accountability system as compared to other districts. Earning a standing of "academic emergency" (meeting 0-6 indicators) or "academic watch" (meeting 7-10 indicators) targets a district as deficient and subjects it to a variety of possible sanctions.

In any case, the contribution of the outcomes of this game to a continued view of Appalachian schooling, and of Appalachians themselves, as *deficient* can hardly be denied. The accountability determinations are aggressively disseminated by the state. Through local report cards, in fact, districts are made to *confess* their shortcomings publicly, a policy move that (given the facts) reminds us of the continuing relevance of Michel Foucault's analyses in *Discipline and Punish* (1973). Possibly, the state has unknowingly imposed a regime that perpetuates the construction of Appalachians as deficient and unruly. As the forgoing discussion implies, the same burden would apply to Ohio's African Americans and to its poor in general. Some observers refer to this *legerdemain* as "blaming the victim."

Likely Contextual and Structural Influences on Mathematics Achievement

This study examines the effects of Appalachian location and other relevant structural variables on Ohio's district-level performance in mathematics. In order to identify the distinct influence of Appalachian location and the other structural variables of interest, the study controls for possibly influential covariates of mathematics achievement. The study therefore asks if each of the structural features of schooling – Appalachian location, rural locale (e.g., Fan & Chen, 2000; Pitts & Reeves, 1999), percentage of expenditure spent on instruction (cf, Greenwald & Hedges, 1996), graduation rate (e.g., Peoples, 1998), and student mobility (e.g., Adduci, 1990; Bruno & Isken, 1996) – has a *unique* influence on a district's performance in mathematics, in consideration of covariates with demonstrated salience.

An extensive body of prior research identifies likely covariates as socioeconomic status (SES; e.g., Mathews, 2001), district size (Johnson, Howley, & Howley, 2002), the interaction of size and SES, (e.g., Howley, 1999), and race (e.g., Lubienski, 2002; Oakes, 1985). Furthermore, in order to account for a district's cumulative performance, the study focuses on the most summative of the various mathematics measures included in Ohio's accountability reckoning.

Graduation rate might seem a strange predictor variable because it is so frequently construed as an outcome measure (dependent variable). The typical usage makes sense, of course, because graduation is the most indisputable result of the pursuit of a school program: does a student receive the credential or not? From a systemic perspective, nonetheless, the *graduation rate* can be thought of as a nexus of influences that together attach the most marginal students to school—in essence, a measure of social capital (cf. Coleman, 1990; Peoples, 1998). Although smaller schools and districts are well known to exhibit higher graduation rates (e.g., Pittman & Haughwout, 1987), the correlations of high school size and graduation rate are moderate rather than strong. Hence, in this study a district's graduation rate serves as a proxy for the construct of social capital, all else hypothetically equal. (Compare Fetler, 1989, for an conceptually similar representation[3] of the relationship between achievement and graduation rate.)

Method

This study examines the mathematics performance of Appalachian Ohio districts, given their comparatively poorer performance in the Ohio Department of Education (ODE) accountability system. Such an investigation is needed in light of the historic portrayal of Appalachia as a realm of undoubted deficiency and, more pressingly, in light of the apparent inadequacy of Appalachian Ohio school districts as represented by the state's accountability judgments.

Hypotheses. We hypothesize that, all else equal, the influence of Appalachian location, rural locale, graduation rate, district mobility rate, and percent of expenditures devoted to instruction will not attain statistical significance. The null hypothesis is a conservative approach, given the possible warrant for directional hypotheses in the education literature.

A common view is that Appalachians (and rural residents in general) place a low value on education (see Whisnant, 1980). Moreover, the current consensus is that expenditures are not robustly associated with school outcomes (e.g., Hanushek, 1997) With respect to our somewhat unorthodox measures of social capital, there is some basis in the prior literature to assume that the association will be positive (e.g., Israel, Beaulieu, & Hartless, 2001). Nevertheless, since we were unable to obtain data on conditions that

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[3] With graduation rate the dependent variable, Fetler used achievement as a control variable. Here, we use graduation rate as the control variable; for similar purposes, we ask, if graduation rate is held constant, what is the net influence of Appalachian and rural locale on mathematics achievement?

have been shown to typify social capital (e.g., neighborhood cohesiveness, strength of social networks), the influence of our proxies is hard to gauge.

Data sources. This study used data on 611 Ohio school districts (all enrolling students through high school) in the academic year 2001-2002 (number of districts varies slightly due to listwise deletion of missing data). Data came from four sources: (1) data on achievement, graduation rate, student mobility rate, expenditures per pupil, and graduation rate came from the ODE; (2) data about Appalachian locale came from the Appalachian Regional Commission (ARC), based on the location of districts within the Ohio counties identified as Appalachian; (3) data on district rural and urban locale came from the Common Core of Data (CCD) of the National Center for Education Statistics of the U.S. Department of Education (2001-02 academic year); and (4) data on educational attainment and composition of the nonwhite population aggregated to the school-district level came from the U.S. Bureau of the Census (decennial 2000 census special school-district aggregation).

Dependent variables. From the ODE's website came the district-level achievement test scores for this study.

Ninth-grade mathematics pass rates. For our first dependent variable, we focused on 9th grade pass rates (the only available score) in mathematics. This test was also administered to those 10th graders who had not passed the test previously, but, in order to maximize variability, we chose the pass-rates for first-time test takers. We construed 9th grade achievement as a kind of culminating measure of district performance, for two reasons. First, the 9th grade is the final year in which the performance of *all students* enrolled is measured (i.e., except for students with disabilities). In the 10th grade, students are permitted to leave high school, and many do. Second, probably because of the phenomenon of early school leaving, similar studies of achievement have demonstrated weaker relationships between dependent and independent variables at senior high school levels (e.g., Bickel, 1999; Howley, 1999).

In addition to mathematics, we also examined (but report in no detail) pass rates on other 9th-grade tests: science, reading, citizenship, and writing.[4] These analyses help us assess the robustness of the influence of the independent variables across the domains of achievement; some influences might be unique to mathematics, for instance, as opposed to reading or citizenship.

Mathematics achievement efficiency. We also examined the mathematics efficiency of Ohio districts, using the ratio of 9th grade mathematics pass rate to expenditure per pupil. In order to improve interpretability, we multiplied the ratio by 1,000, which produced a ratio of percentage increments for each $1,000 increment in per pupil expenditure. More efficient districts "purchase" equivalent pass rates for less money, all else equal. Again, we focused on the influence of Appalachian location, rural locale, graduation rate, district mobility rate, and percent of expenditure used for instruction.

Number of indicators passed. In order to relate achievement performance more closely to accountability performance, in the final analyses reported here, we employed the number of indicators passed as a dependent variable. In zero-order relationships we know that Appalachian location is a "risk factor" for school districts. The interesting question is whether or not, with an array of control variables, it will remain so.

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[4] It is important to note that, unlike the other tests, which are principally multiple-choice tests, writing is scored holistically and thus embeds a greater degree of error and unreliability than the other tests.

Independent variables. Our independent variables included information from all four of our data sources. First, we constructed a more fully specified measure of district socioeconomic status (SES) than is typical in many education studies (which tend to rely on free-and-reduced-price meal rates as an SES proxy).

Socioeconomic status. Recognizing the difficulties associated with any single measure of economic context (see e.g., Oakes & Rossi, 2003), we used a procedure applied by researchers such as Filmer and Pritchett (2001) and Bollen, Glanville, and Stecklov (2002) in which SES is derived as a principal component score from a set of relevant unidimensional measures. In selecting variables to incorporate into the principal component analysis, we were attentive to Coleman's (1990) insight about the importance of two features[5] of economic status: (1) material resources and (2) human resources, such as knowledge, skills, and capacities (i.e., "human capital"). Our composite measure, then, was able to represent the variance shared by three measures of districts' material resources – free and reduced meal rates, median family income, and percent of families receiving Ohio transfer payments; and two measures of "human capital": district-level early achievement[6] and proportion of the adult population 25 or older with a high school diploma or GED.

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[5] Coleman, of course, is also concerned with social capital, and, as separate independent variables in our model, we have included graduation rates and district mobility rates as proxies for social capital within the educational system (the latter a negatively signed proxy for social capital—instability rather than stability).

[6] The 4th grade achievement measure captures an aggregate level of early composite achievement that is highly related, for instance, to family income (zero-order r = +.59) and to 9th-grade pass rates (r = +.68).[6] In order to eliminate the threat of multicollinearity introduced by the use of the interaction of SES and enrollment, both this variable and the size variable were centered on their means.

The principal components analysis yielded a single factor with an eigenvalue above 1.00, accounting for 72.5% of the variance common to all five measures; all component variables loaded at greater than .80. Factor loadings are presented in Table 1.

Proportion of African American population. Because neither the ODE nor the CCD data sources report the percentage of African American students enrolled in districts, we used a reasonable proxy from the 2000 census: proportion of the entire district population that is African American. This variable, however, exhibited substantial positive skewness, a reflection of the fact that the population in many Ohio districts contains few African Americans or none, whereas the more urbanized districts have substantial African American populations. For these reasons (i.e., skewness and many near-zero values) we recoded the values of the variables into quartiles and used the recoded variable in our analyses.

District size. District size measured as enrollment proved to be a highly skewed variable (skew = 9.52), and a natural log transform reduced the skewness to .83. The variable was then centered on its mean.

Interaction of size and SES. The interaction term was computed as the product of the centered size and SES variables. The SES variable is positively associated with achievement, and hence, in the interaction variable, the product of lower SES and smaller size (values less than the mean are negative) yields a positive value for the interaction term, as does high SES and larger size. This information is useful in interpreting the sign of the SES variable in our regression analyses.

Proportion of expenditures on instruction. The proportion of district expenditures devoted to instruction was calculated from expenditure totals in the ODE data set as the ratio of expenditures for instruction per pupil and the total expenditure per pupil.[7] The principal expenditures comprising this variable, of course, are teacher salaries.

Graduation rates and district mobility rates. Graduation and district-level mobility rates were both provided in the ODE data set as district-level rate variables. The former was used in our equations without transformation.

District-level mobility is reported as the percentage of students enrolled in the district for half the year or less, but like proportion of African American population, this variable exhibits very low values in many districts and very high values in others (ranging, in fact, from 0% to 100%). In this case, too, we therefore recoded the values of the variable into quartiles and used the recoded variable as the measure of mobility in our analyses.

Locale variables. We used three location variables: whether or not a district is located in an ARC-specified Appalachian county (coded 0 or 1), whether or not a district is identified as rural by the Common Core of Data (CCD type of locale 7 or 8, coded 0 or 1), and whether or not a district is identified as urban by the same source (type of locale 1 or 2, coded 0 or 1). Other locales (CCD type of locale 3, 4, 5, or 6) constituted the excluded category (urban fringe locales, large and small town locales).

Analysis. As an initial test of the presumption of Appalachian deficiency in mathematics, we calculated marginal means of our dependent variables for Appalachian versus other districts, with SES as a covariate. Our further analyses used regression

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[7] We also computed the proportion of district expenditures devoted to administration in the same way for use in unreported ancillary analyses. The two variables exerted similar influence, but in opposite directions. In most analyses, however, the influence of our chosen variable (percent of expenditures devoted to instruction) was of slightly larger magnitude, and we retained it as the preferred measure.

methods to test the robustness of the influence of the independent variables of interest, namely, Appalachian location, rural locale, graduation rate, district mobility rate, and percent of expenditure devoted to instruction, in consideration of covariates representing well-established influences on achievement.

Finally, given evidence of the robustness of the influence of Appalachian location and rural locale that emerged in the results, separate analyses of these relationships were undertaken for the subgroups of districts (i.e., Appalachian versus other and rural versus other) and with the two dependent variables, number of indicators passed and mathematics achievement efficiency.

Results

In computing marginal means for our first analysis, we encountered the threat of unequal error variances when using the full data set. To counter this challenge, we drew a 50% random sample of cases, which proved sufficient to eliminate the threat.

Overall marginal means for Appalachian locale. Table 2 gives the estimated marginal means for the 9th grade mathematics pass rates in Appalachian versus other districts in this 50% sample. The first data column provides the unadjusted pass rates for the districts; the other districts outperform Appalachian districts by about one-half standard deviation. However, with the imposition of our SES variable as a control, the General Linear Model (GLM) estimate of marginal means shows Appalachian districts performing better than other districts by approximately 1/3 standard deviation. Because this result was not hypothesized, we computed additional analyses to explore the influence of Appalachian location in view of other likely influences.

Overall mathematics regression analysis. Our regression analysis for 9th grade mathematics pass rates of Ohio districts appears in Table 3, and the related correlation matrix appears in Table 4. The correlation matrix (Table 4) shows that the independent variables are weakly to moderately correlated (the strongest correlations among independent variables is between graduation rate and SES at $r = .64$); variance inflation factors, moreover, are all below 3.0, and we conclude that multicollinearity is not a serious threat to the analysis. The equation includes all independent variables specified in the previous discussion (see Table 4 note for their identification).

Remarkably, all independent variables except urban locale (suburban locale is the reference category) exert statistically significant influences ($p < .05$) on the dependent variable, together accounting for 63% of the variance in 9th grade mathematics pass rates. Apart from our composite SES, measure, the additional independent variables contribute about 15% of the variance. Positive influences comprise the following set of variables (given in order of the observed part correlations): socioeconomic status, graduation rate, interaction of size and socioeconomic status,[8] percentage of expenditures devoted to instruction, and Appalachian locale. Negative influences (also in order of declining magnitude of part correlations) comprise the following: percentage of African American population, size, rural locale, and mobility.

The net influence of Appalachian and rural locale is one major focus of interest in this study, and Table 3 shows that both locale variables exert a statistically significant influence all else equal, a surprising result. The net influence is not large, of course, but

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[8] This is the product of two centered variables, and is interpretable as follows: the product of two low values on the source variables produces a positive value in the interaction variable, whereas the product of a low and high value on the source variables produces a negative value in the interaction variable. Hence, the positive correlation expresses the fact that smaller, poorer districts and larger, wealthier districts exhibit higher pass rates. This influence is consistent with the findings of previous Ohio research (Howley, 1999).

the directionality of the influences is opposite in this analysis, with Appalachian location exerting a *positive* influence on 9th grade pass rates, and rural locale exerting an approximately equal *negative* influence.

We repeated the analysis reported in Table 3 for the other subjects tested at the 9th grade level in 2000-2001. Appalachian location exerts a statistically significant positive influence of similar magnitude in reading, science, and in the 9th grade composite of reading and mathematics reported by the state. It does not exert such an influence in citizenship or writing.[9] The significant part correlations for Appalachian locale range from about .06 (math and composite) to .09 (reading). Rural locale, by contrast, is significant in the reading-mathematics composite (doubtless due to its significance for mathematics), but in none of the other equations (i.e., excepting mathematics). In other words, rural locale in Ohio districts exerts a unique negative influence only in mathematics (among 9th grade assessments of district-level student learning).

Table 3 also shows the small, but significant influence of the percent of expenditure devoted to instruction. Districts that choose (or are required in response to negotiated agreements with teachers) to devote larger proportions of their budgets to instructional costs yield a small benefit in terms of achievement. This effect, while evident across the expenditure range, is actually more pronounced in districts with low per-pupil expenditure.[10] As the concept of marginality would suggest, investments in

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[9] The writing test is scored holistically and therefore embeds more error: in that equation, only 5 of our 10 variables exhibited statistically significant influences.

[10] A comparison of regression models with data from districts with low and high overall per pupil expenditures (based on a median split of the data) reveals stronger overall influence of percent of expenditure allocated to instruction in low expenditure districts. The part correlation coefficient is .098 ($p \leq .05$) in low-expenditure districts and .028 (non-significant) in high-expenditure districts.

instruction (i.e., primarily teachers' salaries) seem to yield diminishing returns beyond a certain threshold.

In addition to the influence of percent of expenditure devoted to instruction, two social capital measures, graduation rate and district mobility rate, also exert small effects, with graduation rate exerting a positive effect and district mobility rate a negative one. Taken together, however, these effects demonstrate the *positive influence* of social capital: the inverse of district mobility rate might appropriately be construed as district stability rate, which is a measure of social capital also shown in other studies to exert a positive effect on student achievement (see e.g., Israel et al., 2001).

Mathematics in Appalachian versus other districts. To investigate the possible influence of the variable set among Appalachian as compared to other districts, we computed two backward regression equations with 9th grade mathematics pass rates as the dependent variable: one for each subset of districts. Table 5 presents the results. First, among Appalachian districts in Ohio, the regression model accounts for less than half the variance in the dependent measure that it does among other districts (r^2 = .32 and .70, respectively). Second, the influence of SES is itself weaker by nearly 60 percent among Appalachian as compared to other districts.[11] Third, in both equations rural (but not urban) locale proves to be a statistically significant predictor. (The variable remains in the equation for Appalachian districts under the inclusion rules and is the weakest of the remaining five predictors.) Finally, in both equations socioeconomic status, size, the interaction of size and socioeconomic status, graduation rate, and rural locale are

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[11] Each standard deviation increase in SES is associated with an increase in .62 standard deviations in pass rates among the other districts (i.e., 7.3%), whereas such change yields only .23 standard deviation improvement in Appalachian districts (i.e., 2.4%). Compare also the part correlations (.39 v. .19) and the unstandardized regression coefficients.

significant predictors; among Appalachian districts (but not among "others") mobility is a significant predictor, whereas among the other districts (but not among Appalachian districts), the proportion of the population that is African American and the proportion of expenditures for instruction are significant predictors.

Marginal Appalachian means adjusted for additional predictors. The initial, exploratory, estimation of marginal mean pass rates for Appalachian versus other districts used only our composite SES measure as covariate. In light of the regression results, we recomputed the estimation, using as covariates all variables that proved significant in the foregoing analyses. Once again, unequal error variances proved an evident threat and we drew a 50% sample to deal with the threat. Table 6 reports the results.

As nearly as can be estimated given the predictors (which account for more than 60% of the variance in district-level mathematics pass rates), Appalachian districts are not inferior to other districts. The estimated marginal means in this sample draw are, in fact, higher than those of the other districts at a statistically significant degree ($p < .05$), equivalent to an effect size of .27. We caution against interpreting this result, however, as an indication of superiority; the level of significance is not high, the result varies between significance and non-significance depending on the draw, and the full sample (in which unequal error variance is a threat) also yields a nonsignificant difference (with an obtained value nonetheless favoring the Appalachian districts). We take a conservative position, therefore, and find no reason to reject the null hypothesis.

Analyses for rural locale. We completed parallel analyses for rural locale, which we summarize next, but for which we do not provide tables.[12] In backward stepwise regression analysis for rural districts, socioeconomic status, proportion of the district

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[12] The authors will be pleased to supply these tables upon request.

population that is African American, graduation rate, and mobility remain as significant predictors, accounting for 38% of the variance in 9th grade mathematics pass rates. Among rural districts, Appalachian locale is not a significant predictor. For other districts, socioeconomic status, proportion of the district population that is African American, size, the interaction of socioeconomic status and size, graduation rate, proportion of expenditures for instruction, and Appalachian locale remain in the equation on the final step, accounting for an impressive 75% of the variance in the pass rate.

Marginal means estimated with significant covariates from both equations yield mathematics pass rates for rural locale that are lower by 2% than those for other districts at a statistically significant level (75.8 v. 77.9, respectively, $\underline{p} < .05$). Unequal error variance was not a threat. All the significant predictors from both regression analyses all function as significant covariates in the GLM analysis. Partial eta^2 values for between-subject effects suggest that rural location and Appalachian locale together uniquely contribute about 2% of the variance in the dependent variable.

Mathematics achievement efficiency. The results presented in Tables 3, 5, and 6 provide rather strong evidence that Appalachian location, and, to some extent, rural locale, exert unique influences on district-level 9th grade mathematics achievement. Overall, both variables contribute unique influences, all else equal—with "all else" much more completely specified than is the case in many studies. Appalachian location exerts a unique positive influence on mathematics pass rates, and the opposite is the case for rural locale. Further, separate regression analyses by locale indicate that the specified influences operate differently in Appalachian and rural districts compared with other districts; most notably, in Appalachian and rural districts SES exhibits a much weaker influence on achievement.

These analyses have leveled the playing field to some extent, and, in the process, they have provided somewhat unexpected results, which lend support to the conjecture that some districts might make better use of resources than others. Indirect support for this conjecture comes from two findings reported thus far: (1) the finding that some of the most poorly funded districts realize reasonable achievement results, given the background characteristics of their students, and (2) the finding that percentage of expenditure devoted to instruction has a positive effect on achievement, particularly in low-funded districts.

Another, more direct, way to explore the link between funding and achievement is to examine variables related to fiscal efficiency, that is, the cost per unit outcome. In particular, it might be useful to examine the structural conditions that influence the fiscal efficiency of producing mathematics success at the 9th grade (with "success" defined, of course, as mathematics pass rates).

To examine these influences, we use mathematics achievement efficiency as our dependent variable. Our first analysis is a direct entry regression model using all 10 independent variables, followed by the estimation of marginal means for mathematics achievement efficiency, all else equal (i.e., with independent variables significant in the regression analysis as covariates in the GLM analysis). Regression results are presented in Table 7, the correlation matrix in Table 8, and the estimated marginal means in Table 9.

As might be anticipated, collinearity is not a serious threat to the regression analysis (i.e., correlations among independent variables are again no stronger than moderate and variance inflation factors are all less than 3.0). A number of points are worth noting. First, the zero-order correlation of Appalachian locale and mathematics achievement efficiency (see Table 8) is not statistically significant. Second, the pattern of influence is markedly different from the pattern in the analysis of simple pass rates: the statistically significant variables are all very highly significant ($\underline{p} < .001$). Judging by the strength of the part correlations, three variables exert unique influence of approximately equal (and moderate) strength: socioeconomic status (+.225), proportion of African American population (-.222), and proportion of expenditures devoted to instruction (+.226). Three additional variables contribute approximately equal, but more modest, influence (again, judging by the part correlations): Appalachian location (+.115), size (-.097), and rural locale (+.097). These results are perhaps even more surprising than those for the simple pass-rate dependent variable (see discussion).

The estimation of marginal means via GLM analysis, then, uses these six measures as the covariates of mathematics achievement efficiency (see Table 9). The dependent variable has been created for ease of interpretability—as pass rate purchased per $1,000 unit. Among the notable findings, we see, first, that uncorrected means do not exhibit a statistically significant difference (11.97 v. 11.79, for Appalachian and “others,” respectively). That is, when the playing field is not level, Appalachian districts are as productive as other districts. Second, when we remove the tilt from the playing field via the GLM analysis, Appalachian districts are shown to be more productive ($\underline{p} < .05$) than other districts: All else equal, Appalachian districts purchase 12.6 pass-rate percentage points per $1,000, whereas other districts purchase 11.6 pass-rate percentage points per $1,000 spent (equivalent to an effect size of about .42). In the calculation of "all else equal," Appalachian location contributes about 4% of variance and rural locale about 2% (partial eta^2 values for these covariates). Both influences, as noted previously, are positive. This result was not anticipated.

We performed a parallel analysis for rural locale (results not reported in tabular form). In this analysis, rural districts exhibited statistically significant ($p < .05$) and higher mathematics achievement efficiency on both uncorrected and estimated marginal means, although leveling the playing field via the GLM analysis reduces by about two-thirds the advantage enjoyed by rural districts (12.13/$1,000 v. 11.58/$1,000, equivalent to an effect size of about .21).

<u>Number of indicators met</u>. In view of a series of unexpected findings from the analyses, we performed a final analysis focused not on mathematics pass rates, but on the comparison, all else equal, of Appalachian and other districts' capacity to meet the indicators established in the Ohio accountability scheme (as it existed in 2000-2001). We first performed a regression analysis to identify the significant predictors of our third dependent variable (i.e., number of indicators met). These proved to include the control variables (SES, proportion African American population living in the district, and district size) as well as the hypothesized predictors (graduation rate, rural locale, and mobility), and these six variables were used in the GLM estimation of marginal means, reported in Table 10 (see Table 4 note for the relevant definitions; regression results and correlation matrix available from the authors).

The results in Table 10 show that, as the introductory discussion indicated, Appalachian districts perform substantially worse (equivalent to an effect size of about .71) than other districts. With the effect of statistically significant covariates controlled, however, the estimated marginal means give Appalachian districts a slight (and statistically non-significant) edge over other districts

Conclusions and Recommendations

First we summarize the foregoing results, in order to highlight the key findings. Following the summary, we offer more speculative interpretations of the findings.

Summary of findings. We hypothesized that, with covariates of 9th grade mathematics pass rates statistically controlled, Appalachian districts would not exhibit pass rates that differed at a statistically significant level from other districts. In a conservative interpretation of the findings (cf. Table 6), we accepted the null hypothesis: all else equal, mathematics pass rates in Appalachian districts are not different from those of other districts, in contrast to widely held stereotypes of Appalachian underachievement.

The surprises do not stop here. The regression results in Table 3 also provide evidence that, net of all other significant predictors, Appalachian location exerts a *positive* influence on mathematics pass rates, whereas rural locale exerts a negative influence. Moreover, we found that, with other independent variables controlled, a measure of resource allocation, namely, proportion of expenditures devoted to instruction, also exerted a small but significant influence, as did our two measures of social capital (i.e., one construed in the positive direction as graduation rate and the other construed in the negative direction as mobility rate).

Provoked by these unexpected results, we also examined mathematics achievement efficiency (defined as pass rate per thousand dollars of per pupil expenditure). Again, to our surprise, Appalachian location and rural locale demonstrated significant influences ($\underline{p} < .001$) net of all other influences, in both cases a net positive influence. More surprising still, the efficiency of Appalachian districts, all else equal, proved to exceed that for other districts at a statistically significant level. Finally, all else equal, Appalachian districts exhibited estimated marginal means on "number of indicators met" in the Ohio accountability system that were no different from those exhibited by other districts.

Interpretations of findings. We conclude that Appalachian school districts are by no means doing a substandard job in providing mathematics instruction (analyses not reported show similar results in the other subjects tested in the 9th grade). Although Appalachian Ohio is largely rural and poor, Appalachian location itself—with the influence of poverty and other variables statistically controlled—exerts a positive influence on 9th grade mathematics pass rates.

In terms of what we have called "mathematics achievement efficiency," however, we are in a good position to press a claim of Appalachian superiority. All else equal, $1,000 expended in Appalachian Ohio districts purchases higher mathematics pass rates than it does elsewhere in Ohio. Despite the fact that, all else equal, Appalachians have students passing the 9th grade mathematics test at the same levels as other districts, they achieve this (hitherto unacknowledged) standing with greater efficiency than other districts in Ohio.

How can we account for these findings? First, we need to acknowledge the seriousness of the threats that Appalachian districts face. From the first panel of the regression analysis reported in Table 5, we see that the relevant threats are as follows: (1) comparatively lower socioeconomic status (in the Appendix compare the Appalachian versus "other" means for the components of our SES measure), (2) slightly lower graduation rates, (3) higher rates of student mobility (Table 4 reveals that mobility is moderately correlated to SES, r = -.475), and (4) greater rurality (62.4% of Appalachian districts are rural as compared to 41.5% of other districts). Median family income is lower by about $6,500 (equivalent to an effect size of abut 0.5); public assistance rates are more than twice what they are in the other districts (effect size of about 1.0); graduation rates are also lower by 2.3% (a modest effect size of about .25); and mobility is more than 50% higher (effect size about .40). All of this is consistent with our major findings: Appalachian districts perform as well as one might expect given the threats they confront—the effect size (i.e., about .50) for the unadjusted means is compatible with the magnitude of the threats just recited.

Next we need to identify whether or not Appalachian districts enjoy any advantages. Table 5 identifies one such advantage (the interaction of district size and socioeconomic status), and Table 3 suggests another (Appalachian location).

As revealed in previous research, the interaction of district size and socioeconomic status delivers an achievement advantage to smaller districts serving impoverished communities (see Johnson, Howley, & Howley, 2002 for a list of the relevant studies). Appalachian districts in Ohio appear to use this advantage to good effect, thereby realizing a slight advantage over other districts in the state. By retaining smaller districts in communities that have higher proportions of low-income families, Appalachian districts function more effectively than non-Appalachian districts in reducing the achievement gap in mathematics that typically accompanies differences in community SES.

We also know from the analyses that location in Appalachia itself represents an advantage. But what conditions characterize that advantage? Viewing the distribution of advantages and challenges systemically (i.e., in the Ohio K-12 system as a whole), Appalachian districts are comparatively "advantaged" when other districts confront challenges that Appalachian districts do not confront. Thus, the fact that African Americans are concentrated in Ohio's largest districts presents those districts with challenges seldom encountered in Appalachian districts, and the absence of that challenge is a kind of "advantage." Other districts, as well, are larger than Appalachian districts (3,100 versus 1,900 students, equivalent to an effect size of about .40), and the urban districts are much, much larger. This imparts a similar systemic "advantage." When the net influence of all the advantages and threats is toted up, 9th grade mathematics pass rates are equivalent. (This is simply what the estimated marginal means tell us.)

There is a patent link between funding and accountability, as suggested previously. Nevertheless, previous studies—from Coleman's classic investigation to recent production function studies (see e.g., Hanushek, 1997)—persistently affirm, commonsense wisdom to the contrary (cf. Kozol, 1991), that funding has almost no effect on the outcomes constituting accountability measurements. Our findings, however, offer preliminary evidence suggesting that, while overall funding levels contribute little to achievement, the way funds are used does exert an influence. Particularly among the least well-funded districts in the State, the choice to devote a larger proportion of the per-pupil allocation to instruction (primarily via teachers' salaries) seems to confer an achievement advantage. In Appalachian districts, many of which experience difficulties in recruiting and retaining teachers, practices that concentrate funds in the instructional domain, perhaps by attempting to make teacher salaries more competitive, appear to represent a worthwhile investment.

In addition to the finding that some Appalachian districts choose to allocate limited funds in ways that maximize achievement results, our data show that, in general, Ohio's Appalachian and rural districts are more efficient than other districts in producing achievement outcomes. Persistently under-funded, these districts have apparently learned to do more with less. This accomplishment surely represents unusual and admirable organizational capacity. Considering that Ohio seems to lack the political will to make its school funding system equitable, the adaptations that Appalachian and rural districts have made to relative privation seem to be paying off.

Nevertheless, the payoff is limited to achievement advantages in consideration of the structural circumstances that constrain achievement. Narrowing the achievement gaps resulting from SES differentials will require more. With more resources, Appalachian districts would have greater flexibility to pursue the policy initiatives that already are conferring advantage: sustaining smaller schools and districts and allocating more funding to instruction (teacher salaries; recall that this counsel does not apply to wealthy districts because of the existence of threshold effect).

Recommendations. As implied in the introduction, the provocation for this study was, in part, the suspicion that Appalachian districts did not receive fair treatment under the terms of the Ohio accountability system because the system does not, in fact, render all else equal in making its judgments of merit: 59 of the 125 Appalachian districts (47.2%) were judged in 2000-2001 as deficient (bottom two accountability categories). For the other 477 districts for which we have complete data, 89 (18.7%) were judged as deficient by the state.

Changes in the Ohio accountability system are needed in order to adjust expectations to the challenges and the advantages prevalent among the various districts. More particularly, we advise the use of an adequately specified "value-added" model that establishes reasonable pass rates and growth projections as standards. By reasonable we mean they should be sufficiently responsive to the prevalent challenges and advantages. Such change should *not*, however, embrace the projections for Annual Yearly Progress conceived by NCLB[13] (Lee, 2003; Linn, 2003). Jaekyung Lee, in particular, finds the projections invalid, unreliable, and unfair for rural schools. (Although Appalachian locale in Ohio is distinguishable from rural locale, 78 of the 125 Appalachian Ohio are classified as rural by the National Center for Education Statistics.)

Finally, some rural education advocates have seen in the sequence of events—beginning with litigation and culminating, for now, in the imposition of accountability schemes—a punitive intent, and their point is strengthened somewhat by the tendency of legislatures to impose school consolidation measures following successful litigation (e.g.,

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[13] The provisions responsive to NCLB expectations, not surprisingly, have already been implemented for the current and future years. This change compounds the previous error.

Cure worse than disease, 2002). In any case, the relationship between resources and achievement is complexly contingent and seems rather clearly to depend on *which* resources are used, *where* and *for whom* they are used, and *how* such use transpires (e.g., Wenglinsky, 2002). Funding can be both adequate and equitable—seemingly the best of all possible worlds—but still be poorly applied.

Clearly, even in the best of all possible worlds, districts will still vary in their capacity to apply resources productively. Appalachian school districts are often the special targets of improvement efforts because, since they are poor, they are presumed to be deficient and in special need, therefore, of "improvement." Seldom has the charge (or implication) of deficiency been examined empirically, as in this study.

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TABLES

Table 1

Factor Loadings for Composite SES Variable

Unidimensional variables	
Median family income	+.844
% of students from Ohio Works First families	-.849
early achievement	+.804
% high school graduates (25+ adult population)	+.816
% students receiving free and reduced-price meals	-.938

R^2 = .72.51

Table 2

Estimated marginal means for 9th grade mathematics pass rates in Ohio districts

Locale	Uncorrected Means (SD)	Est. Marginal Means (SE)	N
Appalachian	71.37 (9.78)	79.36 (.541)	229
Other	77.55 (12.09)	75.70 (1.191)	53
Total	76.39 (11.93)	77.53 (.636)	282

Note. Adjusted $R^2 = .547$; eta^2 for Appalachian locale = .026; estimated marginal means estimated from 50% random sample (see text). Mean differences between Appalachian and other districts significant at $p < .05$

Table 3

Summary of Regression Analysis for Variables Predicting Ninth-Grade Mathematics Pass Rates in Ohio School Districts (N=602)

Variable	B	SE B	β	p	Part correlation
INTERCEPT	50.876	6.668	-----	.000	-----
SES	6.385	.485	.545	.000	.326
% AA	-1.453	.322	-.139	.000	-.112
SIZE	-1.701	.411	-.145	.000	-.103
SES*SIZE	.893	.254	.117	.000	.087
GRAD	.228	.051	.175	.000	.111
% INST	22.158	8.973	.066	.014	.061
APPY	1.962	.866	.068	.024	.056
RURAL	-2.071	.709	-.088	.004	-.072
URBAN	1.570	1.957	.027	.423 (ns)	.020 (ns)
MOBILITY	-.688	.319	-.065	.032	-.053

Note. Adjusted $R^2 = .632$; $p < .0001$.

Table 4

Correlations of Percentage of Students Passing 9th Grade Mathematics with Predictor Variables

	MATH9	SES	%AA	SIZE	SES* SIZE	GRAD	%INST	APPY	RURAL	URBAN	MOBILITY
MATH9	1.000	.716	-.324	-.266	.429	.664	-.024	-.181	.068	-.384	-.420
SES		1.000	-.153	-.041	.367	.641	-.070	-.436	-.007	-.332	-.475
% AA			1.000	.502	-.090	-.347	.210	-.063	-.445	.248	.197
SIZE				1.000	-.239	-.365	.291	-.105	-.484	.438	.050
SES*SIZE					1.000	.415	.012	.099	.014	-.569	-.005
GRAD						1.000	-.063	-.105	.199	-.437	-.459
% INST							1.000	.041	-.258	.092	-.021
APPY								1.000	.168	-.066	.230
RURAL									1.000	-.192	-.036
URBAN										1.000	.104
MOBILITY											1.000

Note. n = 602; for $r > .067$, $p < .05$; for $r > .095$, $p < .01$; for $r > .11$, $p < .001$.

SES = composite socioeconomic status (see "independent variables" discussion for details) factor score;
%AA = proportion of the general population of the district of African American ancestry, according to the 2000 census, expressed as a quartile;
SIZE = centered natural logarithm of district enrollment;
SES*SIZE = the product of SES and SIZE;
GRAD = district graduation rate;
% INST = ratio of per pupil expenditures on instruction to total per pupil expenditures;
APPY = district located in ARC county (coded 1 for Appalachian, 0 otherwise) ;
RURAL = district identified as locale type 7 or 8 in the 2000-2001 Common Core of Data listing (coded 1 for rural, 0 otherwise);
URBAN = district identified as locale type 1 or 2 in the 2000-2001 Common Core of Data listing (coded 1 for urban, 0 otherwise);
MOBILITY = proportion of districts students attending the district for less than half the academic year, expressed as a quartile.

Table 5

Summary of Backward Stepwise Regression Analysis for Variables Predicting Ninth-Grade Mathematics Pass Rates in Appalachian versus Other Ohio School Districts (N=602)

A. Appalachian Districts N = 125

Variable	B	SE B	β	p	Part correlation
Intercept	48.994	11.701	----	.000	
SES	3.166	1.213	.229	.010	.194
SES*Size	2.509	.957	.210	.010	.195
GRAD	.405	.119	.303	.001	.253
RURAL	-2.943	1.591	-.139	.067	-.137
MOBILITY	-2.168	.928	-.203	.021	-.174

Note. Adjusted $R^2 = .315$; equation significant at $p < .0001$; inclusion rules: p in = .05, p out = .10

B. Other Districts N = 477

Variable	B	SE B	β	p	Part correlation
Intercept	55.737	6.733		.000	
SES	7.804	.508	.618	.000	.388
% AA	-1.715	.340	-.164	.000	-.127
SIZE	-1.698	.393	-.153	.000	-.109
SES*SIZE	.462	.227	.065	.042	.051
GRAD	.150	.053	.118	.005	.072
% INST	23.150	9.088	.069	.011	.064
RURAL	-1.965	.751	-.082	.009	-.066

Note. Adjusted $R^2 = .696$; equation significant at $p < .0001$; inclusion rules: p in = .05, p out = .10

Table 6

Estimated Marginal Means for 9th Grade Mathematics Pass Rates in Ohio Districts Using the Full Complement of Covariates

Locale	Uncorrected Means (SD)	Est. Marginal Means (SE)	N
Appalachian	73.33 (11.06)	79.12 (.496)	236
Other	77.30 (12.34)	75.84 (1.096)	59
Total	76.51 (12.18)	77.46 (.384)	295

Note. Adjusted R^2 = .632; eta^2 for Appalachian locale = .008; estimated marginal means estimated from 50% random sample (see text). Mean differences between Appalachian and other districts significant at $p < .05$

Table 7

Summary of Regression Analysis for Variables Predicting Ninth-Grade Mathematics Achievement Efficiency in Ohio School Districts (N=602)

Variable	B	SE B	β	p	Part correlation
Intercept	2.064	1.632	----	.206	----
SES	.901	.119	.377	.000	.225
% AA	-.588	.079	-.276	.000	-.222
SIZE	-.326	.100	-.137	.001	-.097
SES*SIZE	.044	.062	.028	.484(ns)	.021
GRAD	.020	.012	.075	.110(ns)	.048
% INST	16.684	2.196	.243	.000	.226
APPY	.817	.212	.139	.000	.115
RURAL	.567	.174	.118	.001	.097
URBAN	-.806	.479	-.067	.093(ns)	-.050
MOBILITY	-.042	.078	-.020	.592(ns)	-.016

Adjusted $R^2 = .469$; equation significant at $p < .0001$

Table 8

Correlations of Mathematics Achievement Efficiency with Predictor Variables

	MATH PROD	SES	%AA	SIZE	SES* SIZE	GRAD	%INST	APPY	RURAL	URBAN	MOBILITY
MATH PROD	1.000	.436	-.461	-.357	.312	.506	.084	.031	.294	-.381	-.279
SES		1.000	-.153	-.041	.367	.641	-.070	-.436	-.007	-.332	-.475
% AA			1.000	.502	-.090	-.347	.210	-.063	-.445	.248	.197
SIZE				1.000	-.239	-.365	.291	-.105	-.484	.438	.050
SES*SIZE					1.000	.415	.012	.099	.014	-.569	-.005
GRAD						1.000	-.063	-.105	.199	-.437	-.459
% INST							1.000	.041	-.258	.092	-.021
APPY								1.000	.168	-.066	.230
RURAL									1.000	-.192	-.036
URBAN										1.000	.104
MOBILITY											1.000

Note. $n = 602$; for $r > .067$, $p < .05$; for $r > .095$, $p < .01$; for $r > .11$, $p < .001$.

Table 9

Estimated Marginal Means for Mathematics Achievement Efficiency in Ohio Districts Using the Full Complement of Covariates (N = 602)

Locale	Uncorrected Means (SD)	Est. Marginal Means (SE)	N
Appalachian	11.97 (2.03)	12.63(.174)	125
Other	11.79 (2.47)	11.62(.082)	477
Total	11.83(2.39)	12.12(.092)	602

Note. Adjusted $R^2 = .464$; eta^2 for Appalachian locale = .041; eta^2 for rural locale = .017 Differences between Appalachian and other districts' estimated means significant at $p < .05$; difference between Appalachian and other districts uncorrected means not statistically significant.

Table 10

Estimated Marginal Means for Number of Indicators Met in Ohio Districts With Significant Covariates (N = 602)

Locale	Uncorrected Means (SD)	Est. Marginal Means (SE)	N
Appalachian	13.57(4.32)	16.96(.392)	239
Other	17.28(5.16)	16.49(.175)	56
Total	16.58(5.21)	16.72(.206)	295

Note. Covariates: SES, % AA, SIZE, GRAD, RURAL, MOBILITY.
Adjusted $R^2 = .752$; eta^2 for Appalachian locale = .004(ns); eta^2 for rural locale = .017. Differences between Appalachian and other districts' estimated means not significant; difference between Appalachian and other districts uncorrected means very highly significant ($p<.0001$).

Appendix

Appalachian Versus Other Districts: Descriptive Statistics

	Appalachian Districts						Other Districts					
	mean	median	sd	N	min	max	mean	median	sd	N	min	max
MATH9	**72.8**	74	10.3	125	35.6	94.4	**78.1**	79.8	11.9	482	23.6	100
INDICATORS MET	**13.5**	14	4.1	125	4	23	**17.5**	18	5.0	482	2	27
MDN INC	**$25,376**	$25,181	$3,049	125	$15,820	$36,377	**$31,918**	$30,549	$6,368	482	$19,141	$61,222
OWF	**13.7**	12.6	8.4	125	0.3	44.6	**6.1**	3.9	7.5	482	0	61.1
HS GRAD	**77.2**	77.9	7.3	125	25.7	88.7	**84.6**	84.7	6.2	482	47.2	98.0
MOBILITY	**11.7**	8.5	18.0	125	0	100	**7.6**	6.3	9.9	482	0	100
ENROLLMENT	**1,879**	1,651	1,110	125	454	9,116	**3,147**	1,853	5,751	482	309	78,190
GRAD RATE	**84.5**	85.7	7.7	125	54.4	98.1	**86.8**	89.1	9.3	482	33.7	100
EXP PER P	**$6,129**	$6096	541	125	$5,031	$8,038	**$6,801**	$6,449	$1,214	482	$5,282	$14,684
% INST	**55.6**	55.6	3.3	125	46	64	**55.3**	55.5	3.5	482	44	66
% ADMIN	**12.5**	12.3	1.9	125	9	17	**12.5**	12.1	2.1	482	5	22
LUNCH	**32.5**	31.3	11.8	125	7.8	59.8	**18.5**	15.4	13.4	477	0.1	80.9
% AA	**1.7**	0.6	2.9	125	0	19.9	**4.2**	0.9	10.0	482	0	93.0

Note. MATH9 = percentage passing the 9th grade mathematics proficiency test on its first administration (2000-2001); INDICATORS MET = number of accountability indicators met, 2000-2001; MDN INC = 2000 median income (census); OWF = percentage of district families receiving Ohio Works First assistance; HS GRAD = percentage of adult (25+) population with high school diploma or equivalent (2000 census); MOBILITY = percentage of district students enrolled for no more than half the academic year; ENROLLMENT = total district enrollment; GRAD RATE = district graduation rate; EXP PER P = total expenditure per pupil in district; % INST = percentage of expenditures for instruction; % ADMIN = percentage of expenditures for administration; LUNCH = percentage of district students receiving subsidized meals; % AA = percentage of district population of African American descent (2000 census).