Research Article

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Parents' Income is a Poor Predictor of SAT Score

Nooffense But[1]

Abstract

Parents' annual income lacks statistical significance as a predictor of state SAT scores when additional variables are well controlled. Spearman rank correlation coefficients reveal parents' income to be a weaker predictor of average SAT scores for each income bracket within each state than parents' education level as a predictor of average SAT scores for each education level within each state. Multiple linear regression of state SAT scores with covariates for sample size, state participation, year, and each possible combination of ordinal variables for parents' income, parents' education, and race shows income to lack statistical significance in 49% of the iterations with greater frequency of insignificance among iterations with higher explained variance. Cohen's d comparisons of the yearly individual SAT advantage of having educated parents show a fairly consistently increasing positive relationship over time, whereas similar analysis of the yearly individual SAT advantage of having high-income parents shows variability somewhat coinciding with the business cycle.

Key words: SAT; socioeconomic status; income; education; race

[1]E-mail: n00ffensebut@gmail.com

Background

Until very recently, the SAT was the most commonly used undergraduate college-entrance exam. Unlike most reports for the ACT, yearly national and state reports for the SAT provide details about students' socioeconomic background (research.collegeboard.org/programs/sat/data). Debate about SAT usefulness and score interpretation would benefit from deeper socioeconomic factors assessment.

Sackett *et al* (2009) recounted a series of accusations that the SAT merely measures family wealth. The College Board's announcement of 2016 SAT reforms has stirred anew claims that "the only persistent statistical result from the SAT is the correlation between high income and high test scores" (Botstein, 2014). Thus, income as an important predictor of SAT scores somewhat fits a view critical of the SAT, which is that financial resources and class privilege unduly enable higher SAT achievement. If the education component of socioeconomic status dominates over the income component, then the relationship between socioeconomic status and scores might instead more accurately reflect a family's values towards education and a hereditary influence shared between test performance and educability.

Sackett *et al* estimated a correlation between SAT scores from 1995 to 1997 and socioeconomic status of 0.42, explaining 18% of variance. They defined socioeconomic status as a composite that equally weighted father's education, mother's education, and family annual income. Their meta-analysis of 55 standardized-test studies, less than half of which were for the SAT, gave the significant correlations of 0.255, 0.284, 0.223, and 0.186 for composite socioeconomic status, father's education, mother's education, and family income, respectively, without utilizing multiple linear regression. A similar study by Sackett *et al* (2012) determined that composite socioeconomic status explained 21.2% of 2006 composite-SAT variance.

Everson and Millsap (2004) used pathway analysis to show socioeconomic status only had a minor direct association with 1995 SAT scores but acted indirectly through high school achievement and "extracurricular activities" like "computer experiences" and "literature experiences." When their model assumed no demographic-group score differences, it overpredicted African-American scores. Including a between-school-level model increased R^2 values, but the use of latent variables at this level did not prevent the percentage of minorities enrolled from having a significant direct association.

The kinds of methodologies used to study socioeconomic status and SAT scores tend to lump together the parents' education levels and income in an arbitrary manner. Such studies are also often limited to a single or small number of years. When a limited number of institutions provide data for a study, results must undergo correction for range restriction. National SAT reports do not lend themselves to regression analyses, but the full collection of state reports contain a wealth of data going back to 1998 that has yet to be exploited in this manner.

This study seeks to thoroughly parse the effects of multiple covariates, including family income, parents' highest education level, and potential confounding variables specific to state or multiple-year comparisons. To do this, full advantage will be taken from all sixteen years of state data. Then, national data will be examined to understand whether the effects of parents' income and education change over time.

Methods

SAT data came from the annual "College-Bound Seniors" reports. Demographic and socioeconomic data came from the Student Descriptive Questionnaire, based on self-report. Analysis used STATA Special Edition, Version 12.1, and R, Version 3.1.0.

State SAT reports are not equivalent to a database. Income levels are not cross-tabulated with education levels or racial groups. In order to make some comparison of parents' income to parents' education level as SAT predictors, two separate Spearman's rank correlation analyses in STATA were necessary, one for income and one for education. Covariates for both were income-bracket or education-level sample size within each state for each year, years since 1997, and state SAT participation rate for each year.

Because state income and education data could not be directly compared in a single Spearman's rank correlation, extensive regression analyses in STATA were conducted, comparing state average SAT scores. Therefore, the regression methodology involved numerous iterations, for which ordinal variables for education and income became continuous variables representing proportions of those above cutoffs. Race is not an ordinal variable because races cannot be ranked, but, in order to apply a consistent approach to this categorical variable akin to the approach taken for parents' income and education, the study required that racial groups be ordered according to national SAT-score gaps, which persisted for all study years. Therefore, race was ordered as Asian Americans, whites, Native Americans, Hispanic Americans, and African Americans with Asian Americans having the highest average. Statistical significance depended upon having a p-value less than 0.05. Non-significant independent variables were never excluded because the goal was to present a standardized iterative representation of how each ordinal variable fared. Each iteration used those three continuous variables and covariates for years since 1997, state sample size for each year, and state SAT participation for each year. For comparison, regression iterations were repeated without the race continuous variables.

The criteria for including covariates were that data for constructing the variable must be readily available and that the variable's significant influence logically could be expected. For example, North Dakota had the highest combined critical-reading and mathematics SAT score in 2013, but, like many Midwestern and Southern states, it favors ACT participation. Such states create upward force on their average SAT scores because only an ambitious minority of students takes the SAT. Therefore, a participation covariate was constructed in the same manner that the College Board determines state participation levels in their "SAT Trends" reports. For each year and state, the number of students taking the SAT is divided by the total number of high school seniors, according to WICHE: Knocking at the College Door, Eighth Edition (Prescott and Bransberger, 2012).

Based on the assumption that population-size drivers confound scores, a size covariate was necessary. For Spearman rank correlations, a single data point represents from 3 to 67,857 students. No scores were available for reports of income brackets or education levels with fewer than three individuals. For regression analyses, a single data point represents from 109 to 136,340 students.

Year might also affect scores through currency inflation, economic transformation, educational trends, the Flynn effect, and yearly SAT changes.

In order to compare income data from different years, some data had to be combined into standard income-bracket categories by calculating the weighted arithmetic mean. Likewise, data for the Hispanic ethnicity was combined from the categories of Mexican American, Puerto Rican, and other Hispanic.

Although the US Census Bureau and many other institutions consider Hispanic to be an ethnicity rather than a race, SAT data draw the latter distinction.

Because multiple included years precede the addition of the writing subtest, because score comparisons of the SAT with the ACT exclude this subtest, and because the College Board announced that this subtest would become optional (Balf, 2014), this study also excludes writing-subtest data. Regression analyses were performed on the summation of yearly average state critical-reading (formerly verbal) and mathematics scores and on these two subtests, separately. In the Spearman rank correlation analyses, this summation was calculated for each income bracket and education level within each state.

Reports for the District of Columbia were also included, as if the capital was another state, because they provide data on additional American students for all years. Maximizing the number of observations and represented students by including the District of Columbia and analyzing 16 years of data reduced the risk that multicollinearity would invalidate comparisons of intercorrelated predictor variables.

Due to the high probability of variable intercorrelation, variance inflation factors were examined in STATA for the composite-SAT iteration with the highest coefficient of determination and the iteration with the highest standard error of one of the independent variables, and extensive commonality analysis in R was added, as well.

A final analytic approach concerned timescale trends for parents' income and parents' education using average individual SAT data from national reports from 1996 to 2013. Those whose parents had bachelor's or graduate degrees were set in contradistinction to others, and groups were combined by weighted arithmetic mean to determine yearly Cohen's d score advantage. The same analysis was conducted thrice for parents' annual income with cutoffs of $20,000, $60,000, and $100,000.

Results

The total number of examinees from 1998 to 2013 was 23,087,193, of whom 13,731,787 answered for parents' income, and 18,751,114 answered for parents' education in state reports. Spearman rank correlations contained a sample of 4,891 observations for income and 4,037 for education. Regression analyses included 816 observations for each iteration of the ordinal variables. Cohen's d comparisons for parents' income from 1996 to 2013 included 16,112,792 students for parents' income and 21,622,320 for parents' education.

	Income-Bracket SAT Score	Income Bracket	State SAT Participation Rate	Years Since 1997	Income-Bracket Sample Size
Income-Bracket SAT Score	1				
Income Bracket	0.6375*	1			
State SAT Participation Rate	-0.6181*	-0.0024	1		
Years Since 1997	-0.0967*	0.0013	-0.0476*	1	
Income-Bracket Sample Size	-0.3702*	0.1530*	0.6937*	-0.0947*	1

Table 1: Spearman rank correlation coefficients for state income-bracket scores (* denotes significant correlation)

	Education-Level SAT Score	Education Level	State SAT Participation Rate	Years Since 1997	Education-Level Sample Size
Education-Level SAT Score	1				
Education Level	0.8115*	1			
State SAT Participation Rate	-0.4651*	-0.0211	1		
Years Since 1997	0.0074	0.0016	-0.0456*	1	
Edu.-Level Sample Size	0.0148	0.3625*	0.6150*	0.0137	1

Table 2: Spearman rank correlation coefficients for state education-level scores (* denotes significant correlation)

Table 1 shows results for the Spearman rank correlation for parents' income. Income bracket and SAT score shared a significant correlation coefficient of 0.64. State participation rate and SAT score had a significant negative association of -0.62. Year and sample size had significant but smaller negative correlations with SAT score. Table 2 gives the Spearman rank correlation results for parents' education. Replacing parents' income with parents' education increased the ordinal variable's correlation coefficient to 0.81 and suppressed the correlation coefficients of other variables such that year and sample size were no longer significant.

Regression Variables	**Adjusted R^2**
Size (β = 0.0861); participation (β = -0.289); year (β = -0.0803); > $20,000 ($\beta$ = 0.0887); associate's, bachelor's, or graduate degree (β = 0.688)	0.925
Size (β = 0.0961); participation (β = -0.244); year (β = -0.0183); Native American, white, or Asian American (β = 0.169); > $60,000 ($\beta$ = -0.0219); bachelor's or graduate degree (β = 0.733)	0.932
For Mathematics: Size (β = 0.155); participation (β = -0.244); year (β = -0.0339); Native American, white, or Asian American (β = 0.209); > $100,000 ($\beta$ = 0.0467); bachelor's or graduate degree (β = 0.684)	0.903
For Critical Reading: Size (β = 0.0327); participation (β = -0.252); year (β = -0.0204); Native American, white, or Asian American (β = 0.133); > $60,000 ($\beta$ = -0.0599); bachelor's or graduate degree (β = 0.740)	0.942

Table 3: Regression results

Table 3 lists regression results selected to maximize the adjusted R^2 value. The first row was selected from regressions using all possible combinations of parents' income and education. The second added race. β standardized coefficients for each covariate show that parents' education predicts state SAT scores best, followed by state SAT participation rate. Regression results for average state SAT mathematics and critical-reading scores, separately and also selected to maximize the adjusted R^2 value, are beneath those for the combined scores.

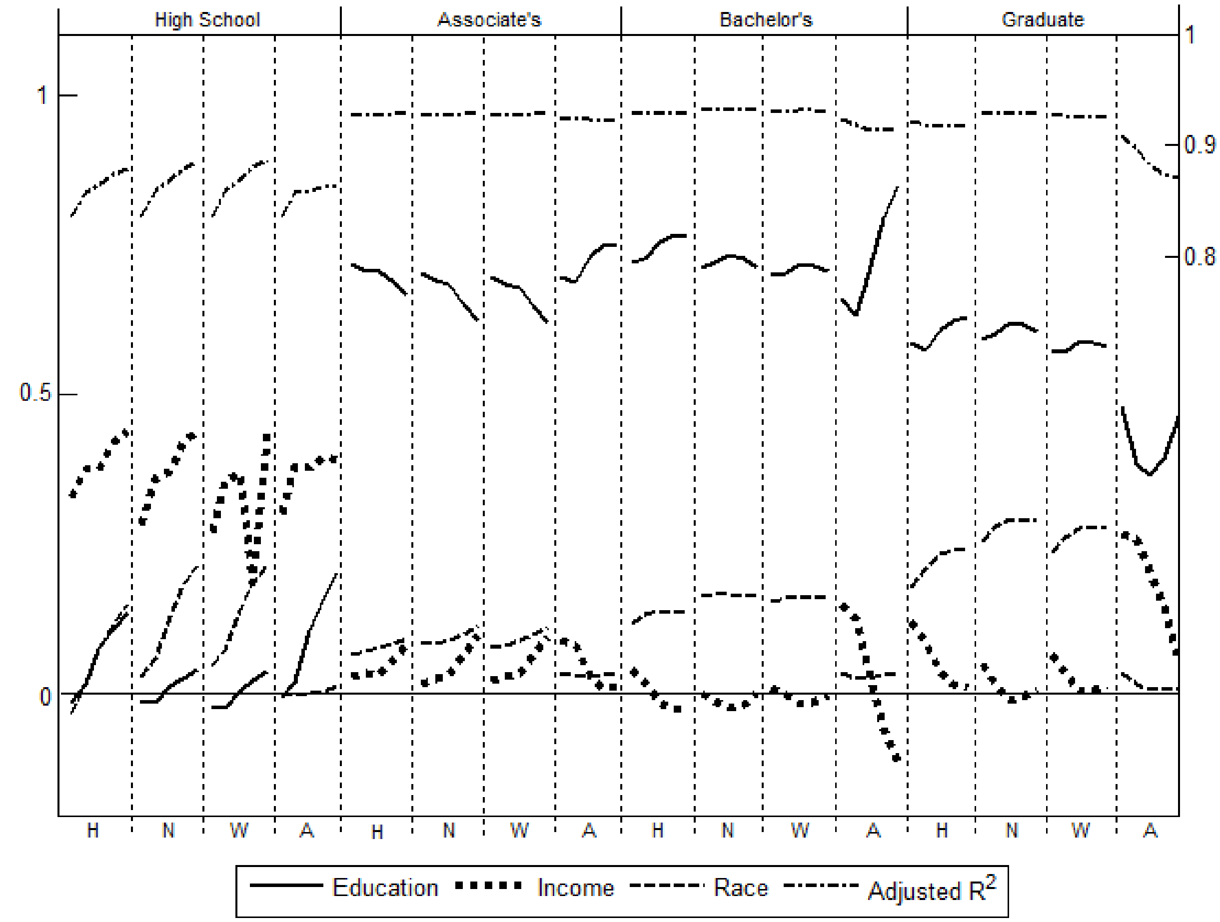

Figure 1: Standardized coefficients compared to adjusted R^2 values, organized by education first, race within each educational category, and income within each racial category

Figure 1 graphs multiple linear regression β coefficients for parents' income, parents' education, and race across all possible combinations under a graph of corresponding adjusted R^2 values, which uses the right vertical axis but the same horizontal axis. The horizontal axis is ordered first by education, which is labeled above the graph, second by race nested within each education category, and lastly by income nested within each racial category ordered from low to high income cutoffs. Race is labeled below the graph. "H" means the racial variable is the proportion within each state who are Hispanic American, Native American, white, or Asian American. "N" means the racial variable is the proportion within each state who are Native American, white, or Asian American. "W" means the racial variable is the proportion within each state who are white or Asian American. "A" means the racial variable is the proportion within each state who are Asian American. Data for the state sample size, state participation rate, and year covariates are not shown. Among all the possible combinations of the education, income, and race variables shown, 49% of income p-values do not meet the standard of statistical significance, compared to 18% and 15% for education and race, respectively. The education variable tends to have the dominant effect size when cutoffs are at the associate's degree or higher. When the education variable is the proportion having a parent with a high school diploma, the income variable has the largest effect sizes. For education, non-significant p-values are highly concentrated among the iterations for which the education variable represents the proportion of parents having at least a high school diploma. That group was the primary group for significant income p-values and relatively low adjusted R^2 values. The vast majority of states had more than 95% of students' parents having at least one high school diploma between the parents. Only California and, recently, Texas had more than 10% of their test-taking population lacking parents with diplomas. When the education variable is the proportion having a parent with a bachelor's degree, the income variable tended to not be significant, except when the race variable was the proportion who are Asian American. Non-significant values for race are highly concentrated among the iterations for which the race variable represents the proportion who are Asian American.

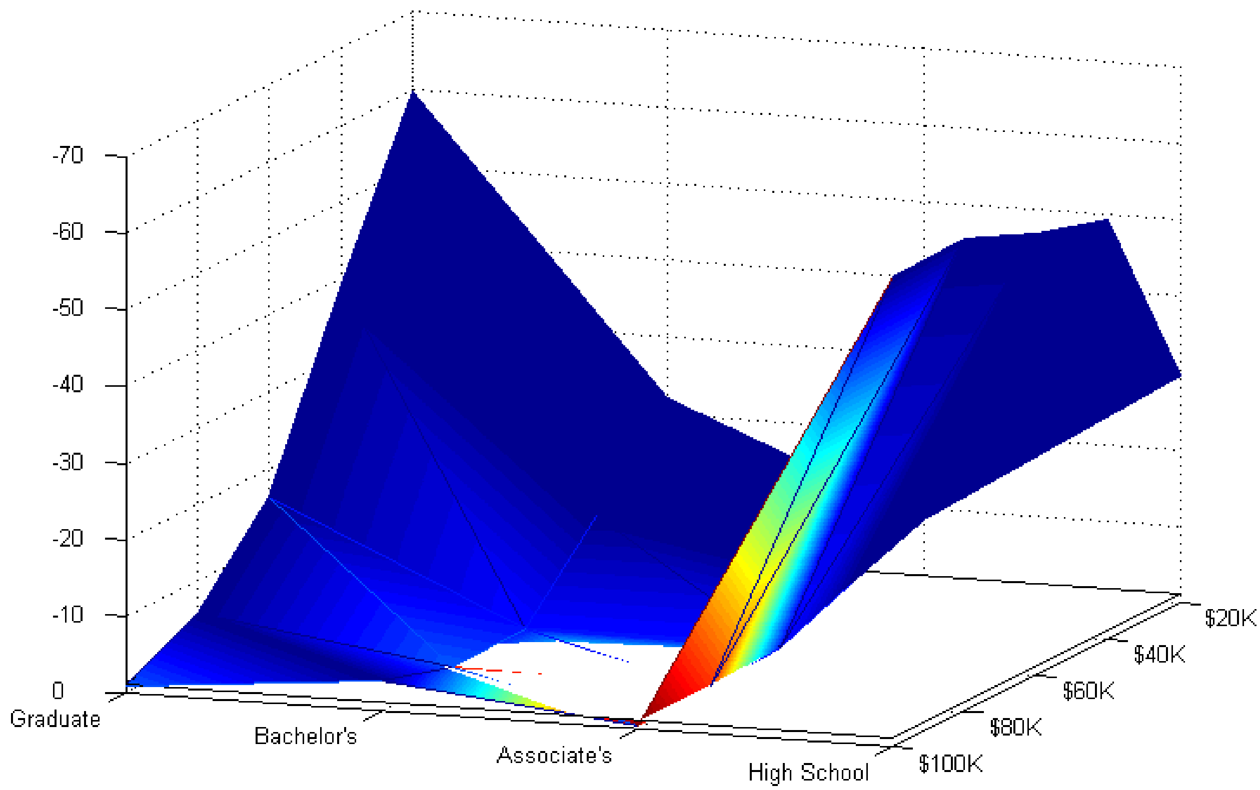

Figure 2a: Income p-values without race as a covariate (p-values are shown on an inverse logarithmic scale)

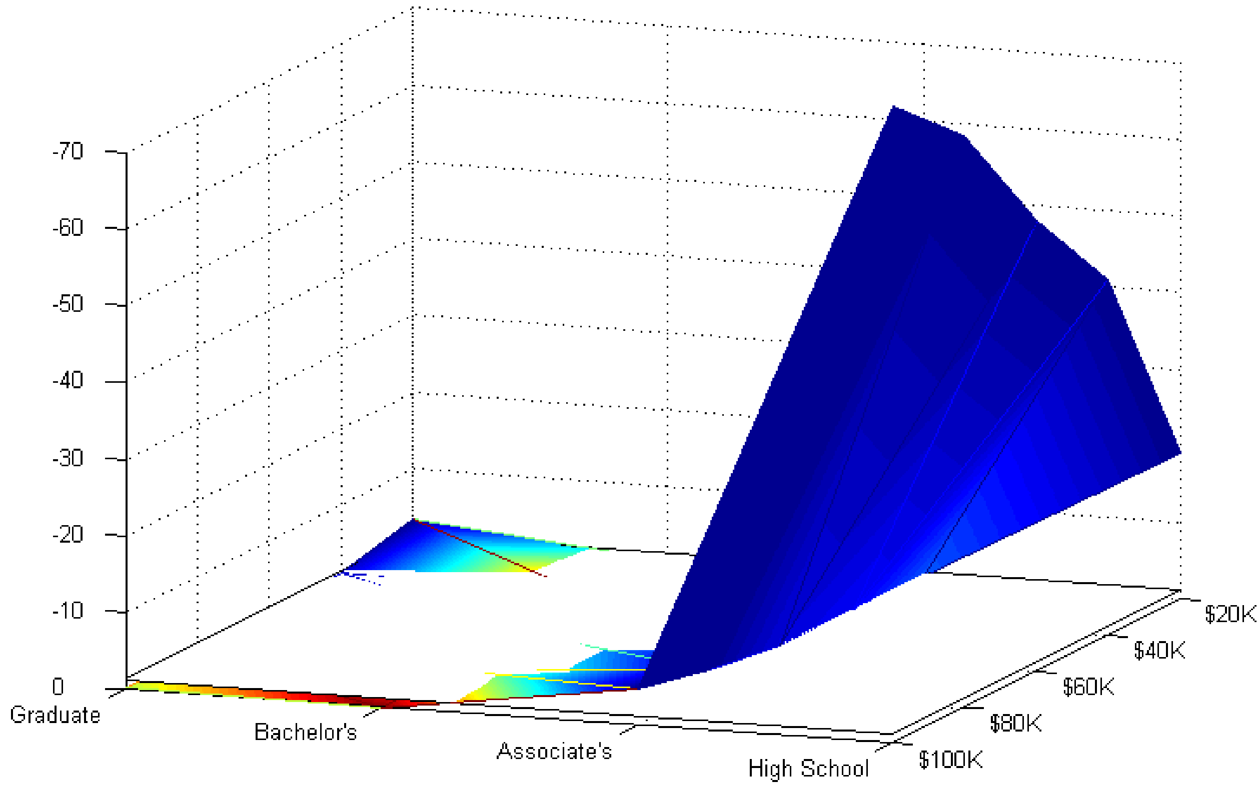

Figure 2b: Income p-values with race as a covariate (p-values are shown on an inverse logarithmic scale)

Figure 2a shows a plot of p-values of parental income for regression with the covariates yearly state participation levels, yearly state population sizes, years since 1997, and the proportion of students' parents with each education level or higher. A horizontal plane intersects the plot at the level of 0.05. The vertical axis is an inverted logarithmic scale of p-values. Figure 2b adds the additional covariate, the proportion of a state's examinees who are white or Asian American. While Figure 2a does show some insignificant values, Figure 2b demonstrates a large suppression effect. Having an income above $20,000, which is approximately the poverty level, was not a significant determinant of SAT scores when the education variable cutoffs were associate's degree or bachelor's degree. Income β coefficients also show this suppression effect, especially when the income variable is the proportion of parents earning more than $40,000 with the education variable being the proportion of parents with graduate degrees. Those β coefficients declined from 0.257 to 0.0365, and the decline when the education variable was the proportion with a graduate degree and the income variable was the proportion earning $20,000 was almost as large.

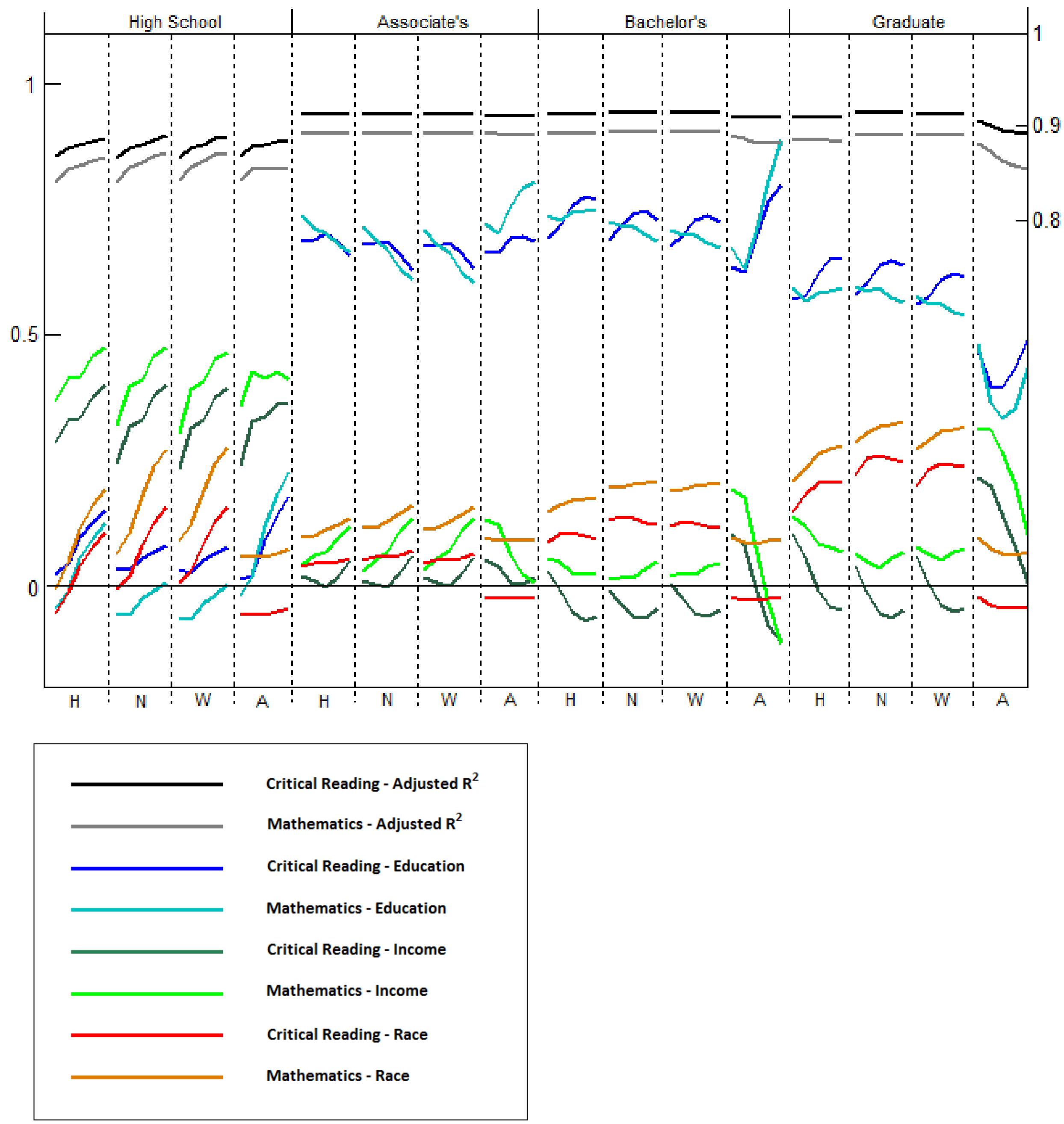

Figure 3: Critical-reading and mathematics standardized coefficients compared to adjusted R^2 values, organized by education first, race within each educational category, and income within each racial category

Regression, using the same covariates and having the average state mathematics or verbal/critical-reading subtest scores as the outcomes of interest rather than the combined scores, produced similar β coefficients, as shown in Figure 3. Scores were especially similar for education, which had only one significantly higher mathematics β coefficient (non-overlapping 95% confidence intervals). However, the mathematics β coefficients for race were consistently higher than those for the verbal/critical-reading subtest with statistically significant differences in 90% of the 80 iterations for each subtest. Asian race was always statistically significant but had a consistently positive β coefficient for mathematics and a consistently negative β coefficient for verbal/critical reading.

This appears to match national report trends since the College Board first started reporting SAT scores by race in 1976. The Asian-American mathematics subtest averages have always outscored the averages every other group, but the Asian-American verbal or critical-reading subtest averages have been lower than the white averages. Asian-American average verbal/critical-reading scores actually surpassed the arithmetic mean of non-Asians in 2003.

The income β coefficients were almost always higher for the mathematics subtest with statistically significant differences in 30% of the iterations for each subtest. When parents' education level was graduate degree, the variable for parents' income was almost always statistically significant with a positive β coefficient for mathematics, and this was nearly so often the case when the education cutoff was associate's degree.

When the education thresholds were bachelor's or graduate degrees, simultaneous with income thresholds being at least $40,000 and race not being Asian, the variable for parents' income almost always had a negative correlation with state SAT verbal/critical-reading scores, and this was statistically significant in about half of these iterations.

Among all possible iterations of the three ordinal variables for regression of verbal/critical-reading and mathematics average state scores, statistical significance was achieved in 68%, 88%, and 96% for the income, education, and race variables, respectively.

Variance Inflation Factors	
Bachelor's Degree	8.52
Participation	4.59
Native American	1.47
$60,000	5.08
Size	1.56
Year	2.50
High School Diploma	4.24
Participation	1.71
Asian American	1.07
$20,000	3.18
Size	2.23
Year	1.14

Table 4: Variance inflation factors

Table 4 shows the variance inflation factors for each independent variable in the composite-SAT regression iteration with the highest coefficient of determination, followed by the iteration with the highest standard error of an independent variable, which was 96.8 for the proportion of students within a state with parents possessing a high school diploma. In the former regression iteration, the highest standard error was for bachelor's degree, and it was 16.40.

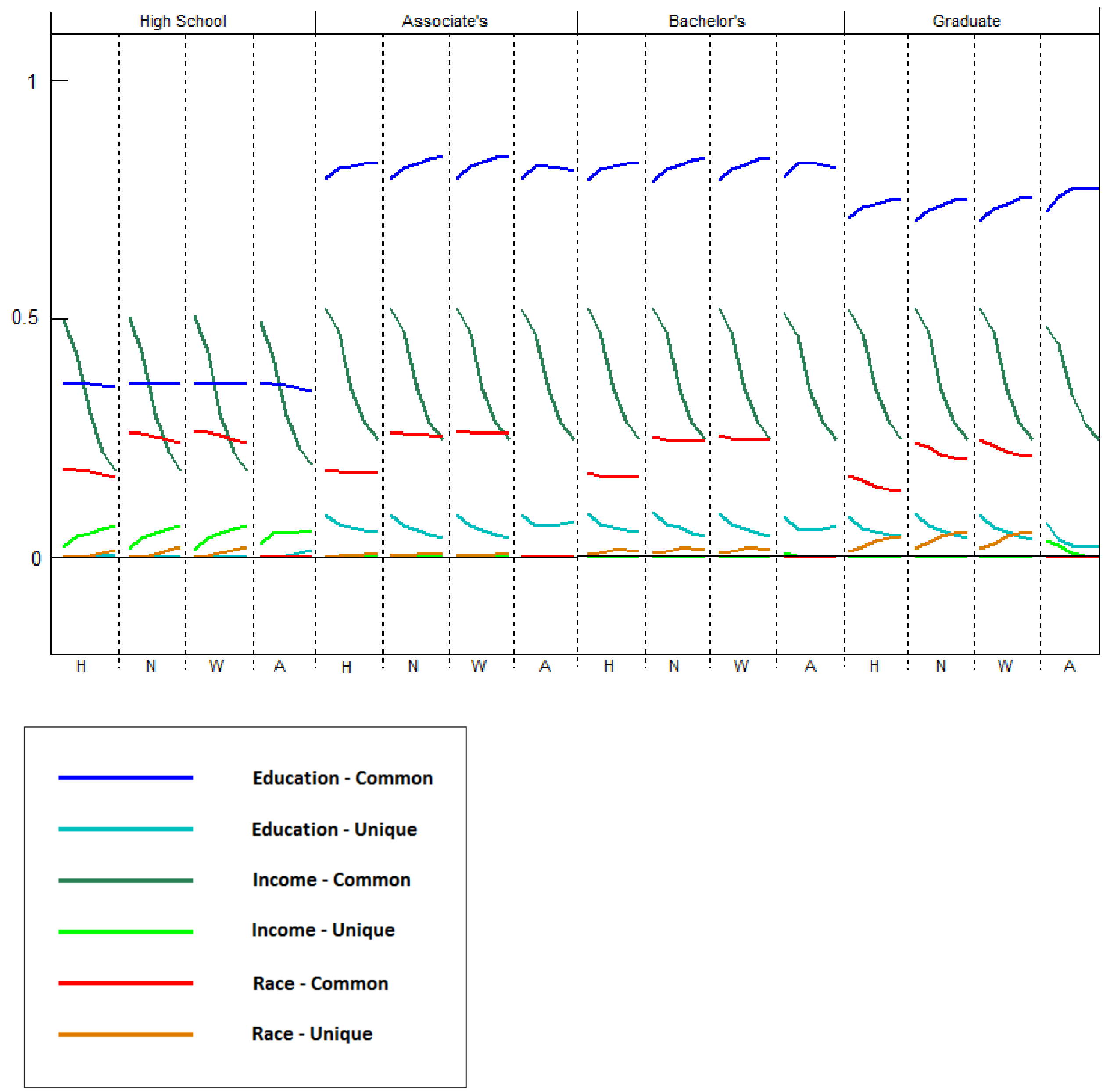

Figure 4: Unique and common commonality coefficients, organized by education first, race within each educational category, and income within each racial category

Given the moderately high variance inflation factors for parents' income and parents' education, commonality coefficients that considered all independent variables were graphed in Figure 4 for parents' education, parents' income, and race. Total common effects of independent variables tended to be much greater than unique effects. Unique effects of parents' income were usually negligible, but the total common effects of income were generally between those of parents' education and race. Otherwise, the order of variables is comparable to that of Figures 1 and 3, and parents' education still seems to dominate.

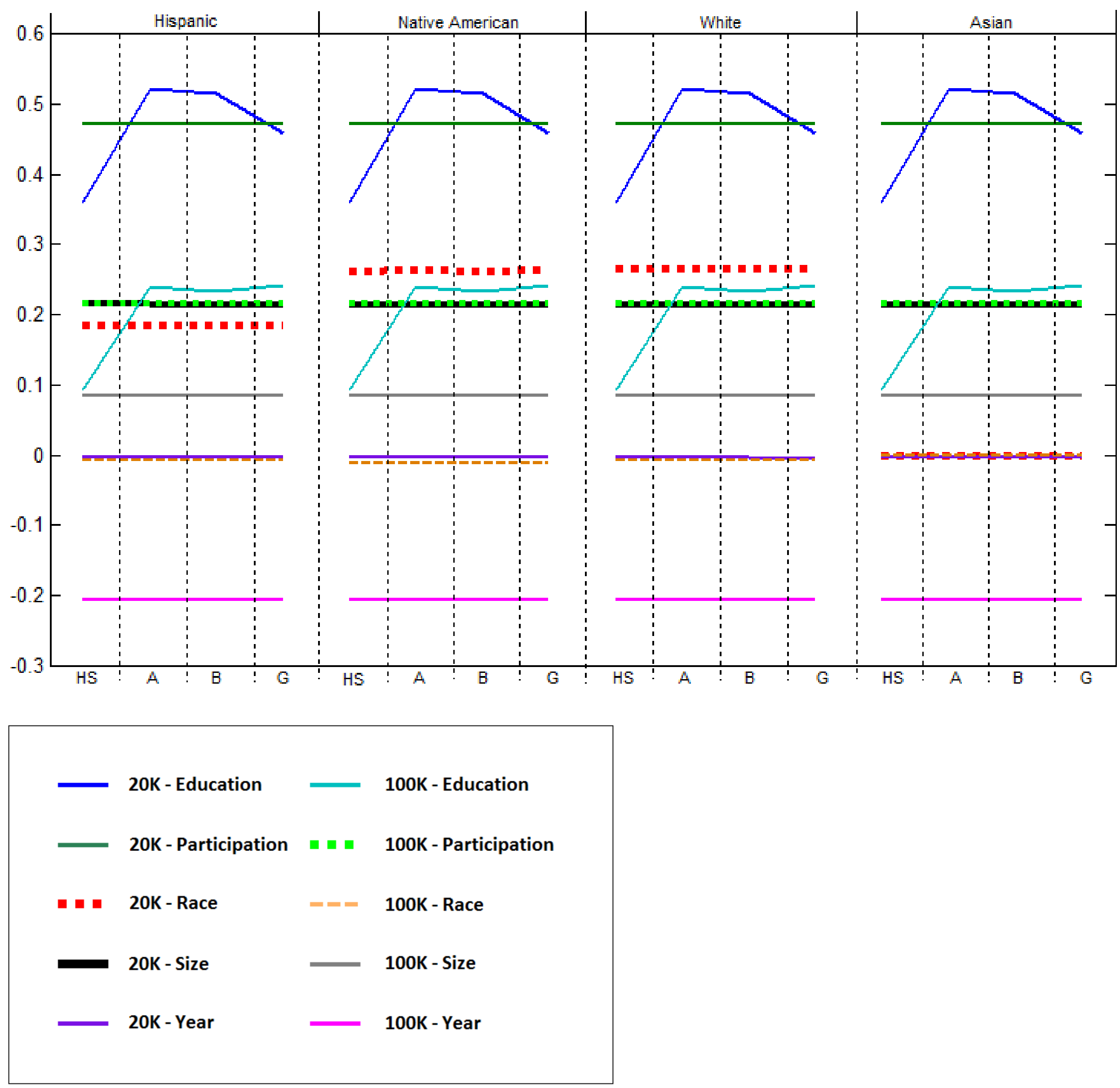

Figure 5: Contributions of each variable to the total common commonality coefficients of parents' income thresholds \$20,000 and \$100,000, organized by race first and educational category within each racial category

Figure 5 parses the common effects for the parents' income thresholds of $20,000 and $100,000 amongst the other independent variables. "HS" refers to the education variable being the proportion of students with a parent having at least a high school diploma, "A," likewise, refers to the associate's degree threshold, "B" refers to the bachelor's degree threshold, and "G" refers to the graduate degree threshold. The variable contributions are somewhat similar to the order of standardized coefficient magnitudes. Race appears to contribute to the common effects of parents' income only at the lower income threshold.

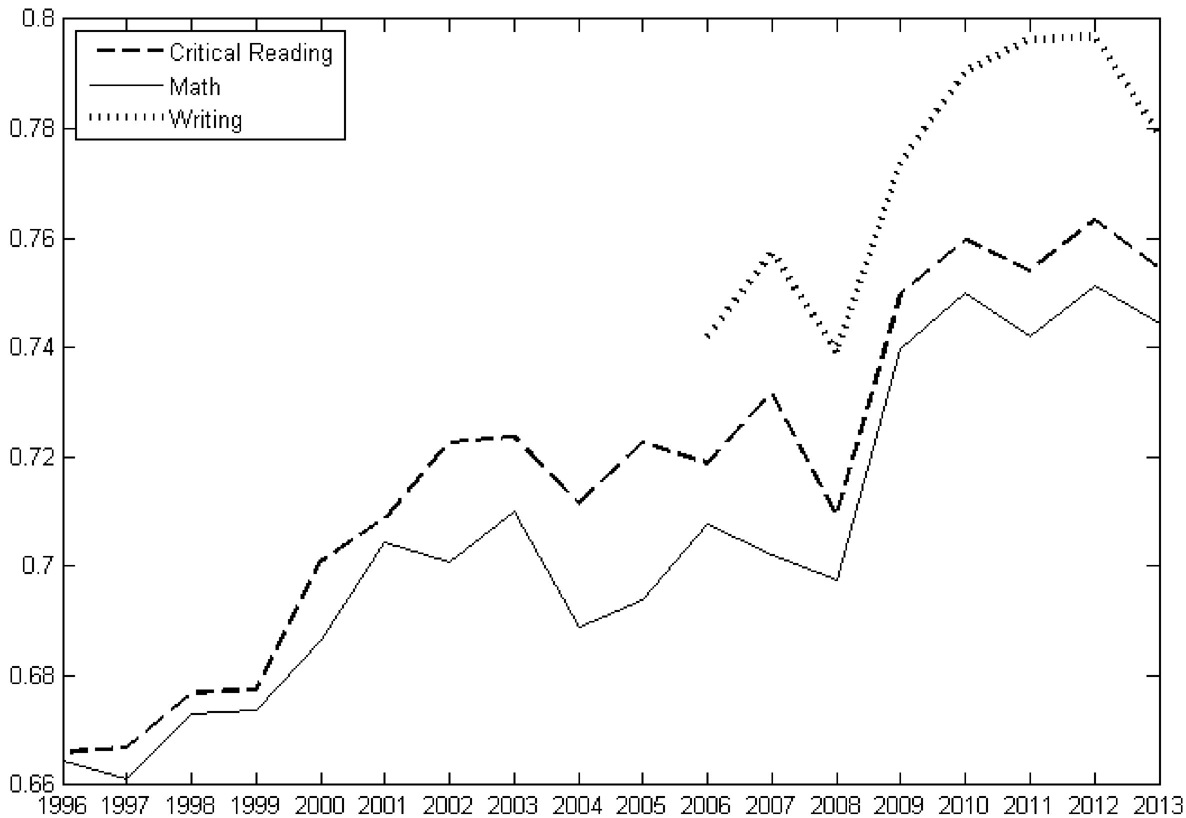

Figure 6: Cohen's d SAT advantage of a parent having a bachelor's degree

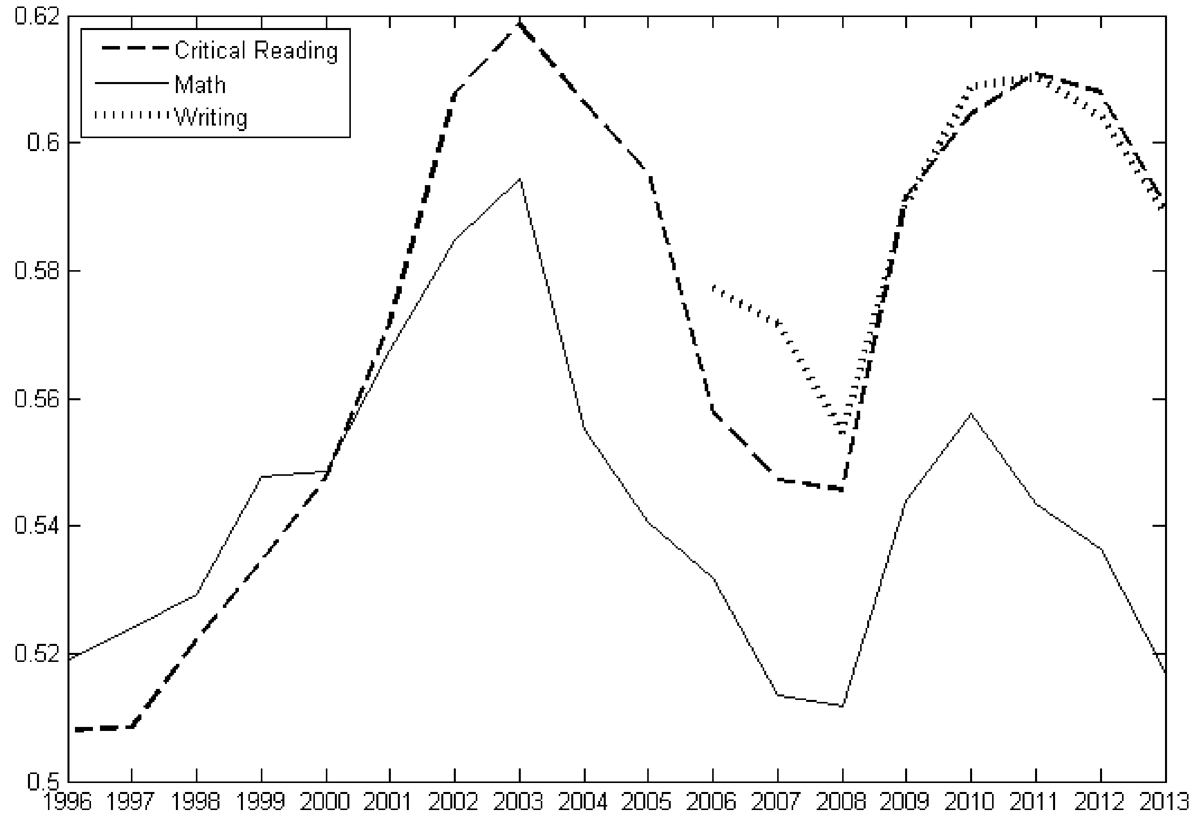

Figure 7: Cohen's d SAT advantage of having parents' annual income above $60,000

The SAT advantage of having a parent with a bachelor's degree has been generally increasing over time. Figure 6 shows the Cohen's d SAT gap between students whose parents' highest education level was a bachelor's or a graduate degree compared to those who answered no high school diploma, high school diploma, or associate's degree. The trends for the SAT advantage for having parents who make more than $20,000 or more than $100,000 were similar to the graph shown in Figure 7 for more than $60,000. This graph shows relative peaks in 2003 and 2011 and a relative trough in 2008. The magnitudes of parental income advantage are lower than parental education advantage. The higher income advantage on the mathematics SAT subtest has decreased relative to the critical-reading subtest over time when the income cutoffs were $60,000 or $100,000.

Discussion

Parents' income has a significant association with SAT scores, but parents' education is consistently stronger, and regression with effective controls for race, education, and other factors, usually suppresses the income variable to insignificance. The income variable achieved significance when the education threshold was high school diploma most likely because so few parents were dropouts that education was no longer effectively controlled, and parents' income became a proxy variable for parents' education. It is possible that the specificity of college-entrance exams to groups defined by attaining a college credential also played a role. This poor control for education resulted in lower levels of explained variance, which is not surprising given education's dominant effect sizes for other education thresholds. Part of this dominance could result from heritability in test performance corresponding to parents' educational attainment, given the high heritability estimates from twins studies for high-stakes standardized exams in the UK and the Netherlands (Bartels *et al,* 2002; Shakeshaft *et al,* 2013). Indeed, a bivariate genome-wide complex trait analysis by Marioni *et al* (2014) found a 0.95 genetic correlation between general intelligence and years of education but only a 0.26 genetic correlation between general intelligence and the Scottish Index of Multiple Deprivation, which measures seven domains of socioeconomic status, including income, education, employment, geographic access, housing, health, and crime. Trzaskowski *et al* (2014), who emphasized parents' education levels and occupations in their definition of socioeconomic status, showed stronger genetic correlations than that of the Marioni *et al* income-influenced definition.

Even so, it is unsurprising that parents' income and parents' education correlate somewhat, and it is reasonable to hypothesize that genetic and developmental effects on cognitive ability account for much of the large common effects of these two variables. In fact, lower state SAT participation is arguably an additional indicator of higher cognitive ability among such SAT-taking students. That might explain its somewhat high standardized coefficient magnitude and its high proportion of the common effects of income commonality analysis and serve to underline how remarkably low, by comparison, the influence of parents' income is, given that hereditary cognitive ability might be divided between the education and participation variables. Some statisticians do not even consider a variance inflation factor less than ten to be a concerning amount of multicollinearity (Neter *et al*, 1983).

The same apparent cancellation of the categorical variable seemed to occur with race for Asian Americans, but when scores for subtests were regressed separately, the Asian racial variable was always statistically significant. The fact that the most proximally scoring racial group is also the majority population likely reduces the magnitude of the effect size for Asian race. The racial variable was the most consistently significant variable of these three ordinal variables for composite scores and subtests, which speaks to its independence from socioeconomic status. Race also explained much of the SAT advantage that appeared to be attributable to parents' income prior to the addition of the racial variable in iterations with low income thresholds simultaneous with the education cutoff being graduate degree.

The fact that the education and race variables' significance seemed to depend upon each variable's own category, but the p-values of the income variable depended upon the kind of the education and race categories further supports the conclusion that income has only weak predictive power for SAT performance. Income was a significant variable of small effect in iterations with discordant education and income thresholds. A stronger case remains for income as a slight predictor of mathematics scores. This might represent the influence of non-intellective traits like motivation on the component of cognitive tests that most influences employment (Duckworth *et al*, 2012). Imaging studies suggest some independence of verbal abilities from others measured by such tests (Duncan *et al,* 2000).

The income variable actually had a significant negative correlation for a number of regression iterations of the verbal/critical-reading subtest when the parents' education thresholds were bachelor's or graduate degree. Heightened verbal skills could inspire less remunerated career choices. This interpretation assumes ability persistence from parent to child.

This study calls into question arbitrary composites of socioeconomic status. Giving equal weight to mother's education, father's education, and family income, as some studies have done, double counts education compared to income by happenstance. Father's income could be considered separately from mother's income, or perhaps income should be ignored for the college-educated parents. A more nuanced approach might increase the overall correlation of socioeconomic status and strengthen the case of those who find its influence concerning.

Attempts to understand predictors of SAT scores using a limited diversity of path-analysis models can suffer from confirmation bias or have equivalent models (MacCallum, 1993). The models of Everson and Millsap (2004) grouped exogenous variables in confusing ways, such as labeling honors classes and AP exams as extracurricular activities instead of indicators of high school performance. They interpreted their approach as confirming a powerful influence of extracurricular activities on SAT scores, yet most university admissions committees arguably have an entirely different conception of extracurricular activities that would de-emphasize private activities like using a computer or reading and emphasize group activities, especially those that involve popularity contests for club leadership or student government. Common perceptions of high school extracurricular activities approximate what Schmitt *et al* (2009) ascribed to organizational citizenship behavior. They explicitly attributed student government and club membership to this label and determined that higher SAT/ACT scores significantly decreased college organizational citizenship behavior (β=-0.107).

It was helpful that Dixon-Román *et al* (2013) uncovered a nonlinear income effect for African-American SAT scores, and this study's use of many regression iterations allows for an examination of such effects. They described this evidence as theoretically suggesting that poor school quality and continued racism expose African-American students to different "treatments" within income levels and even within the same classrooms. Furthermore, they suggested that cultural bias in the SAT, itself, contributed to the nonlinear income effect on African Americans. However, a strong role for bias seems counterintuitive given that racial gaps have been larger on the mathematics subtest than the critical-reading and writing subtests. Also, when considering how income might affect different groups in different ways, it is important to not introduce circular reasoning. For instance, factoring in wealth, as they suggest, would incorporate a behavioral-judgment independent variable into an analysis of test-taking ability, which also might correlate with judgment. A survey by Ariel Investments (2010) raised concerns not just about the savings rate in the African-American community but also investment strategies. Also, Buchmann *et al* (2010) showed that while high-income families are more likely to use SAT test-preparation services, African-American families are significantly more likely to use such services than are white families with similar parental education and income.

Dixon-Román *et al* assumed that poverty hurts African Americans more than whites, but their analysis did not rule out whether minority-outreach efforts might have succeeded in helping lift some higher-scoring African-American families out of poverty, and, thereby, lowered the scores of the group still in poverty, though this would assume some score persistence within families. Consider the Cohen's d timescale graphs. Family educational advantage seems to evince virtually undeviating growth as a predictor of SAT scores, but financial advantage seems to grow as the economy worsens. Rather than postulate that times of economic difficulty almost immediately make wealthy people smarter, one should focus on the exclusivity of the income category. That graph suggests persistence rather than malleability in test scores within a family, which would also fit the more hopeful interpretation of the nonlinear effects of income. The declining relative income advantage on the mathematics subtest compared to the critical-reading subtest also could be related to structural changes to the economy since the decline of the high-technology boom of the 1990's, which also fits this interpretation of persistence within families. Figure 1 seems to contradict Dixon- Román *et al* in finding that the racial variable had its greatest influence at the highest education level and at high income levels.

One potential concern about this study is that it mostly depended upon limited state data rather than the scores of individual students. However, the finding that parents' income poorly predicts SAT score compared to parents' education received support from all three levels of analysis: regression of state averages, Spearman rank correlations, and the magnitudes of income and education individual SAT advantages. Different states have different costs of living, so state-data analysis might actually have an advantage in allowing for controls for variables that influence such state or regional differences.

This study provides a powerful example against the ecology-fallacy label. Asian Americans have historically high average mathematics subtest scores but lower verbal/critical-reading average scores than the white majority. Their verbal scores did surpass those of non-Asians during the years of this study, but Asian race would probably remain a small negative influence on verbal/critical-reading scores in a multiple linear regression analysis of individual scores that includes education and income covariates because US Census data (1990, 2013) have shown above-average income and educational attainment for Asian-American families. Of course, Asian Americans are a minority, comprising only 9% of examinees in 1998 and 12% in 2013. Despite their likely small average verbal disadvantage and small population in many states, this study's consistent regression results for Asian race match verifiable individual SAT-score phenomena. A study with fewer observations, a much smaller represented sample, or fewer or poorly chosen covariates might not have achieved that level of definition, but, fundamentally, states do not take the SAT; people do.

Multiple limitations pertain to the covariates. Considering how many students did not provide information on parents' income, the fact that the data was based on self-reports is a potential weakness. Some of the variables clearly have important effects on SAT score, but exactly why cannot be completely answered with this study. Perhaps additional or alternative variables could be identified. For instance, year was significant in some regression iterations but had small β values. Perhaps year is a proxy variable for other factors like the state of the economy. Finally, Spearman rank correlations included state participation rates, even though those pertain to state-level data, not income brackets and education levels within states. However, the results showed that the variable was still statistically significant.

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