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# District variations in educational resources and student outcomes

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## Abstract

Since the 1970s, poorer school districts lacking educational resources have formed coalitions and sued their respective states. Their lawsuits claim that interdistrict variations in educational resources violate state constitutions because they deny poorer school districts an equal educational opportunity. Using data from school districts in Virginia, this research investigates two questions. First, whether a school district's level of educational resources is associated with its socio-economic characteristics. Second, whether interdistrict variations in student outcomes (achievements, attainments and aspirations) are associated with interdistrict variations in educational resources. Our results indicate that resources are associated with a school district's socioeconomic characteristics and that resources are associated with student outcomes. However, there is evidence of effects of resources on student outcomes only for attainments and aspirations, not for math and reading test scores. © 2000 Elsevier Science Ltd. All rights reserved.

## 1. Introduction

Since the 1970s, poorer school districts have formed coalitions and sued their respective states claiming that interdistrict variations in educational resources violate state constitutions. These lawsuits claim that variations in educational resources deny students in poorer school districts an equal educational opportunity (Hickrod, Hines, Anthony, Dively & Pruyne, 1992; Verstegen, 1994).[1] Verstegen (1994) (p. 243) calls the disparities in

educational resources–student outcomes controversy "the most pressing civil rights issue facing school systems in the 1990s".

This controversy is also reflected in the prior research on educational resources and educational achievement. At the center of this controversy is Hanushek's (Hanushek 1981, 1991) claim that "there is no relationship between expenditures and achievement of students,

unconstitutional because the interdistrict variations resulted in richer school districts having more educational resources than their poorer counterparts. In Virginia, the poorer school district coalition lost their suit at the state Supreme Court level. Verstegen (1994) (p. 250) argues that school finance systems do not need to be repaired; they need to be radically redesigned in an effort to achieve both excellence and equity for all children and all schools.

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[1] Since 1970, more than 60 individual pieces of litigation have been filed, contesting the constitutionality of public school finance systems in 41 states (Hickrod et al., 1992, p. 180). The litigation has been successful in some states. For instance, New Jersey's Supreme Court declared the state's funding system

and that such traditional remedies as reducing class sizes or hiring better trained teachers are unlikely to improve matters" (Hanushek, 1981, p. 19). Hanushek argues that "throwing money at schools" will not improve student achievement. However, Greenwald, Hedges and Laine (1996a,b) claim that their meta-analysis of the prior research (including some of the same research reviewed by Hanushek) shows that school resources are systematically related to student achievement. They conclude that the relationships among school resources and student scores are large enough to be educationally important. Thus, they argue that increasing the funding of public schools *will* improve student scores. Alexander's (Alexander, 1997) review of the literature on school resources and student performances also reaffirms Greenwald et al.'s conclusion.

There are two focal questions raised by this controversy. The first is whether it is actually true that poorer districts receive fewer educational resources than more affluent districts. The second question is a more complex one. It is whether variations in resources are actually associated with variations in student outcomes.

The failure of the prior research to generate consistent findings can be attributed to differences in how researchers specified the relationships among student outcomes, educational resources, ability measures, and the school district's socioeconomic status (SES). One common limitation is the failure to take into account district variations in average student ability. A second is the failure to consider the three-way associations among school districts' educational resources, student performances, and their SES.

In this paper, we attempt to correct for these limitations. We present a theoretical model that hypothesizes that a school district's socioeconomic status is associated with the level of its educational resources and a school district's educational resources do affect student outcomes. However, we argue that, when assessing the effects of resources on student outcomes, it is necessary to take into account average student ability and the districts' socioeconomic characteristics.

## 2. Previous research

Some of the prior research assumes, without providing systematic evidence, that a school district's level of educational resources is associated with its socioeconomic characteristics. Usually, anecdotal evidence is presented that shows that some school districts receive more educational resources than others (Dolan & Schmidt, 1987; Kozol, 1991; Ross, Smith, Nunnery, Douzenis, McLean & Trentham, 1994).

However, some studies do systematically address this issue. Bidwell and Kasarda's (Bidwell & Kasarda, 1975) research shows that in wealthier Colorado school dis-

tricts there was a higher percentage of teaching staff who held at least a Master's degree. Ferguson (1991), in his study of Texas school districts, found that the higher the percentage of adults with some college education in the school district, the more highly qualified the district's teachers. He also found that the percentage of well-qualified teachers decreased as minority school enrolment increased. Ferguson and Ladd (1996) in their analysis of Alabama school districts, confirmed Ferguson's (Ferguson, 1991) results for school districts in Texas.

Hoxby's (Hoxby, 1996) nationwide panel data on school districts support the results from Alabama, Colorado, and Texas. Hoxby found that per-pupil expenditures, average teacher salaries, and the pupil–teacher ratio varied with an array of socioeconomic characteristics. Most prominent among the associations was the consistent relationship between school resources and the school district's socioeconomic status as measured by the median income, median rent, percent of population in poverty, and the unemployment rate. He also found that teacher unionization was positively associated with educational resources.

Finally, in their nationwide analysis of over 17,000 school districts, Parrish and Fowler (1995) found that greater expenditures per student are associated with higher community socioeconomic status as measured by the value of owner-occupied housing or by residents' educational attainment. However, they found that the relationship is less pronounced when socioeconomic status is defined in terms of median household income.

A number of studies have also shown that district variations in student outcomes are associated with district variations in educational resources (Bidwell & Kasarda, 1975; Bidwell & Kasarda, 1976a,b; Borland & Howsen, 1992; Dolan & Schmidt, 1987; Ferguson, 1991; Ferguson & Ladd, 1996; Gyimah-Brempong & Gyapong, 1991; Sander, 1993; Sebold & Dato, 1981; Walberg & Fowler, 1987).[2] An implicit theoretical model guides this research. The model states that student outcomes are raised because the resources directly or indirectly improve the quality of education students receive. Some have argued that student outcomes are more likely to be associated with educational resources that directly influence teacher–student interactions (Bidwell & Kasarda, 1975; Namboodiri, Corwin & Dorsten, 1993). Two resources assumed to affect teacher–student interactions most directly are the level of professional development of the instructors, and the pupil–teacher ratio.

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[2] For an excellent review of the literature before 1975, see Cohn and Millman (1975). There is also literature that examines whether district resources are associated with the rate of return to education. For a detailed survey of the literature see Card and Krueger (1996), Betts (1995, 1996) and Griffin and Ganderton (1996).

It has also been suggested, however, that student outcomes should be positively associated with per-pupil expenditures (Bidwell & Kasarda, 1975; Borland & Howsen, 1992; Dolan & Schmidt, 1987; Ferguson, 1991; Ferguson & Ladd, 1996; Sander, 1993; Sebold & Dato, 1981; Verstegen, 1994) because per-pupil expenditures is a general measure that captures unidentified efforts by a school district to improve its students' outcomes.

Although the results are not wholly consistent, several studies show that, even controlling for the socioeconomic characteristics of the districts, student outcomes are associated with educational resources. Ferguson (1991) (pp. 464–65) reports that educational resources accounted for "between one quarter and one third of the variation among Texas school districts in students' scores on statewide standardized reading exams". Most of the variance was explained by a measure of the quality of Texas' teachers, how well they performed on a statewide recertification examination.

Sander (1993) also presents evidence that district variations in school resources are associated with various student outcomes. He found that ACT scores were associated with additional expenditures if they were targeted toward more and or better teachers and an increase in the pupil–teacher ratio reduces the percentage graduating and planning on attending college. Sander also found evidence that the percentage of college bound increases with higher average teachers' salaries. Research also shows that higher student achievements are associated with lower pupil–teacher ratios (Bidwell & Kasarda, 1975; Dolan & Schmidt, 1987; Ferguson, 1991; Ferguson & Ladd, 1996).

One other result reported in some of these studies is worth noting. Both Dolan and Schmidt (1987) and Ferguson (1991) show that, although some student outcomes are associated with the level of educational resources in a district, educational resources explain less of the variance of these outcomes than do the socioeconomic characteristics of the district. That is, a school district's socioeconomic status appears to be even more important than educational resources in explaining student outcomes.

The research on the association between educational resources and student outcomes has been severely criticized for its inadequate model specification (Alexander & Griffin, 1976a,b; Alexander & Salmon, 1995; Gyimah-Brempong & Gyapong, 1991; Hannan, Freeman & Meyer, 1976; Hanushek 1981, 1991; Hanushek, Rivken & Taylor, 1996). The critics say that misspecification occurs when researchers fail to control for the average student ability in the districts and the socioeconomic context in which school systems operate. It is argued that the absence of these theoretically relevant measures improperly inflates the association between educational resources and outcomes (Griffin & Ganderton, 1996; Hanushek et al., 1996). Alexander and

Griffin (1976a) (p. 146) argue that their omission generates "essentially valueless" results.

One idea expressed in these critiques is that, if there is collinearity between the socioeconomic context (e.g. the percentage of families receiving public assistance) and level of resources, any association between resources and student outcomes may simply be the result of the associations of socioeconomic characteristics with both resources and outcomes. A similar argument is offered to call for including a measure of average ability of the districts' student populations. Researchers argue that the results from research lacking detailed measures of the district's socioeconomic status and value added measures lend little to the debate over whether student outcomes or earnings are related to school resources (Griffin & Ganderton, 1996; Hanushek, 1997; Hanushek et al., 1996).

The important question is not whether resources are associated with student performances, but whether resources are associated with variation in student performances that cannot be explained in other ways. Is there a "value added" effect of having more resources? Few of the studies we have reviewed control for both average student ability and socioeconomic characteristics and those that do leave many unanswered questions (Borland & Howsen, 1992; Ferguson & Ladd, 1996; Gyimah-Brempong & Gyapong, 1991; Sebold & Dato, 1981).

In sum, prior research has shown that some measures of a district's socioeconomic status are associated with its educational resources, and some measures of a district's educational resources are associated with student outcomes. However, few studies have taken into account the full set of relevant measures in a way that makes it possible to consider the effects of what the critics have argued are model specification errors.

Our study builds on the prior research in a way that addresses the above criticisms. We construct a theoretical model that combines all of the relevant factors. These include a measure of average student ability, the appropriate measures of educational resources and student outcomes, and a full array of socioeconomic variables. We derive a set of hypotheses from that model and systematically test them.

## 3. Theoretical model

Fig. 1 outlines a theoretical model that we test that takes into account the underlying model guiding the past research. Our theoretical model also takes into account researchers' criticisms of the prior research.

The model indicates that student outcomes and average student ability vary according to the socioeconomic characteristics of the districts (paths 1 and 2). In addition, the model indicates that student outcomes are associated

Resources

4                   5

Socioeconomic                  1                   Student
characteristics                                    outcomes
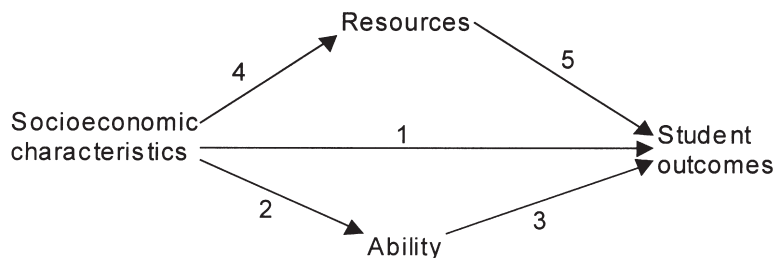
2                   3

Ability

Fig. 1.   The theoretical model.

with average student ability (path 3). These elements of
the model reflect the critics' call for "proper" model
specification. There is little disagreement among
researchers that a school district's socioeconomic charac-
teristics are related to average student ability and student
outcomes (paths 1 and 2). There is also little disagree-
ment among researchers that student outcomes should be
associated with average student ability (path 3). Paths 4
and 5 have been the major focus of attention of most of
the previous research and are the focus of our research.
They address the issue of whether resources vary across
school districts and whether student outcomes are asso-
ciated with school resources. The model, together with
the previous research, provides the basis for the follow-
ing hypotheses.

1. Districts with higher status populations have better
   educational resources.
2. Districts with better educational resources have
   higher student outcomes, even controlling for student
   ability levels and the socioeconomic characteristics of
   the districts.

## 4. Data

We assembled district-level data from the state of Vir-
ginia, which was selected for several reasons. Its govern-
ment agencies compile their data at the county and incor-
porated city level. This allowed us to use multiple data
sources, including the Census Bureau's 1990 Sample
Analyzer Source File, to create a profile of each county's
socioeconomic characteristics. In addition, each of Vir-
ginia's 136 counties and incorporated cities is a separate
school district. Thus, the data collected by Virginia's
Department of Education on student performances and
on the distribution of school resources are aggregated at
the county/school district level. This uniformity in data
collection allowed us to merge multiple data sources that
were all at the same level of aggregation.

Hanushek et al. (1996) argue that aggregated data,
particularly at the state level, create two problems: model
misspecification and an upward bias of school resource

effects. Doing a within-state analysis allows us to avoid
the misspecification errors that may be associated with
interstate research that fails to control for differences in
state policies (Betts, 1995). Our model also minimizes
the relevance of the misspecification argument since we
control for average student ability and the socioeconomic
characteristics of the school district.

Hanushek et al. (1996) also argue that aggregated data
create an upward bias of school resource effects. It is
possible that data aggregated at the school district level
can mask real differences between schools within a dis-
trict. For example, in school districts with wide vari-
ations in socioeconomic characteristics and more than
one high school (such as Henrico county in Virginia), it
is very likely that the schools in the more wealthy sec-
tions will have higher student outcomes than those in
the poorer areas. These between-school differences are
averaged when the data are aggregated at the school dis-
trict level. Unfortunately, Virginia does not collect data
that would allow us to replicate our analysis at the school
or individual level. Consequently, we cannot determine
whether our aggregated data have created an upward bias
of our estimated school resource effects. It is of interest
to note that when Ferguson and Ladd (1996) and Sander
(1993) disaggregated their data to the school or individ-
ual level they substantially reproduced their district level
findings. It is also of interest to note that Hanushek et
al. (1996) present no evidence indicating that data aggre-
gated at the district level create an upward bias of esti-
mated school resource effects.

It is also worthwhile noting that Hanushek et al.'s
(1996) assertion regarding upwardly biased results due
to aggregation is debatable when individual observations
are unavailable. Even though information is always lost
by aggregating to a higher level, Akin and Kniesner
(1976) point out that the amount of information lost does
not always substantively alter the results. Akin and
Kniesner (1976) state that such factors as sampling tech-
nique, variation within each district and the state, and
the number sampled per district and over the state will
determine the extent of deviation from the actual individ-
ual level measure.

Virginia is sociodemographically diverse. The school

districts included in our analyses are located in major metropolitan areas such as Richmond and the areas surrounding Washington DC as well as those located in rural areas dominated by agricultural production. Our analysis is based on 128 of Virginia's 138 school districts.[3] These districts include approximately 1700 schools and 998,463 students.[4]

Our socioeconomic measures of the school districts come from the Census Bureau's 1990 Sample Analyzer Source File. This is a product of the Bureau's internal Sample Edited Detail File (SEDF). The Bureau created this tally to provide early access to census data. These data were aggregated at the school district/county/incorporated city level. Other measures used in the analyses come from the Virginia Department of Education Superintendent's Annual Report for the 1990–91 School Year and the Virginia Educational Association's report on Virginia's Educational Disparities. We merged these data into a single district level file.

## 5. Measures

### 5.1. Student outcomes

Our analysis includes four measures of student outcomes. Consistent with the prior research, our achievement measures are student test scores (READ11 and MATH11). To avoid the issues of nonlinearity associated with using nationally-normed percentiles, READ11 and MATH11 are the school districts' standardized scores for grade 11. These standardized scores are based on the uniform statewide achievement test, Tests of Achievement and Proficiency. Each school district administers the math and reading parts of this test during the eleventh grade.[5]

We also include a measure of student attainment. GRADRATE is the percentage of ninth grade students who graduated high school.

We also include a measure of student aspirations (CONTED) which is the percentage of seniors aspiring to continue their education after graduation. Guidance counselors collect this information from students in twelfth grade during an exit interview. CONTED measures the percentage of students who are planning to continue their education after they graduate from high school either at the junior college or university level.[6]

### 5.2. Educational resources

Consistent with prior research, we consider three measures of educational resources: QUALIF is the percentage of instructional personnel holding postgraduate professional certificates.[7] Betts (1995), Ferguson (1991) and Ferguson and Ladd (1996) include in their research a measure of the proportion of teachers with a master's degree as an indirect measure of teacher quality. We also assume that the proportion of teachers with a postgraduate professional certificate is an indirect measure of teacher quality. Virginia compensates its teachers for continuing their education. P/TRATIO is the ratio of secondary teaching positions to the end of year membership for grades eight through twelve.

Our third measure, the log of INSTRUCTF, is a disaggregated measure of total per-pupil expenditures.[8] It

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[3] We deleted ten school districts from the analysis. The deleted cases include the incorporated cities of Emporia, Fairfax City, Clifton Forge, and Bedford. These school divisions are not independent. Their county's school board is in charge of these schools. Data from these cities are included in their respective counties. The reverse is true for the county of James City. The city of Williamsburg collects the county data. These cities and the county of James City do not independently report their data. Therefore, they are considered as missing cases. Two other missing cases are the cities of Lexington and South Boston. These cities did not report their graduation rates. Neither has a high school. We also deleted two very small incorporated towns that are their own school district, Colonial Beach and West Point. Their average daily membership for 1990 was 577 and 671, respectively. The county of Floyd did not report its special education expenditures for 1989–1990, 1990–1991, or 1991–1992. We deleted it from the analysis.

[4] Virginia does not legally require its students to attend a school in their own district. However, if they attend a school outside their district, either their district school or the students themselves must pay for their tuition. In 1992–1993 (the Department of Education could not provide data for the 1990–1991 school year), Virginia's schools had an average daily membership of 1,029,000 students. Of this total, 2791 students attended a school outside their district, 3400 students attended a regional special education center, and 479 attended a regional board. The latter two are regional schools primarily for special education students. Virginia's Department of Education was unable to determine the number of students enrolled in these regional schools who were not attending the school in their district.

[5] We thank Dan Keeling, Associate Specialist, Division of Assessment and Reporting, Virginia Department of Education for providing us with each school district's standard scores.

[6] Virginia does not collect information, at the district level, on the number of students who *actually* attended either a junior college or a university. It only collects data on the number of students who planned to continue their education.

[7] The Postgraduate Professional Certificate is a 5-year renewable certificate. It is granted to an applicant who has qualified for the Collegiate Professional Certificate, has taught successfully for at least 3 years, and holds an appropriate graduate degree from an accredited institution.

[8] A state formula, in part, determines the total amount of money each school district spends per student. This formula guarantees that each school district will receive a minimum disbursement from the state. The local school district can exceed the state's minimum disbursement. The local school district's monies can come from four sources: local property taxes, a percentage of sales tax receipts, and optionally, locally sponsored

could be argued that total per-pupil expenditures does not adequately measure the amount of money school districts actually spend on classroom related expenditures. For example, total per-pupil expenditures includes monies spent on pupil transportation. The amount of money school districts spend on transportation varies. Rural districts often spend more money than urban school divisions. Consequently, although it may appear that a rural school district has a large per-pupil expenditure, it may actually spend less on classroom related expenditures than an urban school district with less transportation costs. Our measure of per-pupil expenditures deals with the above issue by only including the state and local money each school district spent on *teaching related expenditures* for grades K-12 (e.g. teacher salaries, textbooks, instructional support service staff, etc.).[9]

We also adjusted INSTRUCTF for the total amount of money each school district reported that they spent on special education. Additionally, we adjusted INSTRUCTF for the total amount of federal dollars each school district received.[10] INSTRUCTF measures the total amount of money school districts spent on classroom related expenditures minus the money they spent on special education and received from the federal government. Our measure, INSTRUCTF, is similar to the one used by Ferguson and Ladd (1996). These measures are all taken as of the 1990–1991 academic year. An assumption in our analysis (and in most prior studies) is that the relative levels of resources have been consistent over the past seven to ten years.

### 5.3. Average student ability

Our measure of average student ability is the district's average median grade-standardized (nationally-normed percentile) ability test score for grade 4.[11] We constructed this measure by summing each district's percentile scores on the three parts of the Iowa Basic Cognitive Abilities Test for grade 4. The three parts are verbal, quantitative, and nonverbal.

Because the state of Virginia has been collecting these data for many years, we were able to assemble the scores for 1983, the year when the focal cohort studied in this research was in fourth grade. Thus, although there was bound to have been some attrition and accretion in the cohort, the measures of both average student ability (in grade 4) and student outcomes (in grade 11) are taken from the same cohort. Because it represents the academic performances of students in the same district 7 years earlier, we consider this a preferable measure of ability than those based on test performances of younger stu-

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bonds and grants. The Federal Government also makes minor contributions.

Dolan and Schmidt (1987), in their analysis of 1980–1984 Virginia data, argue that regional cost of living differences may impact the association between student outcomes and measures of educational resources such as per-pupil expenditures and average teacher salaries. The state formula for funding, in part, recognizes these cost of living differences by adding an additional 10%, a "cost of competing adjustment" for the northern Virginia area. Unfortunately, none of the Virginia State agencies we contacted was able to provide us with a recent regional cost of living index. Therefore, we were unable to correct for regional cost of living differences within Virginia because the latest available estimates of regional cost of living costs in Virginia were for the years of 1975–1984 (Dolan & Schmidt, 1987). We present nominal results that, according to Dolan and Schmidt (1987), may moderately underestimate the real relationship between our measure of expenditures and student outcomes.

[9] According to the Virginia Department of Education Superintendent's Annual Report for the 1990–91 School Year, instruction includes the activities dealing directly with the interaction between teachers and students. Instruction includes classroom instruction (but not including summer school and adult education), guidance services, social worker services, homebound instruction, improvement of instruction (but not including summer school and adult education), media services, and office of the principal.

[10] For example, in 1990, the county of Accomack spent $18,202,255.31 on education related expenditures. Accomack also spent $1,277,477 on special education related expenditures. To construct our measure of per-pupil expenditures, INSTRUCTF, we subtracted the amount of money spent on special education related expenditures, $1,277,477, from the amount of money spent on education related expenditures (for Accomack, $18,202,255.31 − $1,277,477 = $16,924,778.31). We then subtracted the federal dollars each school district received

from that amount (for Accomack, $16,924,778.31 − $2,476,460 = $14,448,318.31). We then divided $14,448,318.31 by the average daily attendance (in Accomack, 5086) to get an adjusted per-pupil expenditure measure (for Accomack, $2,840.80). We logged the per-pupil expenditures (for Accomack, 7.95184).

Six counties did not report their special education expenditures for 1990–1991. For three of these counties, Brunswick, Lee, and Sussex, the averages of the 1989–1990 and 1991–1992 expenditures were calculated and substituted for the missing data. For New Kent and Richmond City the missing data were replaced with data from 1991–1992 (data were not available for either 1989–1990 or 1990–1991). The county of Floyd did not report its special education expenditures for 1989–1990, 1990–1991, or 1991–1992. We deleted it from the analysis. We thank Paul Raskopf, Virginia Department of Education, Specialist, Federal Data Reporting, for providing us with each school district's reported expenditures on special education. For an excellent discussion on whether the funding of special education diverts money away from regular instruction see Lankford and Wyckoff (1996).

[11] The Department of Education did not receive standard scores until Spring 1990. Consequently, the only information on test scores for the 1983–1984 academic year that we were able to obtain were the nationally-normed percentiles.

dents during the same year as student outcomes are measured (Ferguson & Ladd, 1996; Sebold & Dato, 1981).

## 5.4. Socioeconomic characteristics

Because Virginia's school districts are coterminous with their respective counties and incorporated cities, we could use 1990 census data and data from a state agency to create aggregate socioeconomic profiles of each school district. Prior research (Sander, 1993; Ferguson & Ladd, 1996; Hoxby, 1996) has considered the school district's socioeconomic status as being multidimensional and has shown that student outcomes are associated with an array of socioeconomic measures.

We include two indicators of the school district's economic affluence, LINCAVG, and POVSTUD. LINCAVG is the log average income level of the school district.[12] POVSTUD is the percentage of the population between the ages of 5 to 18 who live in a family receiving public assistance.[13]

Numerous studies have found student achievement to be negatively associated with percent nonwhite (Armor, 1972; Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld et al., 1966; Crain, 1971; Ferguson, 1991; Ferguson & Ladd, 1996; St. John & Smith, 1969). Our measure (%AFRO) is the percentage of African-Americans in each school district.

Previous research has also found that student outcomes are associated with urbanity. Generally, researchers include measures of a school district's urbanity to capture aspects of its economic affluence that may not be included in measures such as the district's average income level (Ferguson & Ladd, 1996; Ferguson, 1991; Dolan & Schmidt, 1987). For example, Raymond (1968) included his measures of urbanity in a multidimensional index of SES. It could also be argued that measures of urbanity might capture aspects of a school district indirectly related to its economic affluence that may be associated with school outcomes. For example, urban areas may provide students with added incentives to graduate and to continue their education. Urban school

districts may have more continuing education and career opportunities than their rural counterparts.

Ferguson and Ladd (1996) use two measures to differentiate Alabama's level of urbanity, the percentage of a district that is urban and whether the district is a city or county. We use two measures to differentiate Virginia's level of urbanity. CITY is a dichotomy differentiating between city (coded 1) and county (coded 0) districts. DENSITY is the sum of Z-scores of the districts' population density and housing density.

We also constructed an index of the community's proportion of disrupted families. Coleman and Hoffer (1987) (p. 18) suggest that, on average, children raised in single-parent families will be less academically successful than children raised in intact families.[14] Measures of family disruption are only rarely included in analyses of district variation, but Dolan and Schmidt (1987) and Ferguson (1991) did include the percentage of female-headed households in their models, and report some suggestive findings. Our disrupted family scale, DISFAMILY, sums Z scores across three dimensions of family disruption: the percentage of female-headed households with children, the percentage of persons 15 years and over who are divorced, and the percentage of teenage pregnancies.[15]

Finally, we control for district size, LSIZE, the log average daily attendance in the district. Parrish and Fowler (1995) found that per-pupil expenditures increase as the size of the school district decreases.

## 5.5. Methods

We use regression analyses, based on a weighted least squares procedure, to analyze the data. We use a weighted least squares procedure to correct for the problem of unequal variances across observations, heteroskedasticity, a common problem in aggregate data (Ferguson, 1991; Dolan & Schmidt, 1987). We weighted

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[12] We calculated the county or incorporated city's average income level by assigning midpoints to each of the 25 income categories. We increased the open-ended highest income category, $150,000 plus, by 50%, giving it a value of $225,000 (Blau & Blau, 1982; Morgan, 1962).

[13] We also considered including the percentage of the population 25 years and older with 16 years of more of schooling (COLLEGE). However, LINCAVG and POVSTUD were substantially more associated with student outcomes than our college measure. The bivariate relationships between READ11 and MATH11 and INCAVG and POVSTUD were 0.82 and 0.87 and −0.79 and −0.71, respectively. The bivariate associations between READ11 and MATH11 and COLLEGE were 0.47 and 0.41.

[14] High rates of single-parent households also can affect the integrative capacities of functional communities. Sampson (1987) (p. 344) argues "that martial and family disruption may decrease formal social controls at the community level". He also suggests that family disruption may attenuate a community's informal controls. This breakdown in a community's informal control may enhance the influence of peer cultures, as alluded to by Ferguson (1991).

[15] The Virginia Vital Statistics 1990 Annual Report includes the number of teenage pregnancies for the ages of 13–19. The Census groups females aged 12 and 13 together. Therefore, the measure of teenage pregnancy includes 12-year-old females in the denominator. The correlations among these three dimensions of family disruption are: female-headed households with children and the divorce rate, 0.46; female-headed households and the rate of teenage pregnancy, 0.59; the rate of teenage pregnancy and the divorce rate, 0.44.

each observation by the square root of the average daily attendance (Ferguson & Ladd, 1996). We added the value of 1 to one variable, %AFRO, which had two observations of zero. We report unstandardized ($B$) coefficients and their relative standard errors.

### 5.6. Results

Appendix A presents the means, standard deviations, and zero-order correlations for all of the variables used in the analysis. It indicates that there are large interdistrict variations in student outcomes, educational resources, and the school districts' socioeconomic status.

Appendix A also indicates a high degree of collinearity among certain pairs of our socioeconomic measures. For example, the bivariate correlation between LINCAVG and POVSTUD is −0.75. Also, the bivariate relationship between CITY and DENSITY is 0.66 and the bivariate relationship between DSFAMILY and DENSITY is 0.64.

### 5.7. Socioeconomic status and educational resources

Our first hypothesis calls for districts with higher status populations to have greater educational resources. In particular, more resources would be expected in districts with low percentages of families on public assistance, high average incomes, low proportions of African-American residents, and low proportions of disrupted families. The zero-order correlations in Table 1 provide some initial support for the hypothesis. The clearest support comes from the 0.32 correlation between LINCAVG and INSTRUCTF and the −0.22 correlation between

LINCAVG and PTRATIO. Additionally, Table 1 shows a positive correlation between the district's percentage of African-Americans and its pupil–teacher ratio. There is also a positive zero-order relationship between pupil–teacher ratios and the percentage of families with children living on public assistance. However, some of the correlations are the opposite of what the hypothesis would lead us to expect. For instance, districts with many disrupted families have more highly qualified teachers and more funding. Of interest, Table 1 indicates that districts with more educational resources tend to be densely populated and incorporated cities.

Table 2 presents the results from regressing each of the $j$ resource measures ($R_{ji}$) on the seven socioeconomic characteristics:

$$R_{ji} = \alpha + \mathbf{X}_i \beta + \varepsilon_{ji}$$

where $\varepsilon_{ji}$ is an error term, $\mathbf{X}_i$ is the vector of socioeconomic characteristics, and the subscript $i$ denotes the $i$th school district. The null hypothesis is that $\beta=0$. The results of the analysis are given in Table 2.

The level of collinearity among the socioeconomic variables indicates that the standard errors reported in Table 2 may be inflated and thus the coefficient estimates are imprecise. Given such collinearity among independent variables, the individual coefficients must be interpreted with caution.

Table 2 indicates that all $R^2$ values are significant. It also shows that the socioeconomic variables account for over 60% of the variation in INSTRUCTF. They were less successful in accounting for the explained variance in PTRATIO and QUALIF. The socioeconomic vari-

Table 1
Zero-order correlations between educational resources and the sociodemographic characteristics of each district with their significance levels in parentheses[a]

|  | INSTRUCTF | PTRATIO | QUALIF |
|---|---|---|---|
| CITY | 0.373 | −0.052 | 0.314 |
|  | (0.000) | (0.552) | (0.000) |
| DENSITY | 0.655 | −0.167 | 0.356 |
|  | (0.000) | (0.070) | (0.000) |
| DSFAMILY | 0.269 | 0.127 | 0.199 |
|  | (0.002) | (0.150) | (0.024) |
| %AFRO | −0.037 | 0.222 | −0.027 |
|  | (0.674) | (0.011) | (0.775) |
| POVSTUD | −0.075 | 0.227 | 0.140 |
|  | (0.398) | (0.009) | (0.113) |
| LINCAVG | 0.324 | −0.220 | −0.083 |
|  | (0.000) | (0.012) | (0.349) |
| LSIZE | 0.116 | 0.227 | 0.234 |
|  | (0.192) | (0.009) | (0.007) |

[a] $N=128$.

Table 2
WLS regression of educational resources on the socioeconomic characteristics of each district[a]

|  | INSTRUCTF | PTRATIO | QUALIF |
|---|---|---|---|
| CITY | −0.046 | 0.466 | 2.016 |
|  | (0.027) | (0.532) | (2.008) |
| DENSITY | 0.044* | −0.282* | 1.096* |
|  | (0.004) | (0.123) | (0.465) |
| DSFAMILY | 0.004 | −0.109 | −0.371 |
|  | (0.006) | (0.119) | (0.451) |
| %AFRO | −0.147 | −2.384 | −4.450 |
|  | (0.085) | (1.678) | (6.333) |
| POVSTUD | 0.603* | 0.668 | −3.054 |
|  | (0.232) | (4.556) | (17.192) |
| LINCAVG | 0.283* | −0.950 | −9.811* |
|  | (0.066) | (1.313) | (4.954) |
| LSIZE | −0.027* | 0.706* | 1.523* |
|  | (0.008) | (0.176) | (0.665) |
| $R^2$ | 0.601* | 0.196* | 0.174* |

[a] Significance levels are *$p \leq 0.05$ ($N=128$) The regressions also include an intercept term.

Table 3
WLS student outcome equation estimates with resources[a]

|  | READ11 | MATH11 | GRADRATE | CONED |
|---|---|---|---|---|
| INSTRUCTF | 16.718* | 19.694* | 7.251 | 24.840* |
|  | (3.923) | (3.399) | (6.782) | (6.941) |
| QUALIF | −0.056 | −0.104 | 0.121 | 0.333* |
|  | (0.081) | (0.070) | (0.140) | (0.144) |
| PTRATIO | −0.308 | −0.015 | −0.281 | 0.139 |
|  | (0.345) | (0.299) | (0.597) | (0.611) |
| $R^2$ | 0.191* | 0.260* | 0.031 | 0.199* |

[a] Significance levels *$p \leq 0.05$ (N=128). The regressions also include an intercept term.

ables accounted for less than one-fifth of the variance in both PTRATIO and QUALIF. Therefore, although some of the results support our first hypothesis, the evidence is not consistent.

### 5.8. Educational resources and student outcomes

Our second hypothesis suggests that there is a positive association between educational resources and student outcomes. This can be tested by regressing each of the k outcome variables (READ11, MATH11, GRADRATE, CONED) on the set of resource variables:

$$O_{ki} = \gamma + \beta_1 \mathbf{R}_i + \varepsilon_{ki}$$

where $O_{ki}$ denotes the kth outcome variable for school district i, $\mathbf{R}$ is the vector of resource variables and $\varepsilon_{ki}$ is an error term. Critics indicate that the coefficient estimates in the above model may be biased due to the exclusion of such factors as student ability and socio-economic variables (Blackburn & Neumark, 1993; Hanushek, 1997). This issue is addressed later.

The analysis is divided into three tables (Tables 3–5). Table 3 examines the associations between student outcomes and resource measures without controlling for either average ability or the socioeconomic status of the school districts. Results in Table 4 indicate whether student outcomes and resources are associated after controlling for average student ability. The results in Table 5 assess whether student outcomes and resources are associated after controlling for both average student ability and the district's socioeconomic status. Together these tables address whether there is an omitted variable bias in our student outcome–resource equations. They also address whether resources are associated with student outcomes after controlling for average student ability and the socioeconomic status of school districts.

Table 3 reports weighted least squares (WLS) estimates of the outcome equations when the only regressor is the given resource. Table 3 shows that higher levels of funding are associated with both higher test scores and higher rates of expected continuing education. Specifically, an increase in one unit in log funding will result in a 16 point increase in reading scores and a 19 point increase in math scores. The results also show that a one unit in log funding will result in a 24 point increase in the rate of continuing education. The results additionally show that having highly qualified teachers is positively associated with the level of expected continued education. Specifi-

Table 4
WLS student outcome equation estimates controlling for ability[a]

|  | READ11 | MATH11 | GRADRATE | CONED |
|---|---|---|---|---|
| INSTRUCTF | 2.644 | 7.568* | −3.174 | 7.070 |
|  | (2.795) | (2.440) | (7.000) | (6.372) |
| QUALIF | −0.010 | −0.063 | 0.155 | 0.391* |
|  | (0.053) | (0.046) | (0.134) | (0.122) |
| PTRATIO | −0.178 | 0.096 | −0.185 | 0.303 |
|  | (0.226) | (0.197) | (0.567) | (0.516) |
| ABILITY | 0.495* | 0.426* | 0.367* | 0.625* |
|  | (0.038) | (0.033) | (0.096) | (0.087) |
| $R^2$ | 0.655* | 0.679* | 0.133* | 0.433* |

[a] Significance levels *$p \leq 0.05$ (N=128). The regressions also include an intercept term.

Table 5
WLS student outcome estimates controlling for ability and socioeconomic characteristics[a]

|  | READ11 | MATH11 | GRADRATE | CONED |
|---|---|---|---|---|
| INSTRUCTF | 1.155 | 1.732 | 5.299 | −9.822 |
|  | (3.634) | (3.334) | (8.867) | (7.948) |
| QUALIF | 0.025 | −0.022 | 0.369* | 0.349* |
|  | (0.055) | (0.050) | (0.134) | (0.120) |
| PTRATIO | −0.083 | −0.017 | 0.330 | −0.640 |
|  | (0.231) | (0.212) | (0.565) | (0.507) |
| ABILITY | 0.305* | 0.275* | 0.075 | 0.661* |
|  | (0.057) | (0.053) | (0.141) | (0.126) |
| CITY | 2.679* | 1.888 | −0.041 | 5.768* |
|  | (1.107) | (1.015) | (2.701) | (2.421) |
| DENSITY | 0.146 | 0.209 | −2.011* | 1.344* |
|  | (0.291) | (0.267) | (0.710) | (0.636) |
| DSFAMILY | −0.471* | −0.234 | −0.146 | −0.912 |
|  | (0.246) | (0.225) | (0.600) | (0.538) |
| %AFRO | −5.977 | −5.660 | −11.342 | 23.013* |
|  | (3.937) | (3.612) | (9.606) | (8.611) |
| LSIZE | −0.026 | 0.061 | −0.946 | 0.957 |
|  | (0.411) | (0.377) | (1.004) | (0.900) |
| LINCAVG | 2.124 | 6.640* | 18.215* | 2.653 |
|  | (3.309) | (3.036) | (8.076) | (7.239) |
| POVSTUD | −19.492* | 0.994 | 5.838 | 6.749 |
|  | (9.404) | (8.628) | (22.947) | (20.570) |
| $R^2$ | 0.721* | 0.720* | 0.348* | 0.587* |
| *F* statistic that the socioeconomic coefficients are equal to zero | 4.08* | 2.45* | 5.58* | 6.28* |

[a] Significance levels *$p \leq 0.05$ (*N*=128). The regressions also include an intercept term.

cally, a 10% increase in the percentage of teachers with a postgraduate professional certificate would increase the percentage of students planning on continuing their education by 3.3. None of the student outcomes is associated with the ratio of students to secondary teaching positions for grades eight through twelve.

As mentioned earlier, previous research indicates that if the return on resources is estimated without controlling for average ability, the resource–outcome estimates can be generally expected to be biased upwards (Blackburn & Neumark, 1995). In order to consider this, the outcome equation is augmented with an ability factor. As a proxy for student ability we include in the outcome equation the average district percentile scores on the Iowa Basic Cognitive Abilities Test for grade 4 in 1983. Table 4 reports the WLS estimates of the coefficients in the augmented outcome model,

$$O_{ki} = \gamma + \beta_1 \mathbf{R}_i + \beta_2 \mathbf{A}_i + \varepsilon_{ki}$$

where $\mathbf{A}_i$ denotes the average test score for the *i*th district.

The results in Table 4 assess whether failing to include average student ability in the student outcome–resource equations results in omitted variable bias. It also addresses whether student outcomes are associated with

school resources after controlling for average student ability.

In comparing the results from Table 3 with those from Table 4 it is observed that the per-pupil expenditure coefficients substantially decrease when average ability is included in the reading and math equations. The reading coefficient decreases by 85% and the math coefficient by 62%. With regards to continuing education, there is an upward bias in the per-pupil expenditure coefficient. After controlling for average ability, the coefficient for continuing education and per-pupil expenditures decreases by 72% and is no longer statistically significant. Table 4 indicates that for reading and math scores there appears to be substantial upward bias of the per-pupil expenditure coefficient when average ability is not included in the educational production function.

It is important to note that controlling for average ability does not show that resources are irrelevant. Table 4 indicates that for the math score equation per-pupil expenditures is still statistically significant. It indicates that a one-unit increase in log funding will result in a seven point increase in math scores after controlling for ability. Additionally, districts with more educated teachers still have higher rates of expected continued education. A 10% increase in the percentage of teachers with

a postgraduate professional certificate would increase the percentage of students continuing their education by 3.9%.

Critics also argue that omitting socioeconomic measures from the outcome model can result in upwardly biased resource and ability coefficients (Hanushek, 1997; Rizzuto & Wachtel, 1980). This may be particularly the case if, for example, districts that have the most favorable student outcomes have the most resources, highest ability levels, and most favorable socioeconomic characteristics. If this were the case, failing to control for the district's socioeconomic status would result in resource–outcome coefficients that are upwardly biased even after controlling for average ability.

We attempt to control for the omitted-variable bias by including socioeconomic measures in the outcome equation

$$O_{ki} = \gamma + \beta_1 \mathbf{R}_i + \beta_2 \mathbf{A}_i + \beta_3 \mathbf{S}_i + \varepsilon_{ki}$$

where $\mathbf{S}_i$ is the vector of the socioeconomic measures for the $i$th school district.

The results from the WLS analysis of this model are provided in Table 5. The results in this table address the core issue of this paper. That is, are student outcomes associated with school resources after controlling for average student ability and the socioeconomic status of a school district?

Partial $F$-tests were performed in order to determine whether, as a set, the socioeconomic measures explain an additional significant amount of variance in our outcome measures (beyond that accounted for by our resource and average ability measures). The $F$ statistics and their significance levels are presented on the bottom row of Table 5. The $F$-statistics indicate that the socioeconomic measures explain an additional significant amount of variance in student outcomes.

The addition of the socioeconomic measures to our resource–outcome equations changes the significance and size of the resource–outcome coefficients. Math scores are no longer significantly associated with per-pupil expenditures. In addition, the coefficient of the percentage of teachers with a postgraduate professional certificate in the continuing education equation decreased by 11%.

Comparing the results from Table 4 with those in Table 5 also indicates that failing to control for the school district's socioeconomic status may result in misspecified models and downwardly biased resource–outcome coefficients. After controlling for the socioeconomic status of the school district, the coefficient of QUALIF in the GRADRATE equation increased by 42% and attained statistical significance.[16]

The results for the relationships between student outcomes and pupil–teacher ratios remain the same. None of the student outcomes is significantly associated with pupil–teacher ratios.[17]

## 6. Conclusion

This study is relevant to the current debate about the importance of varying resources available to school districts. The two guiding questions are: do districts with higher status populations have better educational resources? Do districts with better educational resources

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[16] It could be argued that estimates of the educational production function that include SES measures are flawed because SES is highly correlated with, for example, per-pupil expenditures. Thus, the inclusion of SES measures unduly reduces the effect of educational resources on student outcomes. We address this concern by estimating the educational production function without any SES measures (i.e. Tables 3 and 4) and with SES measures (i.e. Table 5). The difference in the results from Tables 4 and 5 indicate that including SES measures reduces the size and statistical significance of the relationship between per-pupil expenditures and math scores. The results additionally show a slight reduction in coefficient for the size of the percentage of teachers with a postgraduate professional certificate in the continuing education equation. However, the results also show that including SES measures increases the statistical significance and size of the coefficient of the percentage of teachers with a postgraduate professional certificate in the continuing education equation.

It could also be argued that the economic aspect of SES is the one dimension that will most influence the relationships among educational resources and student outcomes. To test this possibility, we estimated the educational production function with and without our two measures of the economic affluence of a school district (LINCAVG) and (POVSTUD) while controlling for the other dimensions of SES. The results from this analysis are similar to those presented in Table 4 except that per-pupil expenditures are associated with graduation rates.

[17] Virginia places a statewide cap on school districts regarding pupil–teacher ratios of 30 students. A school district must receive written permission from the state to exceed the statewide cap of students in a classroom and exceptions are rarely given. Consequently, the variation across school districts regarding the pupil–teacher ratio is restricted. The ratio of the end of year membership to secondary teaching positions for grades 8 through 12 varies from a low of 6.7 to a high of 19.0 with a standard deviation of 2.020. Of interest, studies that report significant associations between student outcomes and pupil–teacher ratios had ratios that exceeded 31+ students (Akerhielm, 1995) and 29+ (Ferguson & Ladd, 1996). We explored the use of alternative measures of the pupil–teacher ratio such as the pupil–teacher ratio for K-7, K-6, for grade 1, and for English grades 6–12. None of these measures was significantly associated with any student outcome in the full equation and only one, K-6, had significant negative bivariate correlations. It is of interest to note that when Tennessee applied an experimental design and randomly assigned students to larger or smaller classes they found that class size does make a substantive difference (Akerhielm, 1995; Mosteller, 1995).

have higher student outcomes, even controlling for student ability levels and the district's socioeconomic context?

We have shown that there are sizeable differences in the educational resources available to the school districts of Virginia and that the variation in resources is associated with the socioeconomic context of the school district. We have also shown that two student outcomes, graduation and continuing education rates, are significantly associated with the percentage of teachers with a postgraduate professional certificate.

Our analysis shows that school districts could increase graduation rates by 3.6% if they increased their percentage of teachers with a postgraduate professional certificate by 10%. Similarly, the same increase in the percentage of teachers with a postgraduate professional certificate would generate an increase in the percentage of students aspiring to continue their education after graduation by 3.4%. Importantly, our analysis indicates that these increases could occur regardless of the socioeconomic context of the school district.[18]

However, our results show that neither reading nor math scores are associated with the percentage of teachers with a postgraduate professional certificate. Additionally, our analysis indicates that none of our student outcomes is significantly associated with pupil–teacher ratios. Moreover, the results show that none of our student outcomes is significantly associated with per-pupil expenditures given the controls we have used. Thus, our data show that school districts with a higher percentage of teachers with a postgraduate professional certificate do not have significantly higher math and reading scores, other things being equal. Furthermore, school districts with smaller pupil–teacher ratios or higher levels of per-pupil expenditures do not have significantly more favorable student outcomes, other things being equal.

Our research, however, does not allow us to conclude that per-pupil expenditures are irrelevant. The results show that math scores are significantly associated with per-pupil expenditures after controlling for average student ability. The association between math scores and per-pupil expenditures only becomes insignificant after controlling for average student ability *and* the socioeconomic status of a school district. Our research also shows that graduation rates are associated with per-pupil expen-

ditures when measures of a district's level of affluence are excluded from the educational production function (see [16]). Our analysis also suggests that per-pupil expenditures and the school district's socioeconomic characteristics are collinear. The problematic nature of this collinearity is similar to the situation where, despite genetic differences, cigarette smokers living in heavily polluted areas have high rates of lung cancer. Are the high rates of lung cancer caused by smoking or by the heavily polluted air?

We believe that the collinearity among standardized tests, graduation rates, per-pupil expenditures, and the school district's socioeconomic status makes it inconclusive as to whether or not more money, if used appropriately, could improve test scores and graduation rates. Thus, the two questions that have structured this research can both be answered in the affirmative. High status districts do have more resources, and districts with more resources do have more favorable student outcomes, at least for some outcome measures.

Of interest, in Virginia, the debate over the degree to which test scores are associated with a school district's socioeconomic characteristics and with its level of educational resources has resurfaced with a renewed sense of vigor. The introduction of statewide Standards of Learning (SOLs) exams, in 1997–1998, has fueled this renewed concern. Virginia is now holding individual schools accountable for their students' scores.

Virginia has acknowledged that student scores are a reflection of the socioeconomic characteristics of a school district and its level of educational resources. It has also acknowledged that school districts differ in their socioeconomic characteristics and in their level of educational resources. To adjust for these disparities and their potentially downwardly biasing effects on exam scores, Virginia has institutionalized the following structural reforms. Poorer school districts are now receiving additional funds to increase teacher training, instructional support materials, and remediation assistance. They are also receiving additional funds to provide health-related assistance and to reduce pupil–teacher ratios in classrooms for grades K-3. A topic for further research would be to investigate whether the above structural reforms improve student performances, particularly in the more disadvantaged school districts.

### Acknowledgements

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[18] It is important to note that the significant association we found between graduation and continuing education rates and the percentage of teachers with a postgraduate professional certificate does not necessarily imply a causal relationship. For an excellent discussion of the relationship between the characteristics of teachers and educational productivity, see Goldhaber and Brewer (1997). It is also of interest to note that in Virginia the more affluent school districts are not necessarily the school districts with the highest percentage of teachers with a postgraduate professional certificate.

Table 6
Means, standard deviations, and correlation matrix of all variables[a]

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Read11 | – | | | | | | | | | | | | | | |
| 2. Math11 | 0.88 | – | | | | | | | | | | | | | |
| 3. Gradrate | 0.23 | 0.22 | – | | | | | | | | | | | | |
| 4. Coned | 0.40 | 0.39 | 0.05 | – | | | | | | | | | | | |
| 5. City | 0.20 | 0.25 | –0.16 | 0.41 | – | | | | | | | | | | |
| 6. Density | 0.29 | 0.39 | –0.11 | 0.50 | 0.66 | – | | | | | | | | | |
| 7. Dsfamily | –0.21 | –0.09 | –0.28 | 0.13 | 0.64 | 0.52 | – | | | | | | | | |
| 8. %Afro | –0.51 | –0.44 | –0.26 | –0.03 | 0.08 | 0.01 | 0.41 | – | | | | | | | |
| 9. Povstud | –0.59 | –0.51 | –0.27 | –0.20 | 0.12 | –0.03 | 0.39 | 0.42 | – | | | | | | |
| 10. Lincavg | 0.51 | 0.55 | 0.21 | 0.33 | 0.02 | 0.32 | –0.13 | –0.15 | –0.75 | – | | | | | |
| 11. Lsize | 0.10 | 0.20 | –0.04 | 0.25 | 0.10 | 0.36 | 0.19 | –0.04 | –0.15 | 0.37 | – | | | | |
| 12. Ability | 0.75 | 0.72 | 0.22 | 0.55 | 0.19 | 0.35 | –0.14 | –0.48 | –0.59 | 0.60 | 0.26 | – | | | |
| 13. Qualif | 0.08 | 0.07 | 0.12 | 0.29 | 0.31 | 0.35 | 0.19 | –0.02 | 0.14 | –0.08 | 0.23 | 0.22 | – | | |
| 14. Ptratio | 0.07 | 0.05 | 0.12 | –0.00 | –0.14 | –0.20 | –0.21 | –0.22 | –0.11 | 0.04 | 0.21 | 0.12 | –0.05 | – | |
| 15. Instructf | 0.26 | 0.31 | 0.02 | 0.30 | 0.37 | 0.65 | 0.26 | –0.03 | –0.07 | 0.32 | 0.11 | 0.22 | 0.38 | –0.42 | – |
| Mean | 188 | 182 | 74.1 | 70.6 | 0.27 | 1.93 | 2.37 | 0.16 | 0.13 | 10.4 | 8.29 | 52.4 | 31.6 | 11.7 | 8.04 |
| SD | 6.83 | 5.95 | 9.82 | 12.3 | 0.44 | 1.93 | 2.37 | 0.13 | 0.06 | 0.24 | 1.02 | 10.0 | 8.0 | 2.02 | 0.14 |

[a] Lincavg, Lsize, and Instructf have been transformed with a log function. N=128.

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## Appendix A

Table 6

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