Determinants of SAT Scores in North Carolina

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[2] Behrendt, Amy, Jeffrey Eisenach, William R. Johnson. Selectivity bias and the determinants of SAT scores. Economics of Education Review. Vol. 5, Issue 4, 1986. 361-377.

[3] Eberle, Joan L., and Gary L. Peltier. "Is the SAT Biased? A Review of Research". *American Secondary*

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Abstract

This paper examines the effects of different school and district characteristics on SAT scores across North Carolina from 2007 to 2014. Such characteristics include demographics, poverty and wealth indicators, measures of classroom environment, and achievement levels. A pooled time series panel across districts and schools with fixed effects is used to determine the strength of influence these variables have on scores. Ultimately, this paper identifies which characteristics lead to over- or under-performance relative to predicted values; further, it considers the implications of the SAT being more of an "achievement" test versus an "aptitude" test.

JEL Classification: I2, I24

Keywords: Education, SAT, Achievement Gap, Aptitude Test

I. Introduction

This paper focuses on the determinants of the Scholastic Aptitude Test (SAT) scores in North Carolina. All 115 districts (also referred to as Local Education Agencies, or LEAs) and 525 high schools (both public and charter) in North Carolina are analyzed. The time period of interest, 2007 to 2014, reflects the 2400-point format of the SAT. In 2006, the SAT was reintroduced on a 2400-point scale with three sections (Math, Critical Reading, and Writing), each on a 200-800-point scale. At the school level, variables of interest include demographic makeup, measures of wealth and poverty (students living below the poverty line, students receiving free/reduced lunch (FRL), and per-pupil funding), measures of classroom ability (Academically and Intellectually Gifted (AIG) students, Exceptional Children (EC) students, special needs students, enrollment in AP/IB courses and career/technical courses, Limited English Proficiency learners, and class size), and measures of the classroom environment (teacher licensing, attendance, crime, percent of students taking the SAT, and access to computer and internet, and graduation and dropout rates). At the LEA level, the effects of broader resident characteristics on SAT scores, such as demographics, population, non-native English speakers, relative wealth, and educational attainment, are analyzed.

Not every student in North Carolina is mandated to take the SAT. Thus, there is some self-selection bias present, as high school students seeking college admission will take the SAT. Moreover, there are alternative standardized tests for college admissions, such as the ACT and Advanced Placement (AP) and International Baccalaureate (IB) tests. Finally, while the SAT is not a comprehensive measure of educational outcomes or intelligence, the SAT does measure reading

comprehension, writing abilities, and mathematical skills, which are intrinsically useful. In short, this analysis identifies characteristics of schools and LEAs that make them over- or under-performing, relative to predicted scores. This paper is specifically interested in the effects of socioeconomic status and race on scores, as some argue the SAT is biased toward upper-class whites.

II. Background

Behrendt, Eisenach, and Johnson looked at the determinants of SAT scores nationwide in 1982. While the study was thirty years ago, the results are still interesting. Behrendt, *et al.* found that high school graduation rates do not explain SAT score variation, and that schooling variables (such as teacher salaries, teachers per pupil, and per-pupil expenditures) have a negligible effect on SAT scores. However, they did find that demographic variables had a significant effect on scores and that private schools "enhance SAT scores."[2]

Other literature addresses the apparent biased nature of the SAT. Those who argue the SAT is biased point to the fact that economically disadvantaged and minority students typically perform worse on the SAT than their middle-to-upper class counterparts.[3] Regardless, the producer of the SAT, the Educational Testing Service (ETS), says that it stands by its mission to "expand access to higher education for all" and highlights the continuing disparities in educational opportunities for minority students. Moreover, while the ETS and the SAT have come under fire for including "discriminatory test questions" that favor "middle-to-upper class lifestyles," research by Stodolsky and Lesser suggests there are diverse patterns of mental ability between different American ethnic groups. For example, Jewish-American students perform higher on questions of verbal ability and Chinese-American students perform better on spatial conceptualization questions.[4]

The other and bigger question is the extent to which the SAT is an aptitude test, meaning that one cannot study for it beyond learning the rules, versus an achievement test, meaning that one can improve his/her score through studying and practice. The obvious implication of the SAT being an achievement test is that middle-to-upper class students can take preparatory courses and retake the test (which costs $52.50) and come out ahead. Eberle and Peltier agree that, at some level, low-

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[2] Behrendt, Amy, Jeffrey Eisenach, William R. Johnson. Selectivity bias and the determinants of SAT scores. Economics of Education Review. Vol. 5, Issue 4, 1986. 361-377.

[3] Eberle, Joan L., and Gary L. Peltier. "Is the SAT Biased? A Review of Research". *American Secondary Education* 18.1 (1989): 17–24. Web.

[4] S. S. Stodelosky and G. S. Lesser, "Learning Pattern in the Disadvantaged," Harvard Educational Review 30 (1967): 546-593.

income students have access to low-quality educational opportunities. What is more, research suggests that low-income students tend to come from environments that give them less encouragement, attention, and support. While there are still undeniably some instances that indicate bias in questioning (Figure 1), this analysis indicates that the effect of the family on student achievement is an important factor that should not be ignored.

Figure 1: Past Test Questions[5]

RUNNER: Marathon

A. envoy: embassy
B. martyr: massacre
C. oarsman: regatta
D. referee: tournament
E. horse: stable
(The answer was C. The above question has not been used in an SAT sine 1979 .)

Question 1

HEIRLOOM: INHERITANCE

A. payment: currency
B. belonging: receipt
C. land: construction
D. legacy: bill
E. booty: plunder
(The answer was E. The above question has not been used in an SAT since 1982.)

Question 2

22. Some Native American organizations recently have been successful in defending legal land rights previously protected only by tradition and unenforced _____.
A. debts
B. chronicles
C. testimony
D. outposts
E. treaties
(The answer was E).

Question 3

23. Although many women in politics are not feminists, research _____ that there is a pronounced _____ women's rights on the part of office holders who are women.
A. denies ... interest in
B. supports ... neglect in
C. confirms ... concern for
D. obscures ... need for
E. refutes ... consciousness of

Question 4

Helen Ladd suggests a variety of symptoms of low socioeconomic status are relevant to children's subsequent educational outcomes. These include: poor health, limited access to home environments with enriching opportunities, limited access to high-quality preschool education, less participation in summer and afterschool activities, and greater movement in and out of schools. Differences in outcomes between high- and low-socioeconomic status families reflect that middle-to-upper class families are better positioned to ensure their children attend the best schools with the best teachers, and are more likely to invest in out-of-school activities that improve classroom outcomes, such as tutoring, test preparatory courses, and extracurricular activities. Evidently, student poverty levels are correlated with achievement levels.[6] Ladd also discusses how the behaviors and

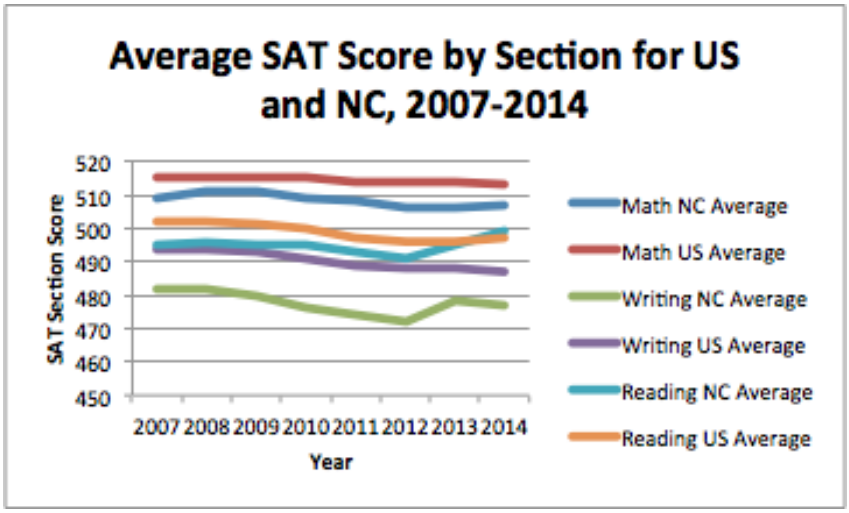
[5] It was argued that Question 1 did not measure student's aptitude or logical reasoning ability, but rather their "knowledge of an upper-middle class recreational activity." Only 22 percent of black students answered Question 1 correctly, as opposed to 53 percent of white students. Along the same lines, Question 2 required "esoteric, culturally specific knowledge." Questions 3 and 4 appear to be aimed at various cultural, racial, and sex groups; therefore, these are also biased test questions.

[6] Ladd, H. F. (2012), Education and Poverty: Confronting the Evidence. J. Pol. Anal. Manage., 31: 203–227. doi: 10.1002/pam.21615.

preferences of teachers are a contributing factor to achievement,[7] as some teachers with strong credentials are reluctant to teach in schools with large concentrations of disadvantaged students.[8] We can think of educational outcomes as a function of public school quality and context. The learning environment may differ across schools and districts due to differences in the quantity and quality of inputs, as well as the effectiveness with which they are used.[9]

Furthermore, the North Carolina public education system ranks near the 50th percentile of the United States. From 2007 to 2014, North Carolina averaged slightly lower than the United States on all sections, except for Critical Reading in 2014. Writing had the highest variance between United States and North Carolina scores.

Figure 2: Average SAT Scores by Section in United States and North Carolina, 2007-2014



The 2014 North Carolina SAT Report breaks down SAT scores by racial/ethnic group. The results in Figure 3 below are reported on a 1600-point scale (Math and Critical Reading scores) to account for changes to SAT scoring, effective 2006. As of 2014, Asian students had the highest performance (1117 of 1600 points). They are followed by white (1066), Hispanic (954), American Indian (934), and black (856) students. This pattern has remained intact over the last nine years. Evidently, black students perform consistently worse than other demographic groups. In 2014, the mean SAT score for black students was 261 points lower than Asian students, 210 points lower than

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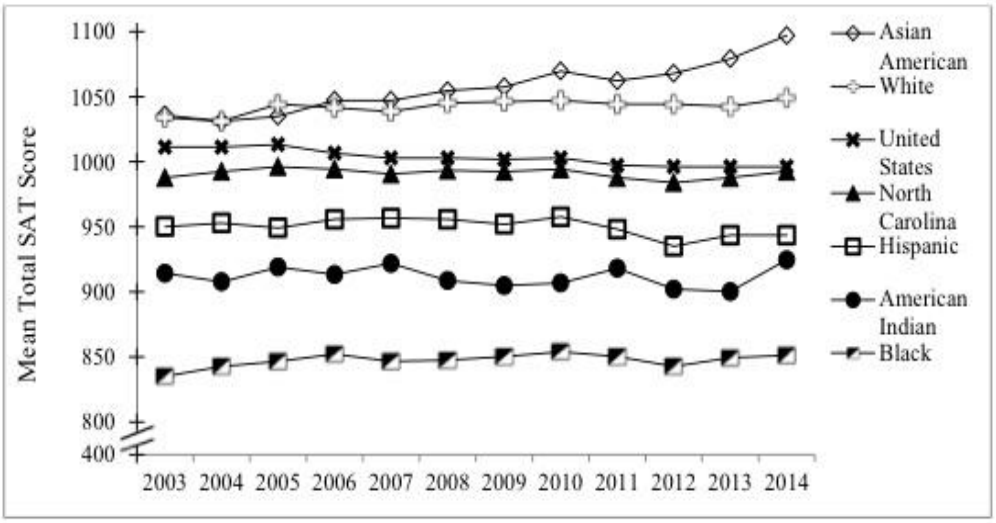
[7] Charles T. Clotfelter. and Helen F. Ladd. and Jacob L. Vigdor. "Teacher Credentials and Student Achievement in High School: A Cross-Subject Analysis with Student Fixed Effects." *Journal of Human Resources* 45.3 (2010): 655-681. *Project MUSE*. Web. 25 Jan. 2016.

[8] Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2011). Teacher mobility, school segregation, and pay-based policies to level the playing field. *Education Finance and Policy*, **6**, 399–438.

[9] Ladd, Helen. F. (2012), Education and Poverty: Confronting the Evidence. *J. Pol. Anal.* Manage., 31: 203–227. doi: 10.1002/pam.21615

white students, 98 points lower than Hispanic students, and 78 points lower than American Indian[10] students. Moreover, black students in North Carolina consistently average 60 points lower on Writing and Critical Reading sections than Hispanic students. This is surprising because Hispanics traditionally have the highest proportion of limited English proficiency in North Carolina.

Figure 3: Mean Total SAT Scores (Math and Critical Reading) in NC by Race/Ethnicity, 2003-2014[11]



III. Methods

This analysis uses time panel regression models with school and district fixed effects. A Haussmann test confirmed the use of fixed effects. Fixed effects control for time-invariant characteristics, such as population mix and historical commitment to education, which could affect educational outcomes and might be correlated with poverty rates.[12]

Principal component analysis (PCA) in STATA is conducted to reduce the dimensionality of the response variables. At the district level, PCA results in the reduction of 21 variables to six major components: EDU_FOREIGN (for educated foreigners), POV (for poverty), CLASS_QUAL (for classroom quality), CAREER (for vocational track students), and MATH and ENG (for demographic effects on classroom). At the school level, PCA results in the reduction of 21 variables to seven major components: POV2 (for poverty), ABIL (for measures of school ability), MIN (for measures of minority students), ACHIEVE (for measures of achievement), CLASS_MIN (for minority presence at the class level), SCH_ENV (for school environment), and finally CLASS_ENV (for classroom environment).

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[10] In the context of North Carolina, Lumbees are all American Indians rather than Black.

[11] The North Carolina 2014 SAT Report. NC Dept. of Public Instruction, Accountability Services Division. Oct. 2014.

[12] https://www.princeton.edu/~otorres/Panel101.pdf

Table 1: List of Variables

Variable	Definition	Source
White	% population identifying as white	ACS
Black	% population identifying as black	ACS
American Indian	% population identifying as American Indian	ACS
Asian	% population identifying as Asian	ACS
Hispanic	% population identifying as Hispanic	ACS
Pacific Islander	% population identifying as Pacific Islander	ACS
Multiracial	% population identifying as multiracial	ACS
P_White	% of students identifying as white	NCERDP
P_Black	% of students identifying as black	NCERDP
P_American Indian	% of students identifying as American Indian	NCERDP
P_Asian	% of students identifying as Asian	NCERDP
P_Hispanic	% of students identifying as Hispanic	NCERDP
P_Pacific Islander	% of students identifying as Pacific Islander	NCERDP
P_Multiracial	% of students identifying as multiracial	NCERDP
SAT Participation	% of students who take the SAT in a given LEA or school	NCERDP
Population	Total number of residents per LEA	ACS
Member	Total number of students per school	NCERDP
Foreign Born	% of population born abroad	ACS
Non-English	% of non-English speaking homes	ACS
High School	% of residents holding a high school diploma	ACS
Bachelor	% of residents holding a Bachelor's degree	ACS
Homeownership	% of homeownership	ACS
Per Capita	Per capita income for LEA	ACS
Median Income	Median income for LEA	ACS
Poverty	% of population living under the poverty line	ACS
Poverty_Sch	% of students living under the poverty line	NCERDP
English Size	Number of students per English I class	NC Report Card
Math Size	Number of students per Algebra I class	NC Report Card
Percent AP/IB	% of students enrolled in AP/IB courses	NCERDP
Percent Career	% of students enrolled in career/technical courses	NCERDP
Local	Per pupil funding from local sources, in dollars	NC Report Card
State	Per pupil funding from state sources, in dollars	NC Report Card
Federal	Per pupil funding from federal sources, in dollars	NC Report Card
Daily Attendance	Average daily attendance, by school	NCERDP
AIG	% of Academically and Intellectually Gifted students	NCERDP
Exceptional Children	% of students with an impairment	NCERDP
FRL	% of students receiving Free and/or Reduced Lunch	NCERDP
Graduation	Graduation rate	NCERDP
Special	% of students with a learning disability	NCERDP
Teacher	% of teachers who are fully licensed	NCERDP
Crime	Number of crimes per year	NCERDP
Comprehension	% of students performing at or above comprehension	NCERDP
Instruct Computer	Number of instructional computers per student	NCERDP
Dropout	Dropout rate	NCERDP
ESL	% of students with limited English proficiency	NCERDP
Class Internet	% of classrooms connected to the Internet	NCERDP

IV. Empirical Results

A. District Level Results

Several descriptive characteristics of the 115 LEAs in North Carolina were collected and regressed against SAT and section scores. District data was collected from the American Community Survey (ACS) and the North Carolina School Report Card website.

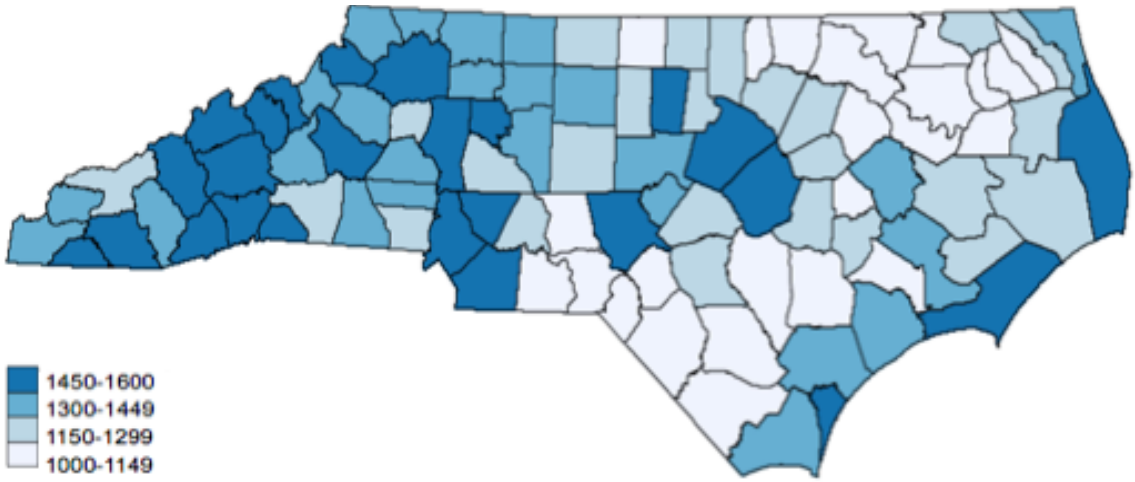
Table 2: District Characteristics on Cumulative and Section SAT Scores

	(1) SAT		*(2) Math*		*(3) Writing*		*(4) Critical Reading*	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
White	.241	1.02	.68	.387	-.469	.321	.031	.366
Black	-3.13***	.995	-.583*	.378	-1.44***	.313	-1.10***	.355
American Indian	-2.08**	1.07	-.220	.406	-1.14***	.342	-.717*	.383
Asian	-4.21	3.18	.117	1.22	-1.66*	.995	-2.66**	1.09
Hispanic	-3.14	2.22	-.989	.870	-.572	.685	-1.58*	.764
Pacific	12.45**	6.32	6.60	2.70	3.07	2.12	2.78	1.93
SAT Participation	-.887**	.189	-.301***	.073	-.260***	.067	-.326***	.070
Population	.00002*	.00001	.000004	.000005	.000009**	.000004	.00001**	.000004
Foreign Born	9.38***	2.72	4.50***	1.06	2.66***	.877	2.22**	1.00
Non-English	-3.30	2.87	-1.95	1.09	-1.48	.908	.127	1.02
High School	2.51***	.762	.835***	.325	.622***	.239	1.05***	.263
Bachelor	3.61***	.564	.749***	.215	1.48***	.194	1.38***	.208
Homeownership	-1.09	.404	-.391**	.159	-.231*	.131	-.463***	.143
Per Capita	.0002	.001	.0002	.0005	.0001	.0004	.0006	.0004
Median Income	-.00002	.0007	-.0003	.0003	-.0001	.0002	-.0001	.0002
Poverty	.665	.867	.516	.343	.430	.280	-.279	.309
English Size	.144	.590	-.073	.242	-.106	.192	.323	.208
Math Size	-.693	.656	-.059	.272	-.317	.215	-.316	.293
Percent AP/IB	.05	.843	-.401	.344	.133	.269	.318	.293
Percent Career	-.734	.727	-.112	.288	-.411*	.236	-.211	.255
Local	-.005	.004	-.002	.002	-.003*	.001	-.001	.001
State	.003	.002	.0005	.0007	.001	.0007	.001	.0008
Federal	-.05***	.004	-.015***	-.015	-.02	.001	-.014***	.002
Constant	1385.02***	117.63	407.54***	46.14	507.49***	37.72	469.91***	41.87
Adj. R^2	.8356		.7858		.8333		.8256	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

Figure 4 below depicts the one hundred counties[13] of North Carolina. Evidently, higher mean SAT scores tend to the western part of the state. Other notable areas include the Charlotte Metropolitan area, the Triad, and the Triangle (see Appendix: Figure B for detailed map of North Carolina).

Figure 4: Average SAT Scores in North Carolina, 2007-2014



i. Population

Population has a positive relationship with SAT scores. For each one thousand resident increase, scores increase by 0.02 points. This is significant at the 10% level. These results extend to section scores, as well. The wealth disparity of populous cities- high levels of wealth existing alongside high levels of poverty- is pointed out in the March 24, 2016 *News & Observer* article identifying the achievement gap in North Carolina. This is further addressed in the **Wealth** section. Therefore, while *Population* might not have as large an effect on SAT scores as initially hypothesized, its underlying components might have interesting effects.

ii. Demographics

To evaluate more effectively claims that the SAT is a racially and culturally biased test, I look at the effect of a one percent increase in a racial/ethnic group on SAT scores. Table 2 indicates that race works in surprising ways. *Multiracial* was omitted to avoid multicollinearity. At the LEA level, *White* and *Pacific Islander* have positive effects on SAT scores. The *Pacific Islander* effect is nearly 13

[13] A note about these maps of North Carolina: There are 115 Local Education Agencies (LEAs) in North Carolina and 100 counties. All 100 counties are an LEA, denoted as County LEAS. There are an additional 15 City LEAs that, in some cases, do not qualify for the same supplemental funding opportunities as County LEAs (i.e., Small County funding). For this graphical analysis, I have absorbed the City LEAs into the greater County LEA.

points, which is large compared to the effects of the other race variables. Interestingly, *Asian, Hispanic, Black,* and *American Indian* all have negative effects on SAT scores (except *Asian* on Math is positive). Even *White* has a negative effect on Writing. *White, Asian,* and *Hispanic* are insignificant at the 10% level. It is odd that *Asian* has a negative effect on most scores, since Asian students are the highest performing group in the state according to the 2014 SAT Report. The negative coefficient on *Asian* and the large effect of *Pacific Islander* are likely due to the small populations throughout the state.[14] Moreover, the US Department of Homeland Security indicates that Asian students attend private schools at a higher rate than other foreign groups, which might contribute to this relationship.[15] Also, the presence of several wealth variables in Table 2 could bias the effect of race variables, due to socioeconomic status. Below, Table 3 below displays the results of regressing solely race variables on scores. *Multiracial* is omitted. While race variables pick up many omitted variables, drawing conclusions about the impact of race on scores from Table 3 is insufficient.

Table 3: Isolated Race Effects on SAT and Section Scores

	(1) SAT		*(2) Math*		*(3) Writing*		*(4) Critical Reading*	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
White	2.69**	1.13	1.37***	.379	.598	.395	.725*	.386
Black	-1.69	1.12	-.152	.376	-.752*	.392	-.783**	.385
Asian	28.16***	1.69	9.61***	.573	9.39***	.594	9.15***	.565
Hispanic	-1.94***	.538	-.479***	.193	-.714***	.175	-.727***	.191
American Indian	-.518	1.18	.216	.401	-.346	.415	-.387	.404
Pacific Islander	18.63***	6.58	7.87***	2.42	4.58**	2.33	6.18***	2.20
Constant	1224.07***	112.61	379.39***	37.66	416.91***	39.27	427.72***	38.54
Adj. R^2	.6784		.6590		.6451		.6676	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

Race appears strongly correlated with a district's mean SAT score. White, Asian, and Pacific Islander populations have positive relationships with scores. *Asian* has the largest positive effect, by magnitude, which reinforces the 2014 SAT Report's findings. *Black, Hispanic*, and *American Indian* have a negative effect on scores; however, *Black* and *American Indian* are not significant. Interestingly, *Hispanic* has the largest negative effect. This finding parts from that of the 2014 SAT Report, which indicates that Hispanic students perform better cumulatively and on all sections of the SAT than black students. However, *Hispanic* has a higher negative magnitude than *Black* only on SAT and

[14] Asian populations rarely reach above 10 percent in a given district and Pacific Islander populations typically include less than three percent of residents.

[15] https://www.bostonglobe.com/metro/2016/03/26/chinaschools/3e9malNHYbwSgGkJqiAcbM/story.html

Math. On verbal sections, *Black* has the greatest negative magnitude. This is interesting, especially as Hispanic students tend to have higher incidences of limited English proficiency than Black students, which would intuitively affect verbal sections more than Math. Of course, these findings should be interpreted with caution, since only race variables are regressed against scores.

As a frame of reference, the five LEAs with the highest mean SAT scores are: Chapel Hill-Carrboro City (1761), Watauga County (1603), Asheville City (1580), Wake County (1569), and Buncombe County (1549). Of the top five scoring LEAs, Wake County has the smallest percentage of white students and most diverse set of demographics. The other four LEAs are mostly comprised of white residents. The five LEAs with the lowest mean SAT scores are: Halifax County (1174), Northampton County (1184), Hertford County (1189), Bertie County (1196), and Washington County (1198). These five LEAs score approximately 400-500 points less than the top five scoring LEAs and are primarily split between black and white students. Evidently, there is a role of race- but how impactful it is requires further investigation, as race has underlying complexity.

iii. Parental Education

Previous literature finds that higher levels of educational attainment correspond with higher incomes, meaning that highly educated parents are more able to provide more opportunities for their children. In turn, their children are more likely to succeed in school. Charlotte, the Triangle, and the Triad report some of the highest mean SAT scores, depicted in dark blue in Figure 4. These areas all rely on highly educated professionals for their respective local industries. These industries are typically higher education, research and development, medicine, and financial services. In turn, the highly educated professionals tend to the middle-to-upper-class; therefore, they can provide more supportive family environments and are more able to provide enrichment opportunities for their children. Of course, a caveat is that many of these professionals send their children to private schools, which is not captured in this analysis.

Evidently, the education levels of the greater district have an important positive impact on SAT scores (Table 2). *High School* and *Bachelor* represent the percentage of residents who hold each of these degrees and are intended to proxy parent educational attainment. A one percent increase in the number of residents with a high school degree leads to a nearly three-point increase in SAT scores. Furthermore, a one percent increase in residents with Bachelor's degrees leads to a nearly four-point increase in SAT scores. These findings are significant at the 1% level. The fact that *Bachelor* has a larger impact by magnitude on SAT scores than *High School* reinforces the idea that families with

highly educated parents have the ability to provide more educational enrichment opportunities for their children so they can perform better. *Bachelor* and *High School* continue to have positive effects on section scores and are significant at the 1% level. For Math, however, *Bachelor* has a smaller effect by magnitude than *High School*. This is perhaps because the SAT does not test math knowledge past Algebra II. Knowledge of higher-level math is unnecessary for success on the Math section. Notably, for Writing, the positive effect of *Bachelor* is over twice that of *High School*. This is likely because higher education helps hone writing skills.

iv. Non-English Speakers (ESL, LEP)

I initially hypothesized that Hispanic and Asian populations have a negative effect on the verbal sections of the SAT, and thereby on mean SAT scores, as these two groups are more inclined to be non-native residents and non-native English speakers. The percentage of foreign-born residents and the percentage of non-English speaking homes proxy limited English proficiency (LEP/ESL) students. Before analyzing the effect of non-English speakers on SAT scores, it is worth considering the correlation between demographics and non-native English speakers (Table 4). It is intuitive that more non-English speaking homes are positively correlated with more foreign-born residents. Regression (2) shows that Asian and Hispanic households are more likely to be non-English speaking, which is also intuitive.

Table 4: Effect of Demographics on Foreign Born and Non-English Speaking Homes

	(1) Foreign Born		*(2) Non-English*	
	Coeff	SE	Coeff	SE
Non-English	.616***	.022		
White	-.017	.016	-.057***	.015
Black	-.023	.016	-.051***	.015
Asian	.369***	.037	1.21***	.025
American Indian	-.008	.016	-.034**	.016
Hispanic	.017	.018	.834***	.009
Pacific Islander	-.668***	.083	-.288***	.089
Constant	2.44	1.64	6.64***	1.58
Adj. R^2	.9523		.9422	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

Interestingly, my initial hypothesis was proven partially incorrect. In fact, *Foreign Born* has nearly ten-point positive effect on SAT scores (Table 2). The *Foreign Born* coefficient is significant. This variable captures the fact that some students are first-generation residents; that is, their parents immigrated to the United States and likely still retain their native language at home. Their children, who are students in North Carolina schools, are typically proficient in English and likely bilingual.

Perhaps unsurprisingly, *Non-English* has a negative effect on SAT scores. More intriguing are the section results. While *Non-English* has a negative impact on Math and Writing, there is a slightly positive effect on Critical Reading, although the variable is insignificant. While Asian and Hispanic homes are more likely to be foreign-born and non-English speaking, *Hispanic* has a more negative effect on scores. Likely, this is attributable to the different socioeconomic classes of Asians and Hispanics; that is, Asians are typically foreign born and well educated, whereas Hispanics typically come from more modest backgrounds. Most notably, *Foreign Born* has a positive effect on SAT scores that is nearly three times the negative effect of *Non-English*. Selection effects likely drive these results. That is, the influx of highly motivated and highly educated immigrants to North Carolina is indirectly responsible for the positive effect of *Foreign Born* on test scores.

v. Wealth

The correlationality between income and academic performance is debated, yet exists, according to research by Helen Ladd. On average, students from disadvantaged households perform worse than those from advantaged households. A simple bivariate regression of state test scores and state poverty rates indicates that 40 percent of the variation in readings scores and 46 percent of the variation in math scores is associated with variation across states in child poverty rates. The addition of one other explanatory variable related to family background- the percent of children who are members of minority groups- increases the explanatory power of the relationship to 50 percent in reading and 51 percent in math. Evidently, family background is highly correlated with student achievement.[16] More recently, the *News & Observer* reported that the achievement gap- the gap between test scores of low-income students and wealthier students- widened in North Carolina more than in any other state over the past few years, according to the Education Equality Index. The index measured achievement gaps at schools in some of the larger cities in the state: Raleigh, Durham Winston-Salem, Greensboro, Fayetteville, and Charlotte. Charlotte had a "large" achievement gap, while the other five had "massive" gaps. The article defines a "massive" achievement gap as students from low-income North Carolina families reaching proficiency at a lower rate than students from other low-income families, on average. A "large" achievement gap is defined as low-income students reaching proficiency at a higher rate than other low-income

[16] Ladd, H. F. (2012), Education and Poverty: Confronting the Evidence. J. Pol. Anal. Manage., 31: 203–227. doi: 10.1002/pam.21615

students, but at a lower rate than other students. Evidently, this index highlights the challenges faced by schools with many highly impoverished students.[17]

To examine the effect of wealth on SAT scores, *Median Income*, *Per Capita,* and *Homeownership* are used to proxy wealth. Then, the level of poverty *(Poverty)* in the LEA was taken into consideration. Furthermore, *Federal, State,* and *Local* were introduced to account for the amount of per-pupil funding received from those three sources. I hypothesized wealthier LEAs would have more resources available to aid students, thus producing higher SAT scores. If the proxies for wealth have a positive relationship for scores, this could indicate that the SAT is more of an achievement test (students can study to improve their scores) versus an aptitude test (students cannot study for it beyond learning the rules).

a. Income

According to Table 2, *Median Income* has a slightly negative relationship with scores. Conversely, *Per Capita* has a slight positive effect on scores. Neither variable is significant at the 10% level, likely due to the small sample size of 115 LEAs. The differing effects of *Median Income* and *Per Capita* indicate the pattern alluded to in the **Population** section. That is, many areas have high-skilled workers in high-paying jobs coexisting alongside low-skilled workers in low-paying jobs. Median income does not indicate much about the dispersal of wealth, whereas per capita income might be less biased since it is more of an average. This could explain why *Median Income* has a negative impact on scores, especially on verbal sections; perhaps it encapsulates the lower-income, low English proficiency group. Thus, *Per Capita* is likely a more representative picture of the relative wealth of a particular district. However, it is insufficient to say that "wealthiness" impacts performance, since wealth does not mean that poverty does not exist. Specifically, it is evident that districts with higher per capita incomes have higher scores. These findings bolster Ladd's conclusion that family background is correlated with student achievement.[18] Perhaps this also indicates the SAT is not as much of an "aptitude" test after all, if proxies for wealth have positive relationships with scores. This could mean that advantaged students are able to prepare more for the test through tutoring and preparatory courses, as well as pay the $52.50 fee to take the SAT multiple times to improve upon their scores.

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[17] Bonner, Lynn. Achievement gap widened in NC more than any other state, according to index. *The News & Observer.* 24 Mar. 2016. Web. http://www.newsobserver.com/news/politics-government/politics-columns-blogs/under-the-dome/article68010477.html

[18] Ladd, H. F. (2012), Education and Poverty: Confronting the Evidence. J. Pol. Anal. Manage., 31: 203–227. doi: 10.1002/pam.21615

b. Funding

The impact of funding on district performance is a long-contested issue. Table 5 below describes the relationship between a district's relative wealth and the amount of per-pupil funding received from federal, state, and local sources, with *Median Income* and *Per Capita* as proxies for wealth. All funding variables (*Federal, State*, and *Local*) are significant at the 1% level. Apparently, "wealthier" LEAs (those with higher median and per capita incomes) receive less federal and state funding than "poorer" LEAs. It makes intuitive sense that *Local* has a positive relationship with SAT scores, as wealthier LEAs are able to fund their schools more from local sources.

Table 5: Wealth Effects on Funding

	(1) Median Income		*(2) Per Capita*	
	Coefficient	SE	Coefficient	SE
Federal	-7.28***	.599	-2.46**	.253
State	-.917***	.213	-.811***	.078
Local	4.47***	.314	3.41***	.148
Constant	47707.47***	1552.71	23882.81***	526.51
Adj. R^2	.4665		.6156	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

However, in Table 2, *Local* and *Federal* have negative coefficients for SAT and section scores, while *State* has positive coefficients. Only *Federal* is significant at the 1% level. The negative coefficient on *Federal* indicates that districts with more federal funding (i.e., poorer districts) have lower SAT scores. However, the coefficients on *Local* and *State* indicate the opposite- that wealthier LEAs have worse performances. Perhaps another variable- wealth proxy or otherwise- is interacting with *Local* and *State* to make them behave differently than expected.

c. Poverty

Table 2 shows a nearly one-point positive effect on SAT scores with every one percent increase in poverty levels, indicating that more poverty is related to higher scores. However, *Poverty* is insignificant at the 10% level. This is interesting because Table 6 indicates *Poverty* is most affected by black, American Indian, and Hispanic populations, which have a negative effect on SAT scores. Perhaps *Poverty* is interacting with another variable- wealth proxy or otherwise- to bias it upward.

Table 6: Demographic Effects on Wealth Variables

	(1) Median Income		*(2) Poverty*	
	Coefficient	SE	Coefficient	SE
White	1143.73***	94.95	-.620***	.058
Black	1021.56***	95.06	.457***	.057
Asian	3421.65***	157.82	-.964***	.136
American Indian	670.07***	103.2	.170***	.062
Hispanic	70.94	51.26	.133***	.037
Pacific Islander	3277.13***	974.5	-2.43***	.631
Constant	-78223.8***	9579.26	81.89***	5.91
Adj. R^2	.4569		.4604	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

A possible explanation for the odd coefficients is that North Carolina provides supplemental "Low Wealth" funding to LEAs with high concentrations of poverty There are 79 "Low Wealth" LEAs in North Carolina as of 2014, out of 115 total LEAs.[19] In short, poorer LEAs get additional funding from the state, which may bias the *State* coefficient upward. Again, it is worth noting that poverty is not perfectly correlated with wealth, and that while Table 6 ignores other important variables, race variables do pick up some important omitted variables.

d. Homeownership

I initially hypothesized that higher homeownership rates indicate greater wealth, and therefore should be positively correlated with SAT scores. However, Table 2 indicates that LEAs with higher levels of homeownership score lower on the SAT.[20] It is intuitive that larger LEAs have lower homeownership rates due to the prevalence of housing rentals and apartment-style living. The influx of professionals, migrant workers, and their families leads to relatively high housing turnover in high-density areas like Charlotte, the Triangle, and the Triad (which also happen to be the highest-achieving areas in the state). On the other hand, high homeownership rates tend to accompany smaller, more rural areas with mediocre schools. While smaller LEAs tend to have higher homeownership rates, they also are more likely to qualify for supplementary "Small LEA" funding.[21]

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[19] Matteson, Brian. Funding North Carolina's Public Schools. Fiscal Research Division. 3 Mar. 2015. http://www.ncleg.net/documentsites/committees/JointAppropriationsEducation/2015%20Session/03_03_2015%20Meeting/FRD_PubSchoolAllotment_2015_03_03.pdf

[20] The effect may be different at the school level within an LEA, but homeownership data was only available at the district level for this analysis.

[21] Matteson, Brian. Funding North Carolina's Public Schools. Fiscal Research Division. 3 Mar. 2015. http://www.ncleg.net/documentsites/committees/JointAppropriationsEducation/2015%20Session/03_03_2015%20Meeting/FRD_PubSchoolAllotment_2015_03_03.pdf

Evidently, homeownership is a proxy for lower levels of wealth, yet the effect may be slightly biased due to the additional funding that smaller LEAs receive.

The **Wealth** section results seem to indicate that wealth alone is not the best factor to consider. A confounding effect might also be that lower income areas may have more students who do not plan on going to college and therefore do not take the SAT anyway.

vi. Classroom Ability

Advanced Placement (AP) and International Baccalaureate (IB) classes are college preparatory classes. Students are eligible for college course credit depending on their final examination scores. As such, these classes are more rigorous than standard high school classes and are taken with college in mind. It makes sense for these college-oriented students to take the SAT (and it is in their best interest to perform well). In Table 2, *Percent AP/IB* has a positive coefficient, except for Math. It is intuitive that students enrolled in AP/IB courses have a positive effect on SAT scores. *Percent Career* has a negative coefficient for all scores. Students enrolled in courses such as carpentry, automotive, and culinary arts are likely preparing for jobs in those respective vocations. The SAT (and a four-year university) may not be their plan. In any case, most vocational/technical schools do not require SAT scores for admission. The effects of *Percent AP/IB* and *Percent Career* are not as large (nor as significant) as I hypothesized, perhaps due to the small sample size of 115 LEAs.

Most students take the SAT after they complete Algebra II and sufficient English classes. Most meet this requirement by their third year in high school, if not before. I hypothesized that smaller student-teacher ratios would lead to higher test scores. However, the effect of class sizes on SAT scores is ambiguous. *English Size* has a positive effect on SAT and Critical Reading, yet a slight negative effect on Writing. This discrepancy is intriguing. A reason for this might be that English grammar, as it is tested on the SAT, is taught during different years in different schools, depending on specific curricula requirements. Therefore, some students might not receive proper English grammar lessons until after they have taken the SAT. Perhaps this lack of mastery is responsible for the negative effect on Writing, not Critical Reading. Conversely, *Math Size* has a negative coefficient for SAT and Math. It is odd that larger English classes have a positive effect on scores, whereas larger math classes have a negative effect on scores. It is possible that instruction methods differ for these subjects and is a confounding (or contributing) factor. Both *English Size* and *Math Size* are insignificant, hence the ambiguity. Ultimately, it may be that English I and Algebra I were not the right classes to analyze. Perhaps I should have looked at classes taken generally during the third year.

B. School Level Results

The characteristics of 493 public schools were collected with the resources of the North Carolina Education Research Data Center (NCERDC). Most of the data is complete; however, there are some exceptions that will be noted as such.

Table 7: School Characteristics on Cumulative and Section SAT Scores

	(1) SAT		*(2)Math*		*(3)Writing*		*(4)Critical Reading*	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
AIG	2.20***	.275	1.18***	.185	1.19***	.193	1.19***	.192
P_American Indian	-1.24	.985	-.784	1.98	-.976	1.84	-2.25	1.93
P_Asian	2.77**	1.33	1.49	1.92	.142	1.77	-.182	1.93
Daily Attendance	2.05	1.50	1.75*	.978	.523	1.04	.678	.992
P_Black	-1.05	.991	-.142	1.89	-.526	1.76	-1.31	1.90
Dropout	-.053	.049	-.042***	.011	-.051***	.01	-.005	.01
EC	-2.27	1.52	.532	.641	-1.00*	.539	-.898*	.538
Percent AP/IB	1.20***	.345	-.326	.411	.208	.288	.214	.306
Percent Career	-.702	.593	.18	.34	-.558	.349	-.473	.348
ESL	2.72*	1.51	-.938***	.824	-.411	.787	-1.44	.876
FRL	-.048	.189	.047	.087	-.006	.078	.041	.074
Graduation	.382	.304	.763**	.292	.073	.273	.155	.257
P_Hispanic	-1.16	1.21	.918	1.94	.099	1.81	-.143	1.97
Class Internet	.598	.413	-.015	.13	-.043	.132	-.062	.138
Poverty_Sch	-.931***	.223	-.376***	.143	-.689***	.124	-.505***	.122
SAT Participation	-.281	.177						
Special	1.12	1.62	-.61	.567	.855*	.512	.794	.554
Teacher	.553*	.333	.827***	.228	.343	.214	.401*	.228
P_White	.406	.957	.542	1.89	-.084	1.75	-.802	1.89
Crime	.893	2.41	.305	1.51	-.593	1.31	.066	1.35
Instruct	.613	3.46	1.47	1.25	.546	1.05	.150	1.17
Computer Member	.032***	.005	.012***	.003	.008**	.003	.008**	.003
Constant	679.78***	184.90	192.63	216.62	426.49**	204.13	486.82**	215.48
Adj. R^2	.7916		.7565		.7510		.7378	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

i. Population

Member and *SAT Participation* were included to discern the impact a school's size has on SAT results. An increase in *SAT Participation* leads to a slight decrease in SAT scores, but the effect is insignificant. However, *Member* has a positive effect on scores, significant at the 1% and 5% levels. This indicates that larger schools perform better on the SAT. While these findings are seemingly in direct opposition, it is worth nothing that they are slightly different measures of size. *SAT Participation* focuses on the specific subset of students taking the SAT, whereas *Member* looks at the entire student body. Arguably, *SAT Participation* is already downward biased because test-takers are typically upperclassmen (more specifically, third year high school students), making the potential test-taker population already a fraction of the size of the student body population. Furthermore, of the potential test-takers, only a particular subset of those eligible students takes the SAT. This downward bias could contribute to the negative relationship between *SAT Participation* and scores.

ii. Demographics

Table 7 indicates that black, Hispanic, and American Indian students have a negative relationship with SAT scores. *P_Multiracial* and *P_Pacific* were omitted due to their small populations and to avoid multicollinearity. *P_American Indian* has the largest negative impact on the SAT, but only slightly (*P_American Indian*: -1.24, *P_Hispanic:* -1.16, *P_Black*: -1.05). These findings part from the 2014 SAT Report, which indicates that black students have the lowest scores, followed by American Indians and Hispanics. Interestingly, *P_Hispanic* has a positive relationship with Math and Writing scores, although it is insignificant. It is interesting that *P_Hispanic* has a positive effect on Writing scores, especially due to the prevalence of limited English proficiency. Further investigation could clarify this effect, but perhaps this relationship does indicate what the 2014 SAT Report found and some other variable is just masking the effect. *P_Asian* and *P_White* have a positive relationship with scores, with the exception of Critical Reading; however, every race variable has a negative impact on Critical Reading and none are significant. Interestingly, all race variables at the school level are insignificant for all four scores, except for *P_Asian* on SAT. Perhaps the lack of significance indicates this school analysis is too granular. Regardless, the general point is that black, Hispanic, and American Indian students have a negative impact on scores, while white and Asian students have a typically positive impact on scores.

iii. Non-English Speakers

At the school level, the effect of students with limited English proficiency *(ESL)* on SAT scores is positive. A one-percent increase in *ESL* has a nearly three-point positive effect on SAT scores, significant at the 10% level. The effect of *ESL* is negative at the section level (Math: -.938, Writing: -.411, Critical Reading: -1.44). It seems contradictory for *ESL* to have a positive effect on cumulative scores and a negative effect on section scores, which are combined for the cumulative score. Perhaps the exclusion of *SAT Participation* in the section regressions is responsible. I re-ran the SAT regression, dropping *SAT Participation.* The *ESL* coefficient fell slightly from 2.72 to 2.53 and remained significant at the 1% level. Evidently, the negative effect of *SAT Participation* is picked up by the *ESL* term, which is then biased downward. Regardless, the adjusted R-squared is higher with *SAT Participation,* so it was kept.

Moreover, district findings indicated that non-English speakers (*Non-English, Foreign Born)* have a negative effect on SAT and verbal scores. The counterintuitive *ESL* results at the school level likely pick up that, on average, a Hispanic ESL student is different from an Asian ESL student. These two groups have higher incidences of English as their second language, yet the difference in effects is likely due to differences in socioeconomic status. Hispanic students are more likely to be impoverished and come from less-educated backgrounds. Asian students tend to have foreign-born, well-educated parents and have higher levels of economic security. Therefore, it is likely the combination and convergence of these socioeconomic factors responsible for this ambiguity.

iv. Wealth

Results at the LEA level indicated that districts with higher per capita incomes perform better than poorer districts. However, higher poverty rates were also correlated with higher scores at the LEA level, leading me to believe that wealth measures might not be as helpful as hypothesized. A closer look at the school level helps to clarify the salience of wealth and poverty for this analysis.

a. FRL

In 2013, a three-person household earning under $35,317 a year was eligible for reduced price lunch.[22] Students receiving free/reduced lunch (*FRL*) proxy the relative wealth of a school. Although *FRL* is insignificant, its coefficient is negative for SAT, indicating that the relative wealth of a school has a negative impact on SAT scores. Section scores are more ambiguous. The

[22] http://www.washingtonexaminer.com/charter-schools-closing-the-gap-between-rich-and-poor-students/article/2586774

coefficient is also negative for Writing, yet positive for Math and Critical Reading. It is fascinating that *FRL* does not have the same effect across Critical Reading and Writing, as these sections test similar concepts. Perhaps another variable, such as race, is interacting with *FRL* to make its effect more ambiguous. Higher levels of poverty (and hence, FRL) accompany minority populations, which could complicate the effect, especially on section scores.

b. Poverty

Poverty_Sch is the most granular variable for measuring poverty in this analysis. Unlike earlier findings at the LEA level, *Poverty_Sch* has a negative coefficient, significant at the 1% level. It is clear that more impoverished students in a school have a negative impact on SAT scores. This gives merit to the idea that a student's academic development is shaped more by his socioeconomic status- the culmination of background, wealth, race, and opportunities- which influences much of his life experiences and environment, rather than simply wealth alone. Moreover, an advantaged student's background allows him/her more experiences and resources that can be used to excel in school and on tests.

v. Classroom Ability

At the district level, it is evident that more college-oriented students have a positive effect on SAT scores. At the school level, I hypothesized these proxies for high-achieving students (variables such as *Percent AP/IB* and *AIG)* would have a positive effect on scores. As aforementioned, AP and IB courses are more rigorous than standard high school classes. Moreover, students identified as Academically or Intellectually Gifted (*AIG*) perform at "substantially high levels of accomplishment when compared with others of their age, experience, or environment."[23] *Percent AP/IB* has a positive effect on SAT and verbal scores, yet a slightly negative effect on Math scores. *AIG* has a positive effect on scores and is significant at the 1% level, which makes intuitive sense. These are good indicators that students enrolled in more rigorous classes (who are more likely to take the SAT, generally speaking) have a positive effect on scores.

On the other hand, I hypothesized that variables for challenged or disabled students (*EC, Special)* and for vocational students (*Percent Career)* would have a negative effect on scores. An Exceptional Child (*EC)* has severe cognitive, learning, or behavioral disabilities. While unlikely that EC students take the SAT, the effect could be monetary; that is, more EC students require more funding, which could affect other aspects of a school. Students with a special need (*Special)* could

[23] http://www.ncpublicschools.org/docs/academicservices/gifted/ncaig-program-standards.pdf

have anything from a mild learning disability to needing larger font on tests, and therefore are not excluded from the test-taking population. *EC* has a negative effect on all scores except for Math, while *Special* has a positive effect on all scores except for Math. The variables are significant. It makes sense that *Special* has a less negative effect on scores than *EC* due to the severity of the disability. Finally, *Percent Career* has a negative effect on all scores except for Math and is not significant. Again, this is likely because these students are pursuing careers in their vocation, rather than taking a standardized test for college admission. It is fascinating that the Math effect is typically unique from the others throughout this analysis. This is likely because quantitative thinking requires a different part of the brain, and instruction styles might be different.

vi. Classroom Environment

Measures of teacher and classroom quality are important factors that indirectly affect SAT scores. *Teacher* has a positive and significant relationship with all scores. Granted, *Teacher* is not a perfect measure of teacher "quality" and simply because a teacher is fully licensed and has more education does not strictly mean that s/he will convey concepts to students better. Moreover, it does not mean that their students will always perform better. However, *Teacher* indicates there is some relationship between teachers and student performance.

Daily Attendance is intended to proxy the level of student commitment to his/her high school education, as well as the level of parent commitment to his/her child's high school education. As hypothesized, *Daily Attendance* has a positive correlation with all scores, but is only significant for Math. *Crime,* interestingly, has a slight positive relationship with scores- except for Writing. Perhaps it is interacting with another variable- such as school size- to get the positive coefficient. *Instruct Computer* and *Class Internet*, other indicators of school quality, have positive relationships with SAT scores, but are not significant. These days, computer technology and access to the Internet is paramount to success in the classroom and in society.

Graduation has a positive effect on scores, while *Dropout* has a negative effect. It is intuitive that they have opposite effects. While obliquely related to test scores, these measures proxy school achievement and capture the attitudes of students toward reaching the high school graduation milestone. Naturally, some high school graduates will go on to college, and will thus have taken the SAT at some point in their high school careers. It makes sense that more students taking the test with hopes of college admissions could be related with higher scores. Ultimately, it is clear that meaningful relationships can be drawn between the learning environment quality and SAT scores.

C. Charter School Results

Charter schools are public schools that receive public funding and do not charge tuition. Charter schools typically have more autonomy in their curricula and operations than traditional public schools. Contrary to popular belief, charter schools have to accept all students who wish to attend. Recent data show that racial minorities and low-income families are taking advantage of charter schools.[24] Today, 37 percent of nationwide charter schools serve majority white student populations, down from 50 percent in 2000. The National Center for Education Statistics found that charter schools serve black and Hispanic students at higher rates than traditional public schools in 2015.[25] Nationwide, currently one in four charter schools has a majority black student population and another one in four has a majority Hispanic student population. By contrast, nine percent of traditional publics schools have majority black student populations and 15 percent have majority Hispanic populations. Ladd and Bifulco indicate that North Carolina charter schools have increased the racial isolation of black and white students and widened the achievement gap between the two groups. Combined with the asymmetric preferences of black and white charter school students, this means there are few racially balanced charter schools in the state.[26] That is, the segregating choices of advantaged students outweigh the integrating choices of disadvantaged students.[27]

Data was collected for only 32 of the 47 charter schools in North Carolina that serve high school students (as of March 17, 2016)[28] from the American Community Survey and the North Carolina Report Card. Table 8 reflects the macro characteristics of charter schools. Unfortunately, data was too incomplete to produce meaningful results at the school level for charter schools. With additional time and data, more can be done to specifically identify which characteristics of charter schools are integral in either helping or hindering SAT score performance.

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[24] http://www.washingtonexaminer.com/charters-serve-minorities-poor-students-at-higher-rates-than-public-schools/article/2565171

[25] http://www.washingtonexaminer.com/charters-serve-minorities-poor-students-at-higher-rates-than-public-schools/article/2565171

[26] Bifulco, Robert and Helen Ladd. School choice, racial segregation, and test-score gaps: Evidence from North Carolina's charter school program

[27] Bifulco, Robert, Helen Ladd, and Stephen Ross. Public school choice and integration evidence from Durham, NC. *Social Science Research*, 2008.

[28] http://www.ncpublicschools.org/charterschools/schools/

Table 8: Macro Characteristics of Charter Schools

	(1) SAT		*(2) Math*		*(3) Writing*		*(4) Critical Reading*	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
White	-1.59	2.22	-.872	.776	-.712	.878	-.013	.829
Black	-2.261	2.39	-1.33	.833	-.886	.946	-.396	.894
American Indian	-24.40***	6.53	-13.62***	1.95	-4.26	2.89	-6.54	2.51
Asian	23.04	14.77	18.84***	4.01	-.069	6.43	4.23	5.94
Hispanic	20.25***	4.54	6.94***	1.67	7.46***	1.87	5.88	1.69
Pacific Islander	-55.94	66.44	-53.35**	22.43	20.01	27.92	-22.1	25.4
SAT Participation	-.754*	.442	-.335***	.077	-.135	.218	-.284	.184
Population	.00002	.00002	.00001*	.000006	.00002*	.000008	.00001**	.000007
Foreign Born	-7.55	12.18	-8.51**	3.75	2.86	5.21	-1.93	4.77
Non-English	-18.13*	11.11	-.615	3.83	-11.74**	4.60	-6.01	4.24
High School	13.62***	2.80	7.62***	1.03	2.24*	1.17	3.76	1.04
Bachelor	2.18	1.78	-1.11*	.669	2.03***	.714	1.28	.669
Homeownership	-1.16	1.58	-.137	.514	-.477	.642	-.546	.602
Per Capita	-.008***	.002	-.004***	.0006	-.002	.0009	-.003	.0008
Median Income	.0025*	.0014	.001***	.0004	.0007	.0006	.0006	.0006
Poverty	1.30	2.66	1.05	.705	.324	1.17	-.064	1.05
English Size	.182	.962	-.198	.363	.065	.366	.315	.375
Math Size	.082	1.20	.643*	.367	-.382	.407	-.180	.54
Percent AP/IB	3.59**	1.63	-.023	.443	1.91***	.720	1.70	.647
Percent Career	-2.52**	1.17	-1.69***	.362	-.220	.541	-.602	.462
Local	-.019***	.006	-.014***	.002	-.004	.003	-.001	.002
State	-.004	.009	-.004	.003	-.004	.004	-.004	.004
Federal	-.054***	.009	-.012***	.002	-.025***	.004	-.017	.003
Constant	768.82**	367.37	64.59	122.18	412.15***	139.98	292.87	142.60
Adj. R^2	.9619		.9620		.9420		.9512	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

i. Population

Population has a slightly positive effect on scores. This is similar to the findings for *Population* at the district level and *Member* at the school level, which indicate that larger districts and larger schools perform better. Conversely, *SAT Participation* has a slightly negative effect on SAT scores. While *SAT Participation* is not a perfect proxy for the size of the charter school, this is what I am more interested in, anyway.

ii. Demographics

The effects of demographics move in the same ways as before, except *White* has a negative effect and *Hispanic* has a positive effect on SAT scores. Moreover, *American Indian, Asian, Hispanic*, and *Pacific Islander* have large absolute effects. These results are likely due to the small sample size of 32 charter schools, compounded with the fact that these four demographic groups have a small presence in charter schools.[29]

iii. Parental Education

High School has a nearly 14-point positive effect on SAT scores and a nearly 7-point positive effect on Math, as well. These effects are larger than the positive effects of *Bachelor, which* only has a 2-point positive effect. While counterintuitive, perhaps this relationship captures the fact that highly educated parents may opt to send their children to private schools, which are not included in this analysis. This relationship is more noticeable at the charter school level due to its small population, as compared to traditional public schools.

iv. Non-English Speakers

Foreign Born and *Non-English* are used to represent non-English speaking students. Interestingly, *Foreign Born* only has a positive effect on Writing but is negative otherwise. *Non-English* has a negative effect on all scores. While the ambiguity for *Foreign Born* could be once more picking up on the differences between an ESL Asian and an ESL Hispanic, overall, these findings indicate that non-English speaking students have a negative effect on scores. More complete data on students with limited English proficiency in charter schools could clarify these results.

v. Wealth

a. Income

Per Capita and *Median Income* have directionally opposite effects at the charter school level than they did at the district level. In charter schools, *Per Capita* has a negative effect on scores and *Median Income* has a positive effect on scores. As noted earlier, *Per Capita* is likely a more comprehensive measure of the wealth of a school or school district than *Median Income.* Perhaps this relationship again captures the idea that wealthier families may opt out of charter school or even traditional public school options, sending their children to private schools instead.

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[29] The range of these racial/ethnic groups are: American Indian, 0.3-4 percent, Asian 3-7.7 percent, Hispanic: 2-13.4 percent, Pacific Islander: 0-0.03 percent. It is evident that these four groups together rarely make up more than 25 percent of the student body at the charter school level.

b. Funding

Charter schools are treated like public schools, in terms of funding; that is, they are funded according to student enrollment. However, the Center for Education Reform found that, nationwide, charter schools receive 64 percent of the funding of traditional public schools ($7,131 per pupil at charter schools versus $11,184 per pupil at traditional public schools).[30] Table 8 indicates that more per-pupil funding at all levels leads to lower scores. As the National Center for Education Statistics found that charter schools are attracting more lower-socioeconomic status students, funding could be confounding with increased poverty levels for a negative effect.

c. Poverty

Nearly 60 percent of charter schools have a majority of students receiving free/reduced lunch. This figure is just under 50 percent for traditional public schools.[31] Thus, it is evident that charter schools serve low-income students at a higher rate than traditional public schools.[32] Interestingly, *Poverty* has a positive relationship with all scores, except for Critical Reading. The variable is not significant at the 10% level. If higher levels of poverty and minority students do in fact accompany charter schools, then the positive effect is interesting and requires further investigation, as it contradicts earlier assumptions that socioeconomically advantaged students perform better on the SAT. Perhaps this relationship also indicates that supplemental funding for impoverished schools does not have the desired effect.

vi. Classroom Ability

Students in AP/IB courses have a positive effect on scores and students in vocational courses have a negative effect on scores. Again, Math has an opposite result that is likely due to the unique quantitative nature of the subject. *Percent AP/IB* has a greater positive effect (nearly four points on the SAT) than the negative effect of *Percent Career* (nearly three points on the SAT). These

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[30] https://www.edreform.com/2012/03/just-the-faqs-charter-schools/
[31] http://www.washingtonexaminer.com/charter-schools-closing-the-gap-between-rich-and-poor-students/article/2586774
[32] http://www.washingtonexaminer.com/charters-serve-minorities-poor-students-at-higher-rates-than-public-schools/article/2565171

intriguing results reinforce the idea that higher-achieving (or at least, college-oriented) students (those enrolled in AP/IB courses) have a positive effect on SAT scores.

vii. Classroom Environment

Larger class sizes have a positive effect on SAT scores and respective SAT section(s) at the charter school level, unlike at the district level. Specifically, *English Size* has a positive effect on SAT, Writing, and Critical Reading scores. *Math Size* has a positive effect on SAT and Math scores. However, not all variables are significant. This is intriguing, as I originally hypothesized lower student-teacher ratios would have a positive effect on scores. Perhaps class sizes tend to be smaller at the charter school than in traditional public schools, so the effect is biased.

V. Principal Component Analysis

A. District

At the district level, the response variable is measured along 21 dimensions. To deal with the problem of multidimensionality of the data, principal component analysis (PCA) in STATA is employed to identify patterns in order to reduce the dimension of the data while keeping information intact. The objective is to derive a subspace of data with less than 21 dimensions that represent the data well. To do this, we need to compute eigenvectors (the components), which are associated with their eigenvalues, which represent the length and magnitude of the eigenvectors. The higher eigenvalues contain more information about data distribution and will subsequently be the candidates for forming the subspace. The procedure for conducting PCA includes detecting the highest correlation between the co-variables and then calculating eigenvalues based on the correlation matrix.

Correlations among response variables confirm the relationships posited above. It is interesting to see how demographics interact with poverty, education levels, and classroom quality variables. The first six components have eigenvalues greater than one. The first component explains 31 percent of variation in the data and the second explains 17 percent. Cumulatively, the first six components explain 74.9 percent of the variation in the data. We choose to only keep components with eigenvalues above one. See Appendix for STATA readings.

Table 9: Principal Components, LEA
Rotation: (unrotated = principal)
(blanks are abs (loading) < 0.3)

Variable	**Comp1**	**Comp2**	**Comp3**	**Comp4**	**Comp5**	**Comp6**
White		-.3844		.3607		
Black		.3219		-.3681	.3370	
American Indian					-.3518	
Asian	.3017					
Hispanic		.3191	-.3520	.3237		
Pacific						-.7288
Local			.3555			
State						
Federal						
English Size			-.3251			.4528
Math Size			-.4028	-.3328		
Percent AP/IB						
Percent Career					.3116	
Population						
Poverty		.3289				
Homeownership		-.3905				
High School						
Bachelor	.3410					
Median Income	.3166				.3004	
Foreign Born		.3054				
Non-English		.3384				

Component 1 represents the highly educated, likely foreign born Asians who work in high paying jobs, in places like Research Triangle Park and Cary, denoted as EDU_FOREIGN. Component 2 is an indicator of poverty, especially concerning minorities, indicated by POV. Component 3 is an indicator of classroom quality, CLASS_QUAL. Components 4 and 6 are more ambiguous, but regard demographic effects on math and English classes (MATH and ENG). Component 5 is an indicator of vocational track students, CAREER.

Notice that variables *State, Federal, Percent AP/IB, Population,* and *High School* are not correlated significantly with any of the principal components; that is, the variables are not correlated with any determinants of SAT scores in question. One way to interpret such a result is taking into account the fact that state and federal funding are more correlated with the enrollment and relative wealth of the school and LEA. Furthermore, the population of an LEA should not have much of an

effect on SAT scores, other than the fact that with more observations, the average approaches the true mean. It is interesting that *Percent AP/IB* and *High School* are not correlated with the principal components. *Percent AP/IB* was intended to proxy for college-preparedness, meaning that students who are enrolled in AP/IB classes would be more inclined to take the SAT and perform better on is since they are preparing for college. *High School* is a proxy for parent educational attainment. Perhaps the effect of parents with a high school degree on SAT scores is simply not as strong as that of parents with a Bachelor's degree. Ultimately, it is reasonable that these variables are not highly correlated with the principal components.

Next, the use of the principal component in lieu of the original variable is justified by using the Kaiser-Meyer-Olkin measure of sampling adequacy, which should be above 0.5. In this instance, it is 0.7066.

Table 10: Principal Components Regression, LEA

	(1) SAT		*(2) Math*		*(3) Writing*		*(4) Critical Reading*	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
EDU_FOREIGN	27.81***	.728	9.09	.278	9.14***	.246	9.58***	.241
POV	-21.65***	.961	-7.78	.351	-6.42***	.339	-7.45***	.324
CLASS_QUAL	.140	1.29	-.877	.489	.838*	.441	.180	.450
MATH	15.1***	1.48	5.26	.566	4.62***	.489	5.22***	.528
CAREER	-18.42***	1.90	-5.62	.732	-5.99***	.631	-6.81***	.645
ENG	-4.65**	1.93	-1.90	.731	-1.57**	.668	-1.18**	.618
Constant	1419.46***	1.77	491.12	.662	455.26***	.599	473.08***	.6109
Adj. R2	.7518		.7074		.7299		.7513	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

Table 10 indicates that conclusions drawn from prior analysis are correct. Specifically, high poverty (*POV*) and more students in vocational courses (*CAREER*) have a negative effect on scores. *POV* reinforces the hypothesis that the SAT might be more of an achievement test than a true aptitude test. *ENG* increases with English class size and decreases with Pacific Islander populations. This might indicate that more minority students are more likely to have a negative effect on verbal scores.

EDU_FOREIGN, CLASS_QUAL, and *MATH* have positive effects on scores. The first two components indicate that educated foreigners' children and high classroom quality have positive effects on SAT scores. What is most intriguing is *MATH*. Evidently, this component increases with larger white and Hispanic populations, yet decreases with larger math class sizes and black

populations. This component reinforces the findings of the 2014 SAT Report, which state that Hispanic students perform better on all components of the SAT than black students.

B. School

At the school level, PCA resulted in the reduction of 21 variables to seven major components. The components are: POV2 (for poverty), ABIL (for school ability), MIN (for minority students), ACHIEVE (for measures of achievement), CLASS_MIN (for minority presence at the class level), SCH_ENV (for school environment), and finally CLASS_ENV (for classroom environment). The first component explains 19 percent of variation and the second explains 16 percent. Cumulatively, all seven components explain 71.9 percent of variation.

Table 11: Principal Components, School

Rotation: (unrotated = principal)
(blanks are abs (loading) < 0.3)

Variable	**Comp1**	**Comp2**	**Comp3**	**Comp4**	**Comp5**	**Comp6**	**Comp7**
AIG		.3734					
P_American Indian						.6302	
P_Asian							
Daily Attendance	-.3101						
P_Black			.3004				
Dropout						-.3378	.5160
EC		.4026					
Percent AP/IB				-.3701			
Percent Career			-.3581				-.3097
ESL			.3077		.4331		
FRL							
Graduation		.3919					
P_Hispanic			.3070		.6262		
Class Internet							.3360
Poverty_Sch	.3045						
SAT Participation							
Special		.4033					
Teacher					.3074		
P_White			-.4049				
Crime							.5119
Instruct Computer				.3038		.3956	
Member				.5742			

Notice that variables *P_Asian, FRL,* and *SAT Participation* are not correlated significantly with any of the principal components. This is surprising, yet likely due to the fact that these variables are not significant at the 10% level. I hypothesized that *FRL* would be a good proxy for student

wealth at the school level, so I am intrigued that it was not present in any of the components. Evidently, *Poverty_Sch* is a better proxy for poverty and wealth. Moreover, it is fascinating that *P_Asian* was the only demographic variables not highly correlated with any of the principal components.

The use of the principal component in lieu of the original variable is justified by using the Kaiser-Meyer-Olkin measure of sampling adequacy, which is 0.5412.

Table 12: Principal Components Regression, School~

	(1) SAT	
	Coeff	SE
POV2	-29.91	1.25
ABIL	20.57	1.35
MIN	.887	1.70
ACHIEVE	-.266	1.84
CLASS_MIN	5.96	1.91
SCH_ENV	4.64	2.01
CLASS_ENV	12.78	2.18
Constant	964.62	2.15
Adj. R2	.7500	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*
~ Enough data was only available to regress against SAT scores, not section scores

Poverty (*POV2)* and achievement (*ACHIEVE)* are the only components with negative effects on SAT scores. *POV* is more self-explanatory and reinforces prior findings that socioeconomically advantaged students perform better on the SAT, whereas *ACHIEVE* is slightly more complex. This component increases with the number of students and amount of technology in a school, yet decreases with the percentage of students enrolled in AP/IB classes. This component could pick up on the fact that there is more technology in larger schools, typically as a byproduct of size. Moreover, the percentage of students enrolled in AP/IB classes can decrease with school size. A small population of students enrolls in these upper-level classes anyway, and the effect could simply be magnified in larger schools.

The remaining five components have positive relationships with SAT scores. *ABIL* increases with *AIG, Graduation, Special*, and *EC*, indicating that greater classroom ability- and disability, interestingly- has a positive effect on SAT scores. *MIN* and *CLASS_MIN* captures the effect of minorities- specifically ESL speakers. These components are negatively correlated with white and vocational students and are positively correlated with teacher quality and minority- Hispanic and black- populations. *MIN* specifically calls my attention to the fact that black students could also be

ESL students. In future analyses, this should be taken into account. *SCH_ENV* and *CLASS_ENV* indicate that the environment has a positive effect on SAT scores, although SCH_ENV increases with dropout and crime rates. This could be a byproduct of school size, or these variables could be confounded with another variable.

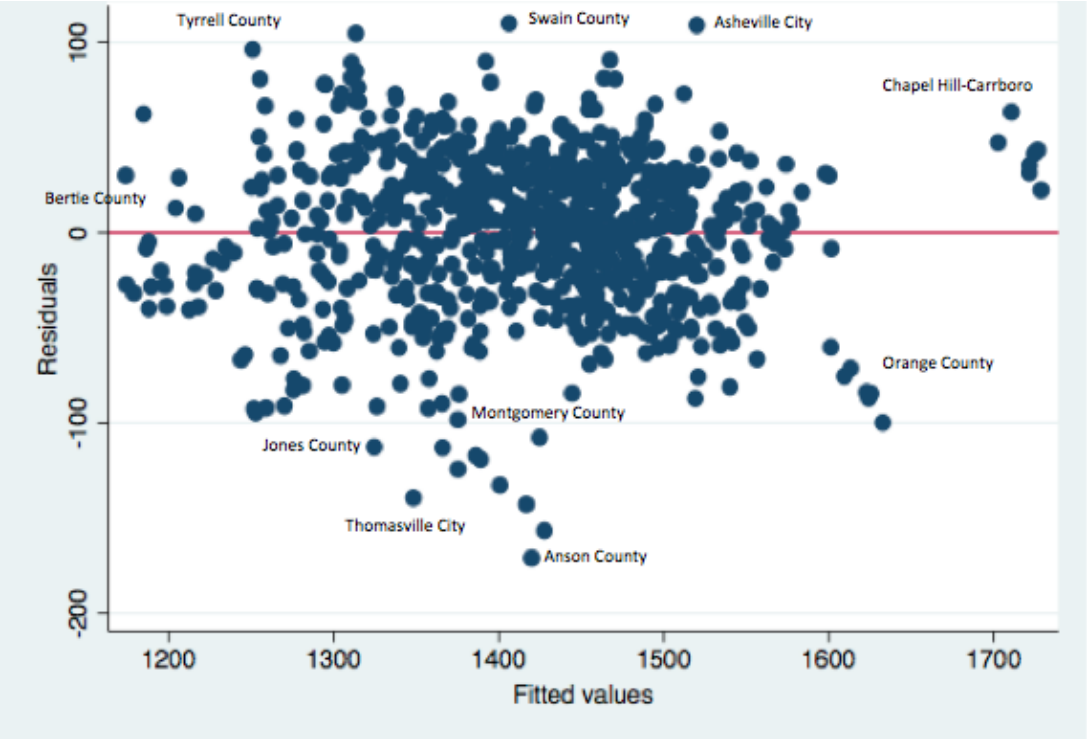
VI. Residual Analysis

In STATA, I created a series of residual-versus-fitted plots to see more clearly which districts and schools over- or under-perform relative to predicted SAT scores. The average SAT score over 2007-2014 is indicated in parentheses.

A. District

As this is an analysis over time, STATA predicted residuals for each district from 2007-2014. Fortunately, data points are relatively clustered for each district, making labeling clear.

Figure 5: District Residuals



<u>Over-Performing LEAs:</u>

On the lower end of the SAT score spectrum is Bertie County (1196), a majority black LEA over-performing by 30 points on average with 23 percent of residents living in poverty. Tyrrell County (1356) over-performs by almost 100 points on average. Nearly 30 percent of Tyrrell residents live in poverty and only 8 percent have Bachelor's degrees. It is 58 percent white and 36

percent black. Swain County (1480), which is 65 percent white and 27 percent American Indian with nearly 20 percent of residents living in poverty, over-performs by nearly 100 points on average. Perhaps unsurprisingly, Chapel Hill-Carrboro City (1761) over-performs consistently by 50 points. It is one of the most highly educated LEAs in the state- of all residents, 95 percent hold high school degrees and 75 percent hold Bachelor's degrees. Nearly 20 percent of residents are foreign-born and have non-English speaking homes.

Apparently, Tyrrell, Swain, and Bertie counties over-perform significantly despite 20-30 percent poverty rates and relatively large proportions of black and American Indian groups. Chapel Hill-Carrboro, a system with a reputation for high SAT scores, still over-performs despite its large foreign-born and non-English speaking population. This indicates that socioeconomic status, which is correlated with race, has a large role in determining SAT scores. However, even though Tyrrell, Swain, and Bertie counties have large minority populations and relatively high levels of poverty, they are still over-performing by a larger magnitude than Chapel Hill-Carrboro. This could mean the model over-weights poverty and race, when in actuality they may not mean as much individually.

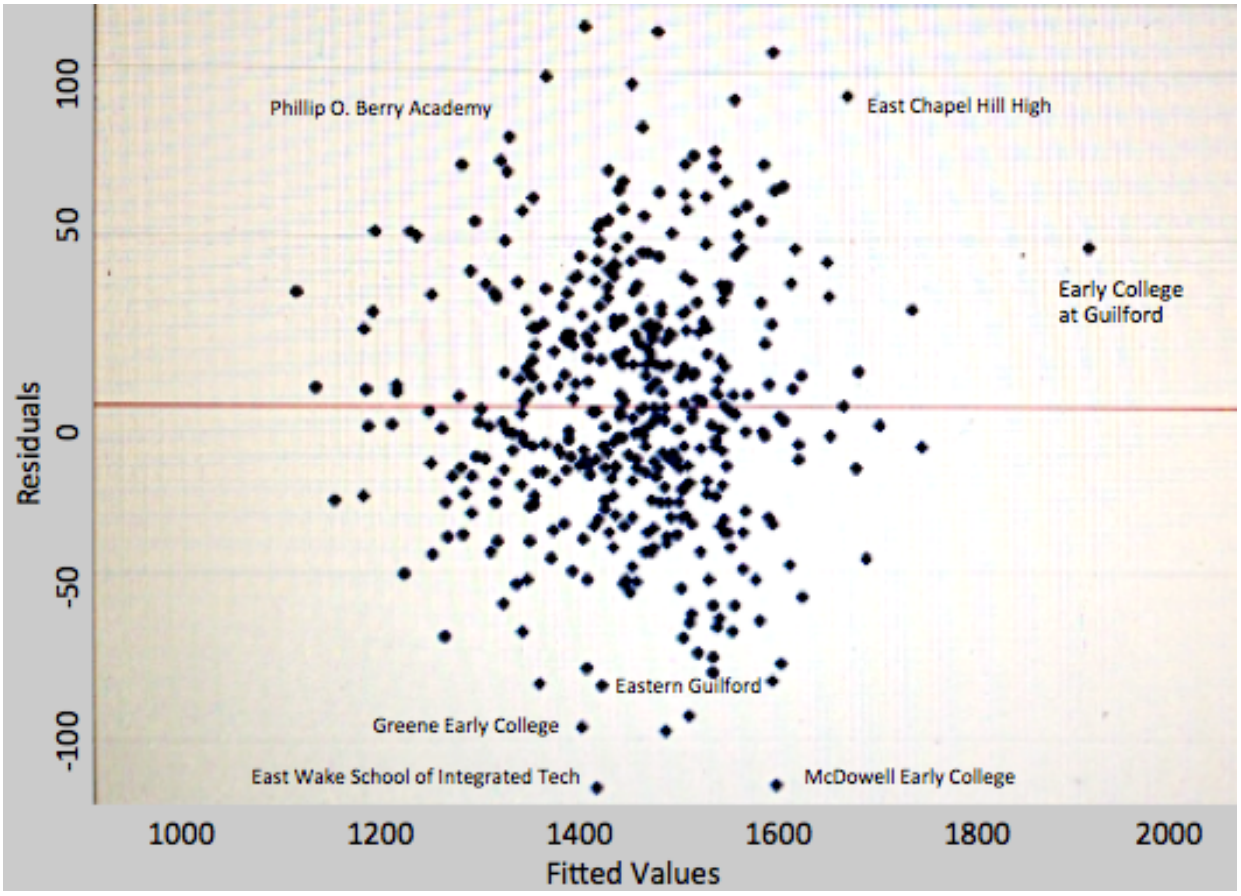
Under-Performing LEAs:

Anson County (1253) posts some of the most under-performing scores in the state. It should average close to 1420. Anson County is 95 percent white with 25 percent of residents living in poverty. Nearly 90 percent of residents do not hold Bachelor's degrees. Evidently, *White* might not have as large a positive effect as predicted. Specifically, Anson County's situation indicates that districts with large black and Hispanic populations should not automatically be cast with a poor reputation, especially since Anson is under-performing by nearly 180 points. Thomasville City (1340) averages at least 130 points lower than its predicted score. Thomasville City has a 25 percent poverty rate and is 70 percent white, with the remaining 30 percent split between black and Hispanic residents. Montgomery County (1293) is nearly 100 points below its predicted value. It is 75 percent white, with the remaining 25 percent split between black and Hispanic. A quarter of residents live in poverty and 15 percent are non-English speaking.

Poverty rates in these under-performing districts are similar to those of the over-performing LEAs. What these under-performers have in common is a large proportion of white students as well as nearly a quarter of residents living in poverty. Although *White* evidently has a positive effect on SAT scores, it is evidently not contributing much to the scores of these under-performing LEAs.

B. School

Figure 6: School Residuals



Over-Performing Schools:

East Chapel Hill High (1776) over-performs by nearly 100 points. East Chapel Hill High has the highest percentage of Asian students in the state (11 percent) and 15 percent of students living in poverty. Nearly 20 percent of students are enrolled in AP/IB courses. East Chapel Hill has a good reputation throughout the state when it comes to academic achievement, so it comes as a bit of a surprise that it is over-achieving on top of already high repute. Early College at Guilford (1989) is 75 percent white, 10 percent Hispanic, and 10 percent black with 6 percent of students living in poverty. It goes without saying that this is a very high average SAT score. Nearly 60 percent of students are enrolled in rigorous AP/IB courses. Finally, Phillip O. Berry Academy (1326) is 80 percent black and 15 percent Hispanic, with 60 percent of students living in poverty. This magnet school for science and technology proudly boasts offerings of more than 40 career/technical education courses, in which nearly 20 percent of students are enrolled. According to its website, the Academy seeks to "prepare students for entrance into competitive four-year universities, two-year community colleges, registered apprenticeship programs as well as high demand, high skill careers in

the private sector.[33] This appears to be a positive, high-energy environment in which students can thrive. Ultimately, these three schools show that learning environment quality is paramount to achievement.

Under-Performing Schools:

East Wake School of Integrated Technology (1290) significantly under-performs by 110 points. It is split between black and white students and 50 percent of students qualify for free/reduced lunch. Of students, over 20 percent are enrolled in career/technical courses. McDowell Early College (1462) also under-performs by 100 points. The student population is a majority white. Of its students, 50 percent receive free/reduced lunch, which indicates a high prevalence of lower socioeconomic status students; therefore, this could be the precipitating factor in these schools' under-performance. It is becoming more evident that socioeconomic status, more so than just demographic makeup or just poverty, affects a school's SAT performance. Greene Early College (1292) also underperforms significantly by 100 points. It is 50 percent Hispanic and 16 percent black with 80 percent of students qualifying for free/reduced lunch. Finally, Eastern Guilford (1303) under-performs by nearly 50 points. Of its students, 60 percent receive free/reduced lunch and most students are black. Less than five percent of students take AP/IB courses. Interestingly, these last two schools have a majority of students receiving free/reduced lunches, but they do not under-perform by as much as the first two schools. Moreover, they have high minority student representation. Evidently, it is more complex than to just attribute under-performance to high minority populations or high levels of impoverished students.

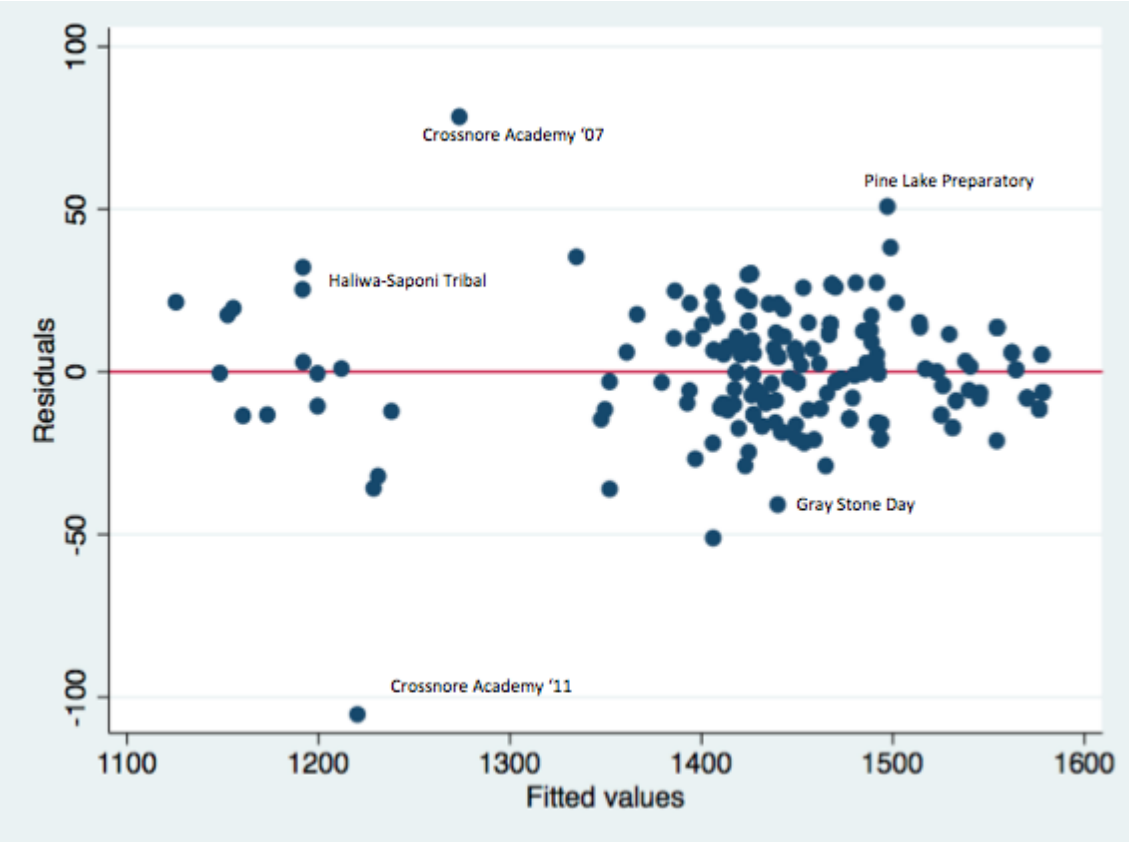
C. Charter School

There were insufficient charter school data for school-level characteristics. Thus, charter school SAT scores were regressed against predicted values based on their respective district characteristics. The residual-versus-fitted plot below shows the predicted average SAT score for each charter school from 2007-2014. Some charter schools have slightly more erratic performances on the SAT than districts and traditional public schools (note Crossnore Academy, below). While charter schools are public schools, they accept students on an application basis and, if the school is in high demand, a lottery system. The implication of this is that the characteristics of a charter

[33] http://www.cms.k12.nc.us/cmsdepartments/ci/MagnetPrograms/MagnetThemes/Pages/PhillipOBerryAcademyofTechnology.aspx

school could vary wildly from year to year. Hence, the years of the SAT average are denoted when applicable.

Figure 7: Charter School Residuals



Over-Performing Charter Schools:

Pine Lake Preparatory (1523) consistently over-performs by 40 points, as indicated by the cluster of points above. The surrounding district is 83 percent white and 12 percent black. Almost a quarter of residents have Bachelor's degrees and 10 percent are non-English speaking. Poverty rates are relatively low for the state, at 13 percent. On the lower end of the spectrum, Haliwa-Saponi Tribal School (1174) largely serves the Haliwa-Saponi Indian Tribe. Before 2009, the school under-performed by 40 points. Since then, it has over-performed by 25 points, on average, as indicated by the cluster of points above. Poverty rates are 28 percent and 11 percent of residents have a Bachelor's degree. Once more, it is clear that demographic makeup is not the ultimate discerning factor when it comes to SAT scores. Whether a charter school serves largely white or American Indian students, it can still over-perform. More can be attributed to the combination and convergence of characteristics such as race, economic background, and education level.

Under-Performing Charter Schools:

In 2007, Crossnore Academy (1211) over-performed by 62 points. However, in 2011, it under-performed by nearly 110 points, and has since under-performed. It is in a district that is 93 percent white. The poverty rate is 18 percent and 20 percent of residents have Bachelor's degrees. Gray Stone Day (1408) has under-performed significantly with increasing magnitude in recent years. Interestingly, fewer than 5 percent of students receive free/reduced lunch and it is a majority white and Asian school. Perhaps its Asian population (typically around 5-10 percent) combined with the fact that it is a small charter school is responsible for its under-performance.

VII. Conclusion

Data at the school and district level reveal similar patterns for determinants of SAT scores. The main insight from this analysis is that socioeconomic status and school environment have the greatest effects on SAT scores. Socioeconomic status accounts for the combination and convergence of factors that describe SAT performance; the fact that race is correlated with socioeconomic factors, like income and education, indicates it is not simply a matter of demographic makeup or even relative wealth that determines scores. Moreover, the school environment, which is impacted by funding, has a positive effect on achievement. Schools with higher graduation rates, more fully licensed teachers, and better classroom amenities are typically more successful. Specifically, the college-preparedness of a school or district bodes well for its average scores. Principal component analysis also indicates that a school's ability and learning environment have a large positive effect on SAT scores, whereas impoverished and vocation-oriented schools have lower scores.

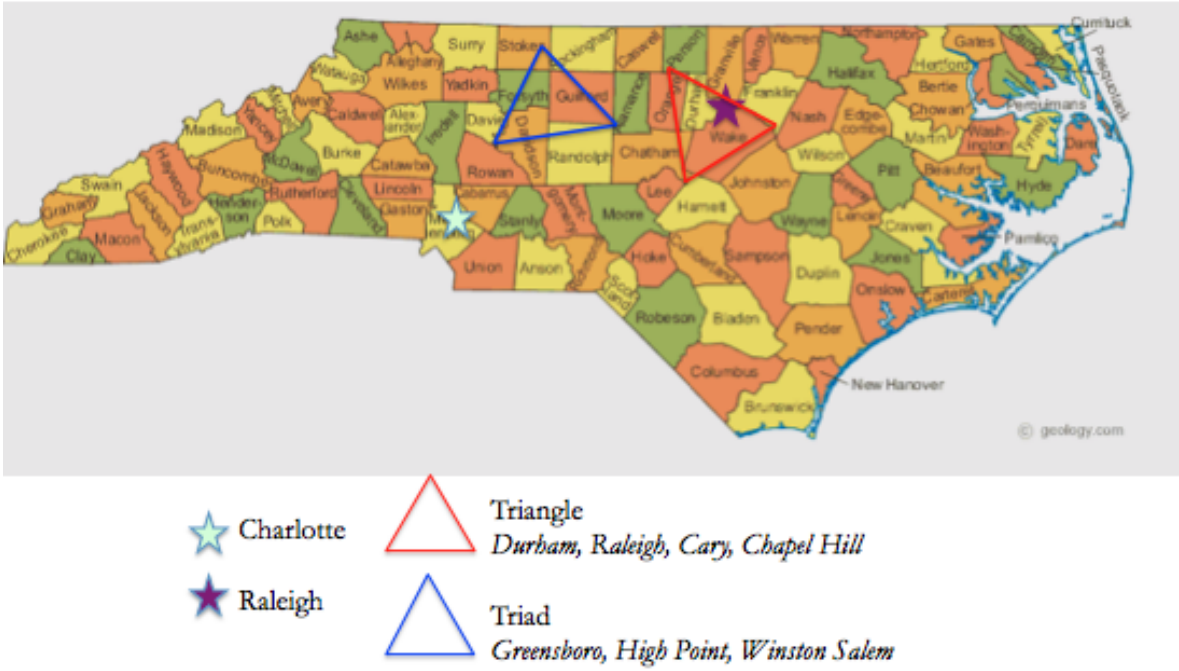
Ultimately, what this analysis makes clear is that there is no simple formula for determining SAT performance. However, these findings indicate that it is a matter of socioeconomic factors and learning environment conditions that contribute to educational outcomes. An implication of these findings is that perhaps the SAT in its 2007-2014 form is more of an achievement test than an "aptitude" test. That is, advantaged students can prepare for the test through tutors, preparatory courses, and study books, and even take the SAT multiple times to increase their scores. The New SAT was released in March 2016, which requires more of an extended, application-based approach to questions rather than regurgitation of formulas and vocabulary. As this new format changes the way that concepts are tested, it will be interesting to see if future analysis on the New SAT scores will reflect similar patterns as determined in this paper.

Appendix

Table 1: Average SAT Scores by Section in United States and North Carolina, 2007-2014

Year	Math NC Average	**Math US Average**	Writing NC Average	**Writing US Average**	Reading NC Average	**Reading US Average**
2007	509	**515**	482	**494**	495	**502**
2008	511	**515**	482	**494**	496	**502**
2009	511	**515**	480	**493**	495	**501**
2010	509	**515**	476	**491**	495	**500**
2011	508	**514**	474	**489**	493	**497**
2012	506	**514**	472	**488**	491	**496**
2013	506	**514**	478	**488**	495	**496**
2014	507	**513**	477	**487**	499	**497**

Figure B: Map of North Carolina Counties and Major Cities



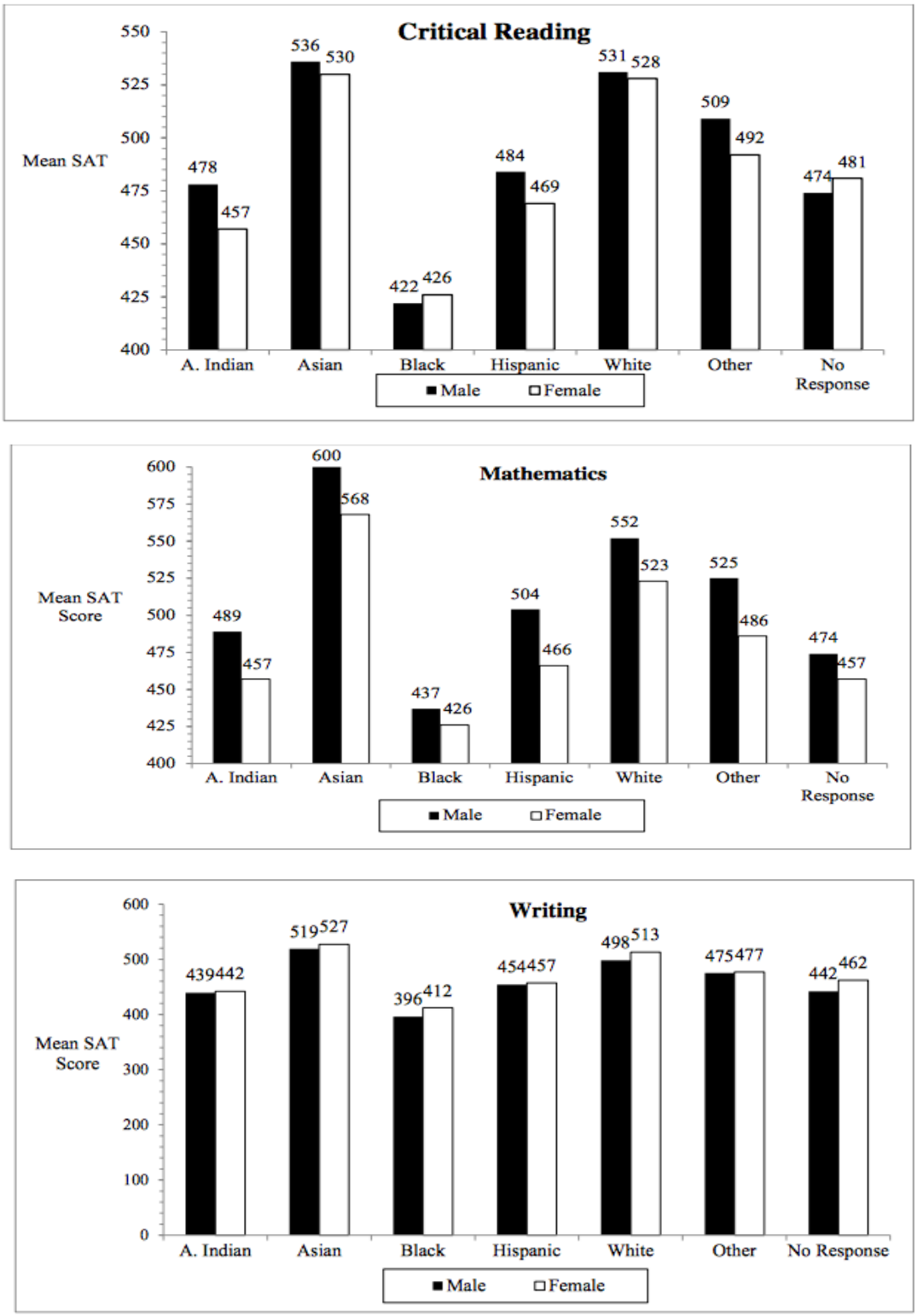
Charlotte

Raleigh

Triangle
Durham, Raleigh, Cary, Chapel Hill

Triad
Greensboro, High Point, Winston Salem

Figure A: Mean SAT Scores by Section for Racial/Ethnic Groups, by Gender, 2013-2014[34]



[34] The North Carolina 2014 SAT Report. NC Dept. of Public Instruction, Accountability Services Division. Oct. 2014.

Table 2: Five Highest Concentrations of Racial/Ethnic Groups, in Descending Order

	Percent Makeup	Average SAT	Location
Asian	6-12	1553	Central NC, Triangle and Triad
Multiracial	3-4	1387	Central NC
White	93-95	1521	Western NC, bordering TN
Pacific Islander	1-2.4	1375	South-Central NC
Hispanic	16-27	1359	Central NC
American Indian	10-41	1350	Western, South Central NC
Black	53-61	1238	Northeast NC, bordering VA

White

Counties Ashe (1505), Clay (1491), Mitchell (1523), Yancey (1517), and Haywood (1567) are approximately 93-95 percent white and average 1521. The second largest demographic is Hispanic students. These counties are located in the western part of the state.

Black

Counties with the largest black student populations are in the northeast part of the state bordering Virginia. Bertie (1235), Hertford (1230), Northampton (1213), Edgecombe (1315), and Halifax (1199) counties are comprised of over 50 percent black (ranging from 53-61 percent) and average 1238.

American Indian

Robeson (1267) and Swain (1420) counties are comprised 40 and 27 percent of American Indian students. Scotland (1298), Jackson (1471), and Hoke (1296) each are comprised nearly ten percent of American Indian students. These counties are located in the western and southern central part of the state and average 1350.

Asian

Chapel Hill- Carrboro City (1761), Orange (1539), Wake (1569), Mecklenburg (1480), and Durham (1418) have the most Asian students. Chapel Hill has 12 percent Asian students and surrounding Orange County has 8 percent. The other three districts have between 5-6 percent. Most are centered around the Triangle area in central North Carolina. The average SAT score is 1553.

Pacific Islanders

Kannapolis City (1413), Scotland (1298), Burke (1481), Cumberland (1385), and Hoke County (1297) have the highest percentages of Pacific Islander students. Kannapolis City has the largest population at 2.4 percent, while the other four LEAs have under 1 percent.. The average SAT score is 1375.

Hispanic

Asheboro City (1420), Duplin (1321), Lee (1431), Sampson (1341), and Lexington City (1281) have the largest Hispanic student populations, ranging from 27-16 percent. These areas are in central North Carolina. The average score is 1359.

Two or More Races

Swain (1421), Cumberland (1385), Onslow (1437), Hoke (1297), and Harnett (1395) all have around four percent of the student population identifying with two or more races. The average SAT score is 1387.

Figure C: Prevalence of High School Graduates in North Carolina, 2010

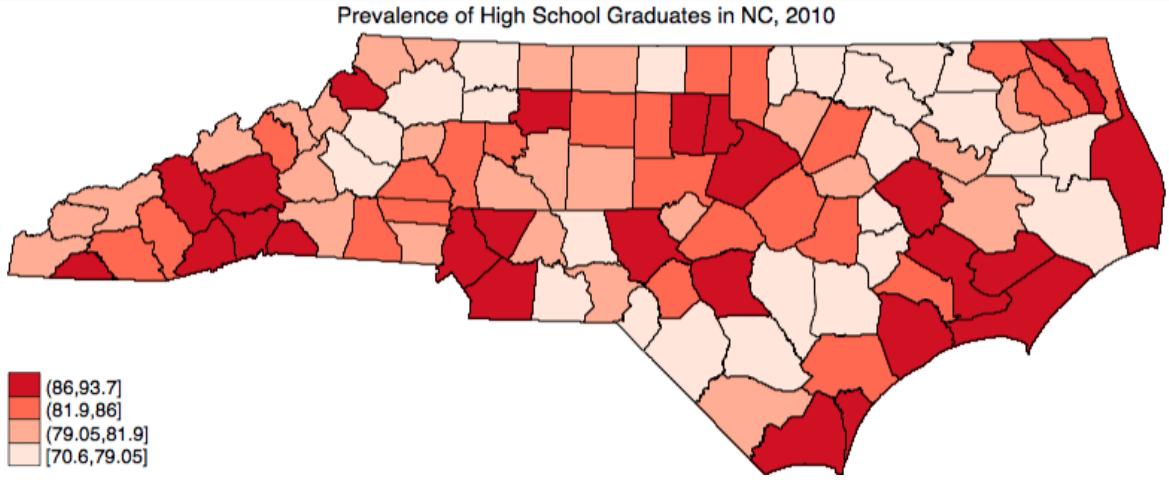
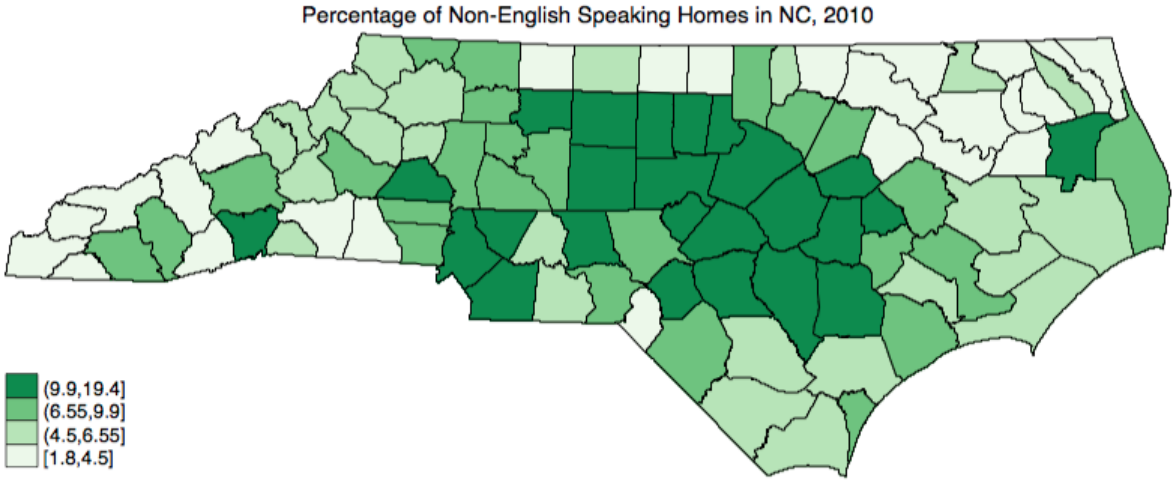
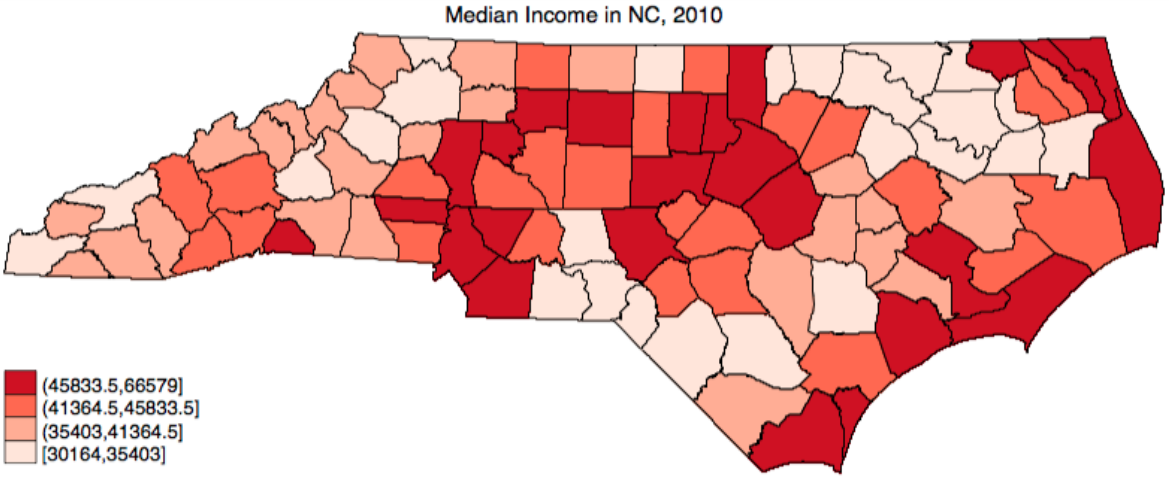


Figure D: Percentage of Non-English Speaking Homes in North Carolina, 2010



Most non-English speaking homes in North Carolina, according to the 2010 United States Census, are located in the central part of the state.

Figure E: Median Income in North Carolina, 2010



The median incomes of North Carolina counties, as determined by the 2010 United States Census, are depicted below. Evidently, the central and eastern-most counties report higher median household incomes.

Figure F: Poverty Rates in North Carolina, 2010

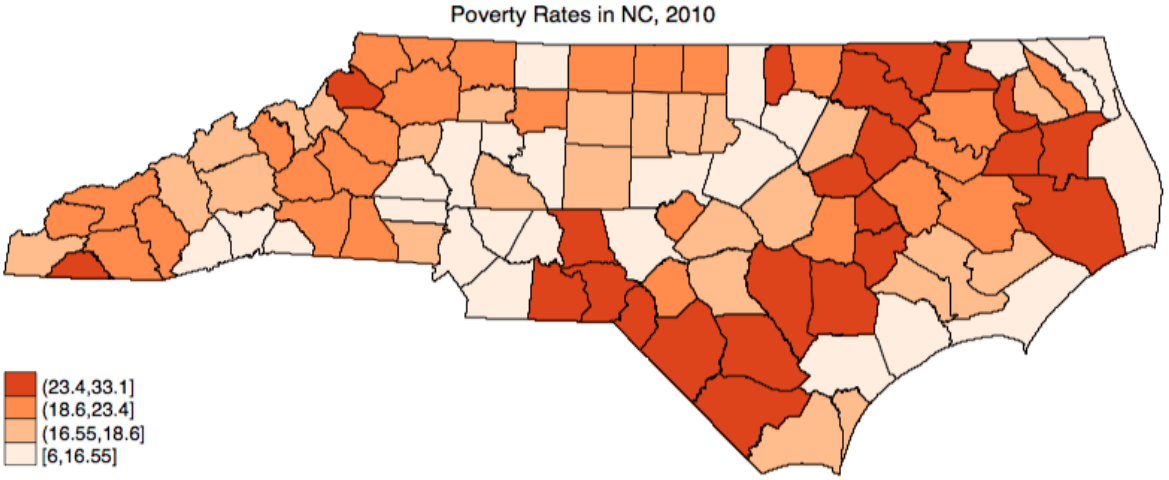


Figure G: Homeownership Rates in North Carolina, 2010

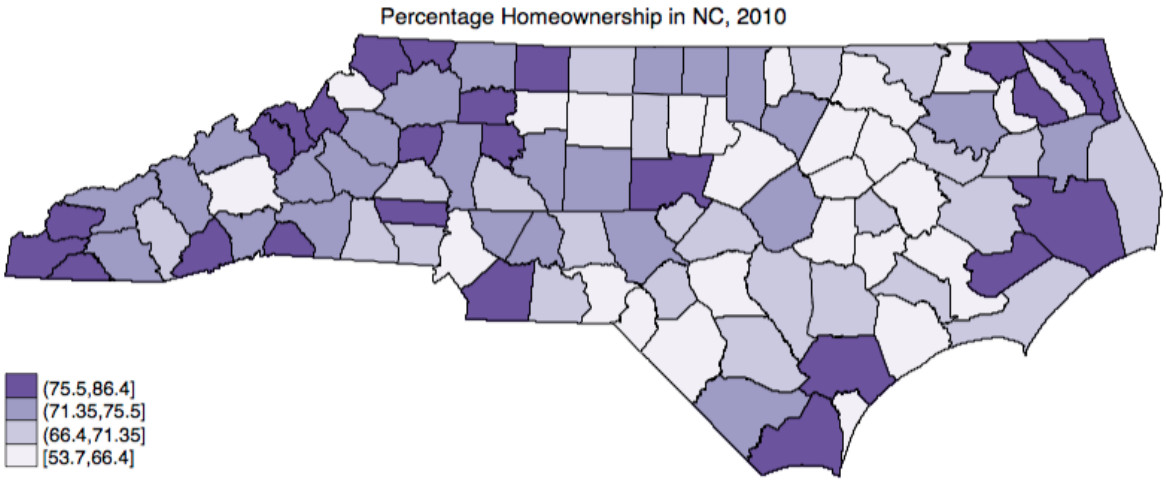


Table 3: Determinants of Homeownership Rates

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

	(1) Homeownership	
	Coeff	SE
Median Income	.0007***	.000
Population	-.0001**	.000
Per Capita	.0004***	.0001
Federal	.0005	.0004
State	.0015***	.0002
Local	-.001***	.0003
Non-English	.142	.167
High School	-.671***	.093
Bachelor	-.289***	.050
White	.874***	.11
Black	.622***	.108
Hispanic	-.483***	.153
Asian	-.622**	.277
American Indian	.91***	.113
Pacific Islander	-.539	.488
Constant	6.88	13.74
Adj. R^2	.7772	

To better understand why homeownership has a negative impact on SAT scores, I delved further into the factors that could impact homeownership. Table 3 looks at the impact of several wealth variables on homeownership, compounded with educational attainment and demographic variables to provide a more comprehensive picture. Evidently, there is a slightly positive relationship between homeownership rates and income, as evidenced by *Median Income* and *Per Capita*. More federal and state funding accompanies higher levels of homeownership and more local funding has a negative relationship with homeownership. Earlier, it was discussed how wealthier LEAs typically have higher levels of local funding and poorer LEAs have higher levels of state and federal funding. Thus, wealthier LEAs have lower levels of homeownership and poorer LEAs have higher levels of homeownership. Interestingly enough, higher educational attainment has a negative effect on homeownership. That is, LEAs with more formally educated residents have lower rates of homeownership. Furthermore, greater Hispanic, Asian, and Pacific Islander populations have a negative effect on homeownership. All race variables are significant at the 1% level, except for Asian, which is significant at the 5% level.

Figure H: Low Wealth Supplemental Funding, FY 13-14[35]

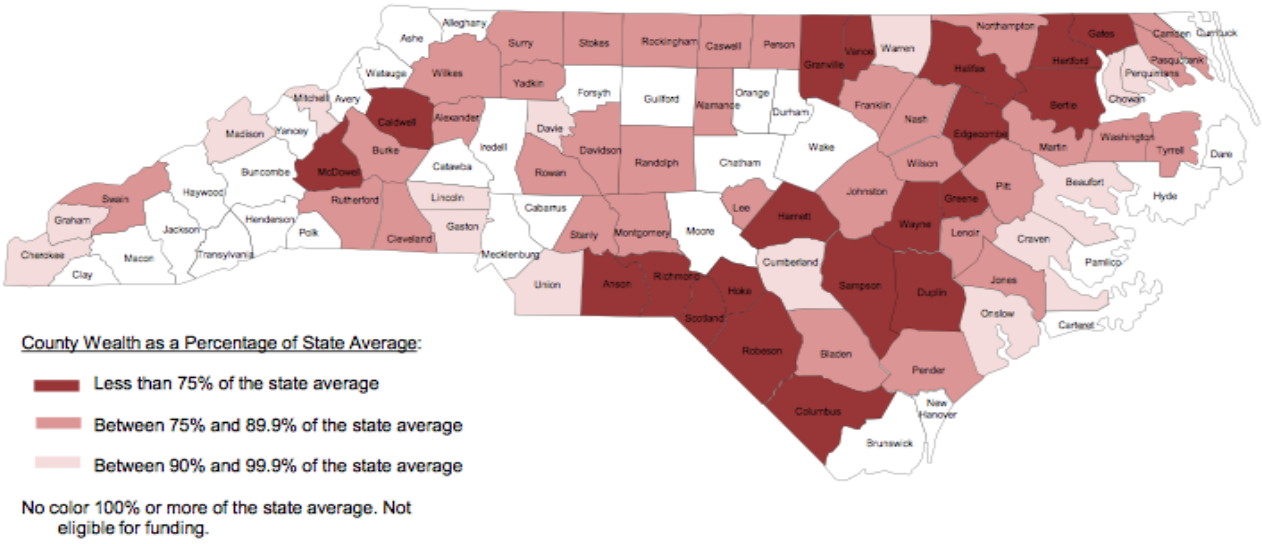


Table 4: Effects of Classroom Variables on SAT

	(1) Total		*(2) Math*		*(3) Writing*		*(4) Critical Reading*	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
English Size	8.88***	.5			2.71***	.168	2.80***	.174
Math Size	-.026	.005	.04	.093				
Percent AP/IB	3.36***	.344	.953***	.122	1.07***	.113	1.24***	.124
Percent Career	-4.03***	.484	-.867***	.165	-1.61***	.164	-1.54***	.175
Constant	1303.46***	14.59	499.77***	3.65	426.18***	4.93	440.71***	5.23
Adj. R2	.1897		.0605		.2025		.1984	

**** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level*

A closer look at the effects of classroom variables on SAT scores in Table 4 provides some more information. English class sizes have a large positive effect on SAT and verbal scores. Furthermore, the effect is significant at the 1% level. Larger math classes have a slight negative effect on cumulative scores, yet a positive effect on the math section. The coefficients are both insignificant at the 10% level. Greater AP/IB class enrollments have a positive effect on scores, significant at the 1% level, and greater career class enrollments have negative effects on scores, significant at the 1% level. Thus, the variables work in the directions hypothesized, at least for the most part.

[35] *Highlights of the North Carolina Public School Budget*. Division of School Business, Information Analysis. North Carolina Department of Public Instruction. Feb. 2014. http://www.ncpublicschools.org/docs/fbs/resources/data/highlights/2014highlights.pdf

Principal Components Analysis STATA Readings

District:

```
. pca white black am asian hisp pacific local state federal engsize mathsize percentenroll percentenro
> ng, comp($ncomp) blanks(.3)

Principal components/correlation                 Number of obs    =        789
                                                 Number of comp.  =         21
                                                 Trace            =         21
    Rotation: (unrotated = principal)            Rho              =     1.0000
```

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	6.41285	2.80782	0.3054	0.3054
Comp2	3.60503	1.56286	0.1717	0.4770
Comp3	2.04217	.52846	0.0972	0.5743
Comp4	1.51371	.410226	0.0721	0.6464
Comp5	1.10349	.0486411	0.0525	0.6989
Comp6	1.05484	.0762978	0.0502	0.7491
Comp7	.978546	.203752	0.0466	0.7957
Comp8	.774795	.0671291	0.0369	0.8326
Comp9	.707666	.184832	0.0337	0.8663
Comp10	.522834	.027754	0.0249	0.8912
Comp11	.49508	.0382619	0.0236	0.9148
Comp12	.456818	.0681013	0.0218	0.9366
Comp13	.388717	.0602755	0.0185	0.9551
Comp14	.328441	.0775579	0.0156	0.9707
Comp15	.250883	.0688997	0.0119	0.9827
Comp16	.181983	.1121	0.0087	0.9913
Comp17	.0698831	.00959701	0.0033	0.9947
Comp18	.0602861	.0293546	0.0029	0.9975
Comp19	.0309316	.0145808	0.0015	0.9990
Comp20	.0163508	.0116624	0.0008	0.9998
Comp21	.00468834	.	0.0002	1.0000

```
 predict EDU_FOREIGN POV CLASS_QUAL MIN_MATH CAREER MIN_ENG
score assumed)
15 components skipped)

coring coefficients
   sum of squares(column-loading) = 1
```

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7	Comp8
white	0.1215	-0.3844	-0.1939	0.3607	-0.1956	0.0122	-0.0689	-0.0089
black	-0.1450	0.3219	0.2022	-0.3681	0.3370	0.0587	-0.1572	0.0729
am	-0.0945	0.0953	0.0198	-0.1362	-0.3518	-0.2332	0.8083	-0.1156
asian	0.3017	0.1630	0.1653	-0.0130	0.0249	0.0986	0.0839	0.0614
hisp	0.1290	0.3191	-0.3520	0.3237	0.1538	-0.1062	0.0483	-0.0198
pacific	0.0081	0.1073	-0.1115	-0.0903	-0.2717	-0.7288	-0.3423	0.3770
local	0.2527	-0.0325	0.3555	0.1769	-0.0806	-0.0167	-0.1360	-0.1863
state	-0.2259	-0.0135	0.2820	0.2324	0.2186	0.0773	0.1293	0.3311
federal	-0.2248	0.2086	0.1432	0.0383	-0.1500	0.1349	-0.0258	0.2818
engsize	0.1336	-0.0239	-0.3251	-0.2130	-0.2562	0.4528	-0.0049	0.2242
mathsize	0.1673	0.0502	-0.4028	-0.3328	-0.1110	0.2144	-0.0519	0.1058
percentenr~l	0.1887	-0.0215	0.2498	0.2181	-0.2024	0.2392	0.0188	0.5129
percentenr~r	-0.2302	-0.0820	-0.2205	0.1047	0.3116	0.0693	-0.0198	-0.2062
pop	0.2297	0.1157	-0.0033	-0.2559	0.2510	-0.0707	0.2283	0.2076
pov	-0.2318	0.3289	0.0989	0.1142	-0.2556	0.1164	-0.0150	-0.1071
homeown	-0.0879	-0.3905	-0.0949	0.1075	0.2673	-0.0937	0.2752	0.3480
hsgrad	0.2926	-0.1984	0.1778	-0.1934	-0.0118	-0.0932	-0.0467	-0.1523
bach	0.3410	0.0036	0.2472	-0.0093	-0.1064	0.0294	0.0141	-0.1829
medianincome	0.3166	-0.1530	0.0477	-0.1533	0.3004	-0.1139	0.0932	0.1073
foreignborn	0.2759	0.3054	-0.0916	0.2614	0.1181	0.0050	0.0852	0.0098
homelang	0.2349	0.3384	-0.1728	0.2861	0.1345	-0.0501	0.0697	0.0142

```
estat kmo
```

```
aiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
white	0.4502
black	0.4313
am	0.1409
asian	0.7570
hisp	0.6797
pacific	0.5446
local	0.8093
state	0.8180
federal	0.9083
engsize	0.7684
mathsize	0.8022
percentenr~l	0.8432
percentenr~r	0.9037
pop	0.7461
pov	0.7773
homeown	0.5722
hsgrad	0.8386
bach	0.8104
medianincome	0.8042
foreignborn	0.7813
homelang	0.7623
Overall	0.7066

School:

Variable	kmo
p_aig	0.7719
p_am	0.0592
p_asian	0.2090
p_avg_dail~d	0.7915
p_black	0.3277
p_drop	0.6003
p_ec	0.7269
p_enroll_a~b	0.6799
p_enroll_wfd	0.6992
p_esl	0.8160
p_frl	0.8389
p_grad	0.8438
p_hisp	0.1672
p_internet~m	0.4838
p_poverty	0.8658
p_sat	0.7707
p_special	0.7242
p_teach_fl~d	0.7920
p_white	0.3524
per_c_num_~e	0.7650
stud_instr~m	0.6900
member	0.6286
Overall	0.5412

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7	Comp8
p_aig		0.3734						
p_am						0.6302		
p_asian								
p_avg_dail~d	-0.3101							
p_black			0.3004					
p_drop						-0.3378	0.5160	0.4254
p_ec		0.4026						
p_enroll_a~b				-0.3701				
p_enroll_wfd			-0.3581				-0.3097	
p_esl			0.3077		0.4331			
p_frl								
p_grad		0.3919						
p_hisp			0.3070		0.6262			
p_internet~m							0.3360	0.6203
p_poverty	0.3045							
p_sat								
p_special		0.4033						
p_teach_fl~d					0.3074			
p_white			-0.4049					
per_c_num_~e							0.5119	
stud_instr~m				0.3038		0.3956		
member				0.5742				

```
. pca p_aig p_am p_asian p_avg_daily_attend p_black p_drop p_ec p_enroll_apib p_enroll_wfd p_esl p
> _frl p_grad p_hisp p_internet_classroom p_poverty p_sat p_special p_teach_flicensed p_white per_
> c_num_crime stud_instruct_comp_num member

Principal components/correlation                  Number of obs    =        420
                                                  Number of comp.  =         22
                                                  Trace            =         22
    Rotation: (unrotated = principal)             Rho              =     1.0000
```

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	4.37983	1.03319	0.1991	0.1991
Comp2	3.34664	1.02879	0.1521	0.3512
Comp3	2.31785	.304163	0.1054	0.4566
Comp4	2.01368	.515251	0.0915	0.5481
Comp5	1.49843	.314356	0.0681	0.6162
Comp6	1.18408	.0974828	0.0538	0.6700
Comp7	1.08659	.132721	0.0494	0.7194
Comp8	.953874	.0432452	0.0434	0.7628
Comp9	.910629	.209568	0.0414	0.8042
Comp10	.701061	.0340221	0.0319	0.8360
Comp11	.667039	.0841242	0.0303	0.8664
Comp12	.582915	.0744598	0.0265	0.8928
Comp13	.508455	.0881984	0.0231	0.9160
Comp14	.420257	.0257765	0.0191	0.9351
Comp15	.39448	.111311	0.0179	0.9530

--more--

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