ESSAYS ON UNDERSTANDING POST-SECONDARY PREPARATION AND MATRICULATION OF HIGH SCHOOL STUDENTS RELATIVE TO DIFFERENTIAL PUBLIC SCHOOL CONTEXTS

BY

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DISSERTATION

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ABSTRACT

This study includes consists of three essays in which I demonstrate that high school contexts are related to the postsecondary preparation, entrance, and matriculation of high school students, particularly for underrepresented populations. My inquiry utilizes comprehensive state longitudinal data, nationally representative longitudinal data, and national school fiscal data, along with quantitative methods to examine these relationships. The dissertation relies on two statistical methods and two unique data sources. Utilizing multilevel modeling and state longitudinal data, the first paper examines the results of school funding policies and the extent to which school funding is related to the postsecondary preparation and matriculation of students. The results suggest that per-pupil revenue is related to an increase in ACT math scores, likelihood of four-year post-secondary enrollment, and four-year post-secondary degree attainment. Utilizing the same Illinois high school data and propensity-score matching techniques, the second paper explores the relationship between a high school's average teacher quality and the postsecondary preparation and matriculation of students identified as Black and Latino. The findings indicate that, for Black and Latino students that attended schools with above-average or higher teachers, ACT math scores are higher and the likelihood of enrollment in a four-year post-secondary institution is greater. Finally, utilizing a nationally representative sample of data from the Educational Longitudinal Study of 2002 (ELS:02), supplemented with Common Core Data, and propensity-score matching, the third paper examines the extent to which the intersection of student socioeconomic status and school quality is related to post-secondary matriculation. For students identified as being from a low socioeconomic background, attending a higher quality school is related to an increase in the likelihood for both two- and four-year post-secondary enrollment. Taken together, the three essays provide further evidence

that increases in school resources, whether it be funding, teachers, or in general, are related to educational achievement, and, more specifically, the likelihood of underrepresented students advancing to and progressing through post-secondary institutions.

For Ava

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Paper I

Money Matters in Illinois:
Exploring the Relationship between Differential Public School Funding and Educational Outcomes of Illinois High School Students

Abstract

This paper explores the relationship between differential public-school funding across Illinois high schools and three educational outcomes: ACT math scores, four-year post-secondary enrollment, and four-year post-secondary completion. Additionally, I explore the extent to which the relationship between school funding and the three educational outcomes differed across racial categories. Utilizing longitudinal data for the Illinois high school graduating cohort of 2003 and multilevel modeling, I show significant and positive relationships between increased public-school funding and all three of the educational outcomes.

Introduction

"Equality of educational opportunity has been accepted as a normative goal of educational policy in the United States since colonial time. It has proven to be as elusive, however, as the proverbial pot of gold at the end of the rainbow. By virtually any standard, there has been a great deal of progress toward achieving equality of educational opportunity in the United States since 1790, but few will argue that it has been accomplished" (Rossmiller, 1987, p. 562).

The deniability of both the Illinois judicial and legislative government branches in addressing the disparate impact of the school funding system has shaped the Illinois public school system in to what is now one of the most regressive systems in the country, allocating less monies, on average, to schools that are charged with educating the state's poorest students. Forty-four years of providing "an efficient system of high quality public educational institutions and services" (Illinois Constitution, 1970) has efficiently maintained a stratified educational system that is of high quality to a few and but lacks relative equity for all.

The role that school funding, among other related factors, has on educational outcomes has been examined by numerous scholars over time with the most notable being the 1966 *Equality of Education Opportunity Report*, more commonly known as the Coleman Report. The result of this research has produced mixed results. Expenditures towards both public and private education has steadily increased since 1966 (U.S. Department of Education, 2006) but the gaps in educational outcomes between white and Black students, white and Latino students, middle/upper class and lower class students, etc. still remain (NCES, 2013). Which brings to question, why have these gaps, over time, persisted or, in some instances, gotten worse? The current structure of educational funding for public schools in the United States is highly decentralized. In all states excluding Hawaii, school districts, and thus, schools rely upon a combination of local property taxes, state education distributions, and a small amount of federal financial support[1]. The decentralized funding structure of public schools has, in some states, created a stratified system of education in which the schools that need the most financial support receive the least. The regressive education funding structure of some states has and continues to allocate limited state resources towards schools in which the schools' per-pupil expenditures far exceed the states foundation minimum while providing just enough funds for poorer schools to reach the foundation minimum. Additionally, the schools that need the most financial support not only educate students that are low-income but are demographically segregated.

The state of Illinois, like other states, faces shortcomings in its attempt to provide equitable educational opportunities within its public education system. Verstegen and Driscoll (2008) note that "current school finance systems are obsolete and antiquated; they have failed to achieve equity or to incorporate adequacy" (p. 332). Also like most states, the education system in Illinois is decentralized, allowing local control of each school to each of its 869 districts. In relation to the rest of the country and according to the most recent (2009-10 school year) data retrieved from the U. S. Department of Education National Center for Education Statistics Common Core of Data (CCD), Illinois has the second worst state funding policy as it relates to

[1] See http://www.schoolfundingfairness.org

equitable distribution of resources[2]. The disparities in state funding for education between the richest school districts and the poorest districts are second only to Nevada. If each district in the Illinois were relatively homogenous across socio-demographic categories and average property values, educational funding opportunities across the state, in theory, would be equitable or, at the minimum, equal. However, that is not the case. According to Orfield and Frankenberg (2014), the public education system in the state of Illinois is one of the most racially and economically segregated in the country. Because of this, the structure of funding public education within the state and other factors, there are large disparities in the total per-pupil revenues between the most funded and least funded school districts. According to a recent study on evidence of equity or adequacy across Illinois schools, Verstegen and Driscoll (2008) found that school funding across all districts was neither equitable nor adequate. Thus, the confounding questions that result from this information is: What does school funding have to do with educational outcomes in Illinois? Can differential levels of between school district funding, among many other student and school factors, result in inequalities of educational opportunity for Illinois students?; Or reduced access to post-secondary education for Illinois students?

Purpose of the Study

Access to and matriculation through institutions of post-secondary education is an issue that has been most recently targeted by President Barack Obama in his most recent educational platform in hopes of increasing the number of individuals with post-secondary credentials. In a growing age of credentialism, pursuit and receipt of post-secondary credentials creates more opportunities than receipt of the high school diploma. Therefore, studying issues, like differential

[2] The Illinois General State Aid funding formula is defined and explained in Appendix A.

school funding, that affect access to and matriculation through institutions of post-secondary education are of utmost importance to the longevity and financial health of the nation.

The purpose of this study is to continue to address the question of 'Does Money Matter?' in education and address how differential school funding among Illinois public high schools may impact post-secondary outcomes for Illinois students. The study examines the relationship between school funding and students' college readiness, as measured by standardized achievement tests, post-secondary entrance, as measured by enrollment in a four-year post-secondary college or university, and post-secondary matriculation for students that enrolled in a four-year college or university. With the understanding that differential levels of school funding matter, the following research questions will guide this study.

1. To what extent does public high school funding relate to educational achievement, as measured by ACT Math subject test score, of Illinois public high school students?
    a. Does the relationship differ across race/ethnicity?
2. To what extent does public high school funding relate to the likelihood of enrollment in a four-year post-secondary institution for Illinois public high school students?
    a. Does the relationship differ across race/ethnicity?
3. To what extent does public high school funding relate to the likelihood of graduation from a four-year post-secondary institution for Illinois public high school students that enroll in a four-year post-secondary institution at any time?
    a. Does the relationship differ across race/ethnicity?

The paper begins with a review of the existing disparities in educational outcomes among underrepresented populations, specifically college entrance and matriculation of Illinois students. Then, I review the existing school funding research and how school funding is related to educational outcomes. Upon noting the limitations in the existing school funding research, I explore the relationships between Illinois public school funding and the educational outcomes listed above for Illinois students. For analyses of these relationships, I draw on cohort data from the Illinois public high school graduating class of 2003 and employ hierarchical linear and logistic modeling techniques.

Background

School Funding in Illinois

The Illinois State Board of Education (ISBE) provides a profile of all public schools in aggregate each year. For the 2012-13 school year, Illinois enrolled over 2 million students, half of which were defined as low-income, in 3,862 schools divided in to 863 regular public school districts. Of the 3,862 schools, 684 were classified as secondary schools, an increase of 19 schools since the 2002-03 school year.

The Illinois school funding structure, as previously discussed, is highly regressive, distributing more funds to school districts that have lower levels of low-income students. In general based on fiscal year 2009 (FY 2009) data, Illinois public schools receive approximately 60 per cent of revenue from local sources, 28 per cent from the state, and the remaining 12 per cent from the federal government (Fritts, 2012). Fritts (2012) notes that “Illinois ranked lowest among states in the percentage of revenues from state source” (p. 1). Illinois schools are funded under the General State Aid (GSA) grant program which “represents 66% of all state general funds expenditures on PreK-12 education in Illinois and consists of two funding streams” (IEFA, 2013, p. 2). The first stream is the Formula Grant, which is utilized to place schools into three formula categories (Foundation Level, Alternative, Flat Grant) based on the school’s ability, through local resources, to meet the minimum per-pupil funding level of $6,119.[3] If a school is unable to meet the minimum per-pupil funding level utilizing local resources, it is the state's responsibility to make up the difference between the funding ability of the school and the minimum funding level of $6,119. For FY 2011, this formula applied to "625 school districts and 75 lab and alternative schools that enrolled 71 per cent of the state's students" (Fritts, 35). For schools that use the alternative formula, their local resources are able to supply between 93 per cent and 175 per cent of the minimum per-pupil funding level of $6,119. The alternative formula applies to "171 districts that enrolled 24 per cent of the state's students", allocating between $219 and $437 per-pupil to each district. The remaining 69 school districts fall under the flat grant formula. School districts that use the flat grant formula have local resources that are able to provide more than 175 per cent of the minimum per funding level of $6,119. These school districts, which enroll the remaining 5 per cent of the state's students, receive a flat grant of $218 per-pupil. [4] Of the total allocated state funds used to fund Illinois public schools, approximately 44 per cent is distributed under the Formula Grant stream.

The remaining 22 per cent of allocated GSA funds is distributed through the Poverty Grant. This funding stream is used to allocate monies to school districts based on the level of low-income students in the district. Low-income students are identified as students that "receive services from the Illinois Department of Human Services through one of four program: Medicaid, the Children's Health Insurance Program, TANF, or Food Stamps" (IEFA, 2013). Under the Poverty Grant, school districts receive a minimum of $355 per low-income pupil if less than 15 per cent of students in the district are classified as low-income. All other school districts receive an amount based on a formula that takes in to account the percentage of students

[3] The definitions of each foundation level can be found in Appendix A.
[4] This data can be found in tabular form in Appendix B, table B.1.

classified as low-income.[5] One consideration to keep in mind is that "the Poverty Grant is not equalized, meaning it does not consider how wealthy a school district is in determining the amount of grant awarded. Even the wealthiest districts receive some amount of Poverty Grant funding" (IEFA, 2013).

The current fiscal climate of the state has bared grim news for all state programs, including education. Unfortunately, the state has been unable to fully fund the GSA, providing less than 100 per cent of the calculated disbursement under the Foundation formula. In particular, the Illinois Education Funding Advisory Board (EFAB), in their 2013 report, notes that, for FY 2012 and FY 2013, a shortfall in state appropriated funds resulted in a reduction of 5 and 11 per cent, respectively, of the amounts owed to each school district regardless of which of the three formulas used. As there is no legislative statue on how to address funding shortfalls, the current method of fund allocation is in place by default (EFAB, 2013), resulting in fewer funds for the schools that need it them the most.

The legality of the Illinois school funding formula has not been without contention. In 1996, the Committee for Education Rights, citing that "the disparities in educational resources and opportunity among Illinois school districts are some of the most severe in the nation" challenged the funding formula at the time and the meaning of language in the Illinois constitution, concluding that "the efficiency requirement guarantees some measure of equality in educational funding and opportunity" (*Committee for Education Rights*, 1996). Although the support for the case was highly factual, the Supreme Court of Illinois affirmed a prior Appellate Court ruling to dismiss the complaints noting, in summary, that it was not the place of the courts to define a "high-quality" education and that the definition is one of a debatable policy concern

[5] The Poverty Grant formula for school districts that have 15% or more low-income students is as follows: $(\% \text{ of low-income students})^2 \times \$2,700 + \$294.25$. (IEFA, 2013)

(*Committee for Education Rights,* 1996). Another class action case that challenged the definition of the language in the Illinois Constitution, among other charges, was brought forward in 1999. A class representing students and parents from the East St. Louis School District 189 challenged "the adequacy of the education being provided to them in District 189" (*Lewis E. v. Spagnola, 1999)*. The Illinois Supreme Court, citing the *Committee for Education Right* case, affirmed the lower court's ruling.

A more recent case has challenged the Illinois Supreme Court's decisions in these two cases. The Chicago and Quad County Urban Leagues have challenged that the Illinois school funding system violates the civil rights of public school students, noting that

> the State's public school funding scheme (1) disparately impacts racial and ethnic minority students who attend districts with a high concentration of minority students by distributing an unequal level of funding to those school districts; (2) violates the Uniformity of Taxation provision of the Illinois Constitution; (3) violates students' right to attend "high quality educational institutions" guaranteed by the Education Article under the Illinois Constitution; and (4) violates students' rights to equal protection under the Illinois Constitution (Chicago Urban League and Quad County Urban League v. State of Illinois and Illinois State Board of Education, 2008).

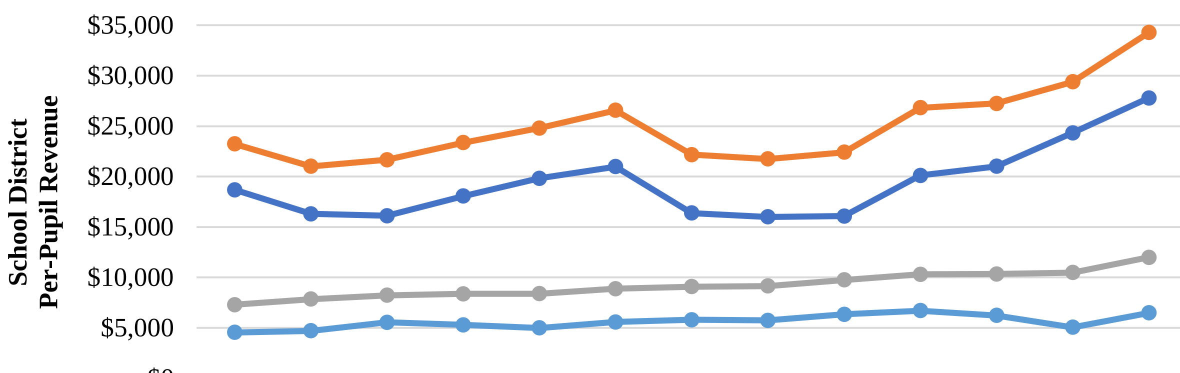
This case has yet to be decided.

Based on the use of the equalized assessed value of property within each school district, the GSA formula assumes that school districts have the capacity to generate the available local resources used to calculate the amount of state aid owed to each district under the foundation level. This assumption can place undue tax burden on owners in low property value districts. As property values decline, district revenues decrease when the taxation rate remains constant and only increase if the taxation rate is increased. Thus, in order to maintain the level of school funding necessary to reach foundation level, local school districts must levy taxes at a higher rate. As discussed in the court cases, it is up to the school district and local authorities to determine the amount of funds that each is willing and deems necessary to produce a "high quality education" for its students (Illinois Constitution, 1970). It is the responsibility of the state, based on the GSA formula, to insure that the set foundation level is met given the assumed capacity of the local tax base of the school district. The purpose of this dissertation will not be to dissect the entire GSA formula. However, to understand how the disparities in educational funding are created, one must closely examine the inner workings of the state's main funding formula which, along with local revenue sources, contributes over 70 per cent of revenue to schools.

The current Illinois public school funding structure has been in place since 1999 when the Illinois legislature approved a $500 million increase in the appropriations to public schools. This

Figure 1.1

Illinois State & Local
School District Per Pupil Revenue Trends
FY1999 - FY2011



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Minimum	$4,54	$4,70	$5,54	$5,29	$4,98	$5,58	$5,79	$5,74	$6,34	$6,70	$6,23	$5,06	$6,48
Maximum	$23,2	$21,0	$21,6	$23,3	$24,8	$26,5	$22,1	$21,7	$22,4	$26,8	$27,2	$29,3	$34,2
Mean	$7,29	$7,84	$8,23	$8,37	$8,38	$8,88	$9,08	$9,15	$9,75	$10,3	$10,3	$10,4	$11,9
Max-Min	$18,6	$16,3	$16,1	$18,0	$19,8	$20,9	$16,3	$16,0	$16,0	$20,1	$21,0	$24,3	$27,7

action was on the heels of two lawsuits, Edgar (1996) and Spagnola (1999), both of which challenged the equality of the Illinois public school funding system. In both cases, the Illinois Supreme Court affirmed a lower court's ruling, noting that it was not the place of the courts to define a "high-quality" education (Edgar, 1996) or determine the adequacy (Spagnola, 1999) of, at the time, the present system. The foundation level has increased, as expected, since fiscal year 1999, but only marginally[6].

Although the foundation level minimum has increased, the funding gap in per-pupil revenue between the lowest and highest funded public school districts, that enroll high school students, has increased. Beginning in FY1999 through FY2011, the gap in per-pupil revenue between the lowest and highest funded public school districts has increased from $18,685 to $27,782.

Literature Review

Although the study is interested in the impact of public high school funding on students' college readiness and enrollment, college readiness and enrollment are contingent on other factors due to the structural nature of public schooling and the public school system. This chapter provides a brief overview and critique of the existing literature that addresses the history of public school finance, as well as, factors that impact the college readiness, enrollment, and four-year degree attainment of students historically underrepresented in four-year post-secondary institutions.

School Funding

[6] The foundation level in Illinois is the minimum per-pupil revenue level for public school students. The foundation level for FY15 was $6,119. For more information on the Illinois public school funding formula, please see Appendix B.

Historically, research examining the relationship between school funding and educational outcomes has been mixed. Hanushek (1989) and Hedges et al. (1994) conducted meta-analyses that examined prior research studies which addressed the impact of differential school funding on educational outcomes with differing results. Hanushek (1989) reaffirmed the strong, positive correlation between school funding and educational outcomes but concluded that “the strength of the relationship disappears when one controls for differences in family background” (p. 49). In a response to Hanushek (1989), Hedges et al. (1994) concluded the opposite, noting that “strong support for at least some positive effects of resource inputs and little support for the existence of negative effects” and thus, “the question of whether more resources are needed to produce real improvement in our nation's schools can no longer be ignored” (p. 13). The differing results provide the reasons to continue questioning the relationship between school funding and educational outcomes.

When school funding or funds are discussed, there are multiple levels in which allocated school funds have to flow before reaching and affecting the students. School funding measures can be aggregated (general per-pupil expenditure) or disaggregated (instructional, administrative, and capital/building per-pupil expenditures). Thus, research on school funding and its effect on educational attainment and outcomes has focused on the factors that directly and indirectly impact student outcomes and how those factors are affected by school funding. Specifically, Sebold and Dato (1981) found that equalization of per-pupil expenditures across school districts in California increased standardized test scores. Furthermore, school funding, as measured by total per-pupil expenditures, was found to be related to the ability of schools to improve school quality and pay for more teachers leading to higher levels of educational attainment (Card and Krueger, 1992). Payne and Biddle (1999) found similar results, noting that increased school funding at the district level was positively related to an increase in mathematics achievement. Lower levels of instructional and capital per-pupil spending were found to be associated with greater mathematics achievement gaps across a nationally representative sample of students (Wenglinksy, 1997). Condron and Roscigno (2003), utilizing school level data, found similar results. Most notably, an increase in school funding per-pupil expenditures resulted in positive levels of student proficiency in reading, mathematics, science, and citizenship.

Each of these studies has demonstrated that increased school funding is positively related to both student educational outcomes and attainment. However, each study had its limitations. Some utilized cross-sectional data (Sebold and Dato, 1981; Wenglinsky, 1997; Payne and Biddle, 1999; Condron and Roscigno, 2003) which can limit actual causal assertions because outside factors attributable to educational attainment are not accounted for. Also, use of nationally representative data (Card and Krueger, 1992; Wenglinsky, 1997) can limit generalizability of the findings because of the decentralized structure of school funding. The current push for large, statewide longitudinal data systems may provide the kind of data necessary to account for the long-term impact of school funding and allow for research examining the effects of different funding structures within and across state lines. Thus, continued research on how school funding is related to educational attainment is justified.

Explanations of Gaps in Educational Attainment

A number of studies have been conducted and research reports have been written that have sought to explain the disparities in educational attainment between white and non-Asian minority students at each level of the education pipeline. Since 1964, multiple studies have reported that educational attainment can be linked to ascribed characteristics (family income, socioeconomic status), achieved characteristics (high school track placement, academic performance, ability), non-cognitive characteristics (educational aspirations and expectations, peer group relationships, discipline), and institutional factors (school socioeconomic and racial composition, financial aid). These studies will be further discussed.

Ascribed. One of the earliest and most influential studies and subsequent reports was released by James Coleman and colleagues. The Equality of Educational Opportunity report "described a massive study that had been commissioned by the National Center for Education Statistics in response to the Civil Rights Act of 1964" (Biddle, p. 5). In the report, Coleman et al. concluded that school related factors such as quality and funding did not impact educational achievement while a student's family background and peer group relationships accounted for the differences in educational achievement between students, specifically white and Black students. (Coleman et al, 1966). However, the findings from the Coleman Report have been scrutinized since the results were rushed to press. In a recent study, utilizing the same data and multi-level modeling, Borman and Dowling (2010) concluded that "40% of the difference in achievement can be found between schools" (p. 1201). Family background can be measured by socioeconomic status, income, family composition, or cultural capital. Some of the measured differences in educational attainment at the secondary level can be explained by socioeconomic status and family composition (Roscigno & Ainsworth-Darnell, 1999) as well as income (Wilson & Portes, 1975; Mortenson, 1991; Cameron and Heckman, 2001). In particular, Cameron and Heckman (2001) note in their longitudinal study that "equalizing these long-term factors, minority youth are more likely to complete high school and enter college than are majority youth, even after controlling for selectivity in educational attainment. Conditioning on background variables, family income has a stronger effect on who stays in high school and who graduates than it has on who attends college" (p. 3). In relation to post-secondary educational attainment, Karabel & Astin (1975) found that differences in the quality of college attended can be mediated by parental socioeconomic status.

Achieved. Achieved characteristics are the factors that can be measured through some measure of testing. Student ability and academic performance are factors that have been related to educational attainment and the achievement gaps previously discussed. Research has shown that student ability and academic performance accounts for differences in educational attainment between white and non-Asian minority students when discussing the quality of college attended (Karabel, 1975) and placement in high school academic program (Wolfle, 1985). Wolfle (1985) surmises that a student's ability determines the academic track placement and, thereby, "curriculum differentiation in high school plays a major role in subsequent educational attainment presumably by allocating to selected students the prerequisite skills and credentials necessary for postsecondary matriculation. This process seems to work about the same for both whites and blacks" (p. 517). Hearn (1988) concluded similar findings, specifically that a student's high school track were positively associated with attending higher cost (more prestigious) institutions of higher educations and, therefore, a better chance for increased educational attainment. Furthermore, Wilson and Portes (1975) and Kerckhoff and Campbell (1977) suggest that academic performance is strongly related to educational attainment for Black students. Kerckhoff & Campbell (1977), when discussing Black student academic performance, note that "if they manage to do well there, they are at least as likely as whites to obtain further education" (p. 26).

Non-cognitive. Non-cognitive factors have also been linked to educational attainment. Non-cognitive factors can include a student's educational aspirations and expectations, self-concept, goals, and levels of discipline. Kerckhoff (1977) found that high levels of discipline were a strong negative predictor of educational attainment for Black students and not so much for white students. Low levels of reported discipline for Black students had a positive effect on educational outcomes (Kerckhoff, 1977). Additionally, educational aspirations and educational expectations were found to be related to educational attainment for students at both the secondary and post-secondary education levels (Wilson & Portes, 1975; Tracey & Sedlacek, 1987; Hearn, 1988). Tracey and Sedlacek (1987), referencing Black students, reported that factors such as a student's positive self-concept, support networks, leadership roles, and realistic self-appraisal attributed to persistence in post-secondary education, and, therefore increasing the students chance for increased educational attainment.

Institutional. Finally, institutional factors and characteristics have been found to be influential in educational achievement and attainment for students. Institutional factors can be the quality of the school facilities, the student racial and socioeconomic demographic composition of the school, and the policies practiced by the institutions. Both racial and socioeconomic school composition has been shown to have effects on educational attainment for Black students. Thornton and Eckland (1980) reported that school socioeconomic composition "had an overall positive effect on the college of attendance of blacks" (p. 251) but had no measureable effect for white students. Roscigno (1998) found similar results when assessing the effects of racial composition on academic achievement. Most notably, average reading and mathematics scores are positively influenced by attending a "white segregated school" and are negatively influenced by attending a "black segregated school" (Roscigno, 1998). Policies that affect access to educational opportunities have also been found to influence educational attainment. Sazama (1992), in discussing federal student aid programs, found that "the concentration of children from rich families is still greatest in the academically more prestigious schools regardless of the federal student financial aid program" (p. 141 – 142).

Data & Methods

Data

The study utilizes a longitudinal data set comprised of both student-, school-, and district-level information regarding the Illinois high school class of 2003 (IERC:03). Data, accessed through shared data agreements with the Illinois Board of Higher Education (IBHE) and American College Testing (ACT), was compiled by the Illinois Education Research Council (IERC). Additionally, higher education enrollment data, received from the National Student Clearinghouse (NSC), and employment data, received from the Illinois Department of Employment Security (IDES), was merged by IERC with the aforementioned data, resulting in a comprehensive statewide longitudinal data set that tracks the Illinois high school class of 2003 from high school to college and/or the workforce (Lichtenberger & Dietrich, 2012).

In 2001, as part of the required Prairie State Achievement Examinations (PSAE), the state of Illinois required all high school juniors to take the American College Testing (ACT) examination. As such, the graduating class of 2003 was the second full cohort of students to sit for the exam. Prior to 2001, sitting for the ACT exam was optional for students, and, therefore, the results of the examination were not fully representative of all Illinois high school students. (Lichtenberger & Dietrich, 2012). Therefore, the strength of the IERC:03 data is that it provides data for the entire population of Illinois high school students from the class of 2003 and not just a sample. Issues associated with sampling error, weights, etc. don't apply; offering a distinct advantage over using accessible national and state based representative data.

The entire IERC:03 data consists of 115,676 cases, including student data from both private and public high schools. For the purposes of the proposed study, only data from students that attended public schools (n=628) and identified as African-American (n=8,906), American Indian/Alaskan Native (n=411), White (non-Latino) (n=58,004), Latino (n=7,460), or Asian/Pacific Islander (3,625) will be used (n=78,406). Of the 628 public high schools, 483 operate in unitary districts and the remaining 145 operate in high school districts[7].

Additionally, the utilizes student data obtained from the optional ACT Student Interest Profiler survey administered during the examination along with post-secondary enrollment data provided by the NSC. The data collected contains self-reported student data including demographic information, self-reported high school transcript information, and information related to the student's post-high school academic and/or professional trajectory. The post-secondary enrollment information contains information regarding the type of post-secondary institution initially attended, if any, and the characteristics of the institution. Furthermore, the study utilizes high school data associated with each student. The high school data consists of information regarding the school's enrollment, funding and expenditure levels, standardized test (PSAE) averages and ranges, and teacher characteristics. A list of the variables and their descriptions can be found in tables 1 and 2 of Appendix A.

Index of teacher academic capital. A measure of school level teacher quality will be used in the analysis. Research has shown that teacher quality positively influences educational outcomes. Additionally, research has shown that the quality of teachers between schools is not

[7] Unitary districts are comprised of both elementary and secondary schools where high-school districts are only comprised of secondary schools. The difference is made here because the revenue data available is at the district level and not the individual school. Revenue allocation decisions to each school are made at the district level. Per-pupil revenue is averaged across all students in a district. For unitary districts, where some students are in elementary schools, average per-pupil revenue for high-school students will be underestimated.

the same. In particular, teacher quality within schools is inversely related to the percentage of non-Asian minority and low-income students. Therefore, a measure of school-level teacher quality will be used to account for these differences. For the purposes of this study, teacher quality will be represented by the Index of Teacher Academic Capital (ITAC). The ITAC is a variable that was created by White, Presley, and DeAngelis (2008) to assess the varying levels of teacher quality among Illinois public schools. The ITAC is a weighted combination of five school level attributes "that were found to be most theoretically and statistically similar" White, Presley, & DeAngelis, 2008, p. 9). The five measures that comprise the ITAC are:

> "1. The mean ACT composite score of teachers at the school; 2. The mean ACT English score of teachers at the school; 3. The percentage of teachers at the school who failed the Illinois Basic Skills test on their first attempt; 4. The percentage of teachers at the school who were emergency/provisionally certified; 5. The mean Barron's competitiveness ranking of the undergraduate institutions attended by the school's teachers (Barron's, 2003)" (White, Presley, & DeAngelis, 2008, p. 9-10)[8].

These five components were chosen based on a two studies (Rice, 2003; Wayne & Youngs, 2003) that reviewed the "measureable attributes of teachers, such as their number of years of teaching, experience, and student outcomes" (DeAngelis, Presley, & White, 2005, p. 4). Principal component analysis was used to construct ITAC[9].

Method

Descriptive statistics are used to analyze the structure of each variable. Each variable was checked for completeness and missing data noted. Continuous variables were standardized so

[8] This data was acquired from the Teacher Services Record (TSR) maintained by the Illinois State Board of Education (ISBE). IERC maintains a shared-data agreement with ISBE that facilitated access to the data.
[9] The ITAC construction was based on previous work done by DeAngelis et al. (2005). A discussion on the methods used to construct the ITAC can be found in both DeAngelis et al. (2005) and White et al. (2008).

that each has a mean of 0 and a standard deviation of 1. Standardization allows for easier comparability of variables with different scales and ranges[10]. The structure of the data is such that students are nested within schools and schools are nested within school districts. To account for the nesting in the data, I utilize both hierarchical linear and logit modeling (HLM). The nested structure of the data lends itself well to the use of multilevel modeling techniques. The relevance of the use of each of the multilevel modeling techniques to address the research questions, as well as the procedure to construct each model will be further discussed.

Hierarchical Linear and Logit Modeling. The use of hierarchical linear modeling (HLM) will allow the hypothesized model to better account for the clustering within the data, accounting for both the within school and between school variation, and providing better model fit comparing to standard ordinary least squares regression (OLS). Unlike ordinary least squares regression (OLS), the results of the HLM are not based on a R^2value but rather fit statistics compared to an unconditional model. Engberg and Wolniak (2010) utilized the Educational Longitudinal Study of 2002 (ELS:02), nationally representative data, and hierarchical general linear modeling (HGLM), a more generalized form of HLM, to analyze both school factors and student factors that are related to post-secondary enrollment, finding that both school and student factors affected the measured outcome, confirming the effects of clustering within ELS:02. Snijders and Boskers (2012) note that "within-group relations can be, in principle, completely different from between-group relations" (p. 27). In this case, the within-group relations are denoted by the clustering of students within schools and the clustering of schools within school districts. The between-group relations are denoted by the relations between the schools and the relations between school districts.

[10] In this case, the scale of per-pupil revenue is in thousands of dollars while other variables, like GPA and parental income, are scaled between 1 and 10.

As such, Snijders and Boskers (2012) note that "it is necessary to consider within- and between-group relations jointly, whenever clustering of micro-units in macro-units is meaningful for the phenomenon being studied" (p. 27). If one or more of these conditions are met, steps to construct a parsimonious, hierarchical linear model will be done. The hypothesized linear mixed model can be found in Appendix C while a description of the variables can found in Appendix B. The model parameters are estimated using maximum likelihood (ML) estimation. Snijders and Boskers (2012) note that two major methods of parameter estimation are ML and residual maximum likelihood (REML). The results of ML is that parameter estimates have downward bias compared to REML parameter estimates. Because the number of cases in the IERC:03 data set is vast, the differences between the ML and REML estimates are negligible (Snijders & Boskers, 2012). Similar to OLS regression, the final linear model produces parameter coefficients that estimate the relationship of each parameter to the dependent variable. Significance of the estimates is determined by not only assessing the t-statistic but also the relative size of the standard error of each estimate to the actual estimate. The final logit models provide odds ratios that are explained as the relative relationship between each independent variable on: 1. the probability of a student enrolling in a four-year college or university versus any other post-secondary outcome; and 2. the probability of a student, that did enroll in a four-year college or university, obtaining at least a bachelor's degree.

Variation between schools and districts. The use of multilevel modeling is valid if there measured significant between-group variation in both the independent and dependent variables. In particular to this study, the structure of the data is such that there are three levels: students; schools; school districts. The variables from each level can be found in Appendix B. One might question the necessity of utilizing a three-level model. However, the data predicates this specific method. Because of data limitations, the measure of funding, particularly per-pupil funding, is at the district level[11]. Funding distribution is only reported at the district level and within-district distribution between schools is not reported within the Common Core of Data (NCES)[12]. In order for a three-level model to be utilized, the between-group variances at both the district and school level should be found to be significantly different. Using the "mixed" procedure, STATA outputs results of likelihood ratio (LR) test that "is a comparison of the fitted mixed model to standard regression with no group-level random effects" (Statacorp, 2013). The null (empty) model is assessed to check to see if there is a statistical difference between the fitted three-level model and the standard regression model. The LR test for the null model had a chi-square value of 20403.37 and was significantly different from zero. For this model, the LR test indicates that the null hypothesis should be rejected and the three-level model is significantly different from the standard (no group-level) regression model. For the final three-level model, the chi-square value of the LR test is 1937.32 and is significantly different from zero, indicating that the final three-level model is significantly different from the standard regression model using the same variables.

There are statistical/software limitations in using the LR test for any model with three or more levels. This is due to the "distribution theory for mixed-model comparison tests" (Statacorp, 2013). Specifically, there are two complications that should be considered:

> "First, the variances v_11 and v_22 are restricted to be positive, and testing them against zero presents the same boundary condition described above. Second, constraints such as v_11 = 0 implicitly restrict the covariance v_12 to be zero as well, and from a technical

[11] A description of the Illinois public school system, including district types, can be found in Appendix A.
[12] School-specific funding levels are available in select year for some Illinoi schools through the Office of Civil Rights database.

> standpoint, it is unclear how many parameters need to be restricted to reduce the model to one with no group-level random effects" (Statacorp, 2013).

Because of this conservative limitation, two-level models (school and district), both null and final, were checked. All four of the two-level models produced LR test results that were significantly different from zero. With the results of these tests, the LR test results from the three-level can be strongly argued as valid.

Results

To review, the three main research questions seek to understand the extent to which public high school funding is related to educational achievement (ACT Math Score), four-year post-secondary enrollment, and four-year post-secondary graduation. The sub-question for each asked if the relationships differ across race/ethnicity. The results are presented in the order of the research questions.

Math ACT Score

To address the first research question, hierarchical linear modeling was used to better understand the extent to which high school funding is related to a student's ACT math score. The average ACT math score for the population was 20.2, which is slightly under the national average for ACT math scores in 2003 (ACT, 2011)[13]. In the model 1 (Table 1.1), which does not include any covariates other than per-pupil revenue, we find that a one standard deviation increase in per-pupil revenue is associated with three-quarters of a point increase in math ACT score.

[13] The average ACT math scores reported are for the 2003 senior class. Illinois students took the ACT exam as high school juniors.

When student demographic and socioeconomic variables were added in model 2 (Table 1.1), the average math ACT score increased relative to model 1 by 0.7 points[14]. The relationship between per-pupil revenue and math ACT score increased slightly to almost a full point. Relative to male students, students that identified as female had lower math ACT scores, on average. Compared to white students, students that identified as Black, Latino, and American Indian/Alaskan Native had average math ACT scores that were 3.0, 2.3, and 2.8 points lower, respectively. Additionally, students that identified as Asian had average math ACT scores that were 1.4 points higher than white students. Furthermore, a one standard deviation increase in the reported parental income of a student was found to be associated with a half point increase in math ACT scores.

In model 3 (Table 1.1), school-level variables are added to the previous model. The average ACT score did not change but the relationship between per-pupil revenue and math ACT score decreased slightly. In model 3, which includes the school-level variables, a one standard deviation increase in per-pupil revenue was associated with approximately a three-quarter point increase in math ACT scores. A standard deviation increase in the average ITAC score was found to be associated with just under a one point increase in the average ACT math score. Additionally, a one standard deviation increase in the percentage of minority students is associated with a .4 point decrease in the ACT math score. The relationship between average math ACT scores and both the student demographic and socioeconomic variables did not change significantly between model 2 and 3, while remaining statistically significant.

To address the sub-question of does the relationship between per-pupil revenue and ACT math score differ by race, the final model (Table 1.1, model 4) includes an interaction term

[14] It should be noted that the sample is reduced for models 2 through 4 in Table 1. This is due to missing data.

between the variables per-pupil revenue and race. The coefficient of per-pupil revenue increases slightly in model 4 compared to model 3, from .722 to .925. The association between per-pupil revenue and ACT math score remained positive. The coefficients for both the student- and school-level variables were similar to model 3 and the relationships remained statistically significant.

Regarding the interaction terms (Table 1.1, model 4), the coefficient of interaction terms in regression expresses the rate of change in which the terms increase or decrease relative to the dependent variable. In this case, the interaction coefficient between the continuous variable, per-pupil revenue, and the categorical variable, race, expresses the rate in which ACT math scores changes relative to per-pupil revenue for each racial classification compared to the null racial classification, white. If the interaction terms were not significant, then we could assume that rate of change of ACT math scores relative to per-pupil revenue was not significantly different across the racial categories. In the case of this model, there were significant differences in the interaction term across the racial categories. White was the null racial classification used to assess the interaction between per-pupil revenue and race relative to ACT math scores. Relative to white students, as per-pupil revenue increases, the rate of change for ACT scores among Asian students increases and decreases for Latino and Black students.

Four-Year Post-Secondary Enrollment

A next step in the path of upward mobility is enrolling in an institution of higher education, particularly a four-year, baccalaureate degree granting institution. To address the second research question, hierarchical logistic regression modeling is used to assess the extent to which school funding is related to the likelihood of four-year post-secondary enrollment relative to any other outcome. In model 1 (Table 1.2), the baseline relationship between per-pupil revenue and four-year enrollment is addressed. As expected, a one standard deviation increase in per-pupil revenue is related to a 27% increase in the probability of enrolling in a four-year school relative to the probability of not enrolling in a four-year school.

Model 2 (Table 1.2) introduces student demographics and socioeconomic characteristics to the previous model. Relative to white students, Asian students are 34% more likely to enroll in a four-year institution. On the other hand, students that identified as Black, Latino, and American Indian/Alaskan Native were found to be 15%, 89%, and 188% less likely to enroll in a four-year institution relative to white students. Women were found to be 32% more likely to enroll in a four-year institution relative to men. Furthermore, an increase of a student's parental income of one standard deviation is related to a 16% increase in the likelihood of four-year enrollment relative to not enrolling. Overall, the relationship between per-pupil revenue and the likelihood of four-year enrollment remained consistent. For model 2 (Table 1.2), a one standard deviation increase in per-pupil revenue is associated with a 32% increase in the likelihood of enrolling in a four-year institution relative to not enrolling in a four-year institution.

The next model introduces school-level characteristic variables, namely the percentage of minority students and the school's ITAC score (Table 1.2, model 3). Both school level variables were found to be statistically significant but in opposite directions. An increase in the percentage of minority students for a student's attended school is related to a 19% decrease in the likelihood of four-year college enrollment relative to not enrolling. Conversely, an increase in the ITAC score for a student's attended school is related to a 22% increase in the likelihood of four-year college enrollment. The coefficients for the student demographic and socioeconomic variables remained stable and are still statistically significant. Relative to men, women are more likely to attend a four-year college. Compared to students that identified as white, students that identified as Asian are more likely to attend a four-year college, while students that identified as Black, Latino, or American Indian/Alaskan Native are less likely to attend a four-year college. The relationship between per-pupil revenue and four-year post-secondary was similar to model 2 and remained statistically significant.

Finally, interaction terms are included in model 4 (Table 1.2). The interaction between race and per-pupil revenue was found not to have a statistically significant relationship with the likelihood of four-year post-secondary enrollment. Although the interaction terms were not significant, the coefficient for per-pupil revenue increased compared to model 3. In model 4, a one-standard deviation increase in per-pupil revenue is associated with approximately a 35% increase in the likelihood of four-year enrollment to not enrolling in a four-year institution.

Four-year College Degree Attainment

Upon enrolling in a four-year college, degree attainment is the next logical major milestone on the path of educational mobility. To address the final research question, hierarchical logistic regression is, again, used to assess the extent to which school funding is related to the the likelihood of bachelor's degree attainment relative to any other outcome for students that enrolled in a four-year college. In model 1 (Table 1.3), the baseline relationship between per-pupil revenue and bachelor's degree attainment is addressed. A one standard deviation increase in per-pupil revenue is related to a 15% increase in the probability of student degree attainment.

Model 2 (Table 1.3) introduces student demographics and socioeconomic characteristics to the previous model. Relative to white students, Asian students are 24% more likely to obtain a bachelor's degree. On the other hand, students that identified as Black, Latino, and American Indian/Alaskan Native were found to be 2.4, 2.0, and 3.0 times less likely to enroll in a to obtain a four-year degree relative to white students. Women were found to be 46% more likely to obtain a bachelor's degree relative to men. Furthermore, an increase of a student's parental income of one standard deviation is related to a 13% increase in the likelihood of bachelor's degree attainment. Overall, the relationship between per-pupil revenue and the likelihood of four-year enrollment was similar compared to model 1. For model 2 (Table 1.2), a one standard deviation increase in per-pupil revenue is associated with a 19% increase in the likelihood of bachelor's degree attainment.

The next model introduces school-level characteristic variables, namely the percentage of minority students and the school's ITAC score (Table 1.2, model 3). Both school level variables were found to be statistically significant but in opposite directions. An increase in the percentage of minority students for a student's attended school is related to a 19% decrease in the likelihood of bachelor's degree attainment. Conversely, an increase in the ITAC score for a student's attended school is related to a 28% increase in the likelihood of bachelor's degree attainment. The coefficients for the student demographic and socioeconomic variables remained stable compared to model 2 and are still statistically significant. Relative to men, women are more likely to attend a four-year college. Compared to students that identified as white, students that identified as Asian are more likely to attend a four-year college, while students that identified as Black, Latino, or American Indian/Alaskan Native are less likely to attend a four-year college. Overall, the relationship between per-pupil revenue and the likelihood of four-year enrollment was smaller compared to model 2. For model 3 (Table 1.2), a one standard deviation increase in per-pupil revenue is associated with a 12% increase in the likelihood of bachelor's degree attainment.

Finally, interaction terms are included in model 4 (Table 1.2). The interaction between race and per-pupil revenue was found not to have a statistically significant relationship with the likelihood of four-year post-secondary enrollment. Although the interaction terms were not significant, the coefficient for per-pupil revenue increased compared to model 3. In model 4, a one-standard deviation increase in per-pupil revenue is associated with approximately a 35% increase in the likelihood of four-year enrollment to not enrolling in a four-year institution.

Limitations

There are some limitations to this study. Firstly, the school finance data is at district level and not school level, and, more importantly lacks specificity of how the money is allocated within the schools. More specific data that shows the allocation of revenue within schools could help address the concerns of aggregation bias found in prior school funding research (see Hanushek, Rivkin, & Taylor, 1996). The sample of the data, restricted to the graduating cohort of Illinois public high school students, provides a limitation in the generalizability of the findings. Additionally, the data does not account for prior educational experiences of the students, nor does it account for students changing high schools between the junior and senior years.

Regarding the ACT survey data, the student response data is self-reported. The accuracy of the parent’s income has to be accounted for when examining the results of the study. The parent’s income variable was measured using a 10-point categorical scale, which can be found in Appendix B. For each of the three models, the parental income variable was used as a continuous variable with the assumption that the difference between each category was the same. The use of ACT math scores as a measure of college readiness or preparation is also a limitation, both statistically and theoretically. College readiness is a multi-faceted construct. The ACT math score provides a small but significant glimpse into the actual college readiness of a student. ACT math is significant because it, along with the other subject test scores, are used in the admission process to some four-year colleges or universities.

Discussion

The results of the three models have shown that there is a significant relationship between school district per-pupil revenue and educational outcomes for Illinois public high school students. The findings confirm the results of prior research that student factors (parent's income), school factors (teacher quality and minority student percentage), along with per-pupil revenue are significantly related to measures of both educational achievement and attainment.

The findings show that money does matter in education and it matters to very significant outcomes relative to upward mobility. Research has shown that the path of social mobility includes some form of post-secondary education (Haveman & Smeeding, 2006). In this study, the results show that differential per-pupil funding is significantly related to three key points in the upward mobility path, namely college readiness, college enrollment, and college completion.

It should be noted that the coefficient of per-pupil revenue in each of the three models decreases when average teacher academic capital is introduced. It would be expected that this should happen given the time order of events in which these two variables occur relative to the school outcomes. Prior research suggests that increases in school funding through equalization efforts led to increases in the quality of teachers within schools (Darling-Hammond, 2000). What should also be noted is that, even after the teacher variable is introduced, the relationships between per-pupil revenue and two outcomes, ACT math scores four-year college enrollment, is still significant and positively related. Prior literature notes the need to understand how funds are allocated within schools and across school districts. The significance of per-pupil revenue after the introduction of average teacher characteristics reinforces the idea that there are other school characteristics beyond the teacher that influence student academic outcomes. Additionally, school factors outside of teaching may be influenced by per-pupil revenue. If all available school covariates that were related to per-pupil revenue were available and included in the model, it could be argued that the relationship of per-pupil revenue to the academic outcomes would become insignificant because the effect of revenue will be distributed through the related covariates. This further reinforces the need to better understand the path that revenue takes from the school district to the schools. If a measure of teaching does not make the relationship between revenue and educational outcomes insignificant, then the items that revenue is used for should be accounted for if we are to better understand how money matters.

The significance of the relationship between per-pupil revenue and bachelor's degree completion is also concerning. To see the association remain after four years brings about a few questions that warrant further exploration. In particular, why does the relationship remain after four years? Is this a nuance of this particular dataset? How much does high school matter in post-secondary completion? Is it the high school resources provided by the revenue that makes a difference? Is per-pupil revenue another measure of social capital within the school district?

The results of the interaction between per-pupil revenue and race signals cause for concern. Students that identified as White and Asian seem to benefit more, specifically in increased ACT math scores, from an increase in per-pupil revenue. Past research, as previously discussed, has shown that differential school funding makes a difference in educational outcomes in spite of any other factors. However, the results of the interaction terms in this study show that school funding is more strongly related to White and Asian students' ACT math scores more than Black students, and effects the likelihood of bachelor's degree completion for White students compared to Black students that enroll in a four-year college or university. What cannot be answered from this data is why this is the case.

One reason could be the impact of within-school tracking and access to college-preparation courses. In a review of Rosenbaum's (1978) *Making Inequality: The Hidden Curriculum of High School Tracking*, Heyns (1978) notes that "Rosenbaum argues, quite convincingly, that [school tracking] constitutes the most fundamental distinction within the school. Track placement defines the essential labels, branding students as 'brains' if they are college bound and stigmatizing those in other tracks" (p. 272). Oakes (1982) found that poor and minority students were disproportionately impacted educationally and by being in enrolled in low-academic tracks. Per-pupil revenue and the racial and socioeconomic composition of schools tend to be inversely correlated. Additionally, college-preparation courses tend to be positively related to standardized test scores, college entrance, and college matriculation. If Black and Latino students are disproportionately tracked in less academically rigorous courses in schools that have higher concentrations of white and Asian students and schools that have higher per-pupil revenue streams, the "effect" of increased per-pupil revenue can be inflated.

School contexts, particularly the socioeconomic and racial composition of schools, have been shown to be related to educational attainment. The combination of low-poverty and low-minority student enrollments in schools are positively correlated with educational achievement and attainment. Subsequently, schools with students that are high poverty and majority minority tend to be negatively related to educational achievement and attainment (Orfield & Lee, 2005). According to Martire (2014), Illinois public schools are some of the most segregated, both by race and socioeconomic status, schools in the country. Unfortunately, segregation by race and socioeconomic status in Illinois is one and the same. Per the GSA funding formula, over 60% of

Illinois public school revenue is based on local wealth. The interaction between the increased racial/socioeconomic segregation and the reliance on local property wealth to fund schools provides an explanation as to why an increase in per-pupil revenue benefits White and Asian students more than minority students. The increasing disparity in per-pupil revenue coupled with increased segregation may exacerbate the inequalities in educational outcomes across Illinois public schools, specifically for low-income and minority students. Increasing per-pupil revenue is beneficial. Increasing per-pupil revenue while schools become increasingly segregated is even more beneficial for the students that attend schools that are less segregated.

Conclusion

School funding matters to educational outcomes. Differential school funding matters even more. In this study, I explored the extent to which differential levels of school funding was related to three educational outcomes: ACT Math test scores, four-year post-secondary enrollment, and four-year post-secondary completion. Additionally, I explored the extent to which the relationship between school funding and the three educational outcomes differed across racial categories. Findings suggest that differential levels of school funding do matter for all three educational outcomes and the relationships differ across racial categories.

If there is to be equity in resource allocation to public schools, continuing to base the bulk of resource generation on local wealth seems to be a futile strategy. Senate Bill 16 (SB16) is the most recent legislative bill that seeks to change the GSA funding formula for public schools in Illinois. The main component of SB14 redirects the way state funds are appropriated, providing a higher percentage of state aid to public schools based on the poverty level within the school district. As of now, approximately 40% of the state's school funding allocation is based on poverty. SB16 would change that to 90%, directing more state funds to higher poverty school districts. This new bill is a step in the right direction in providing more equality of education opportunity for all of its citizens.

There may be cause for concern in providing a more equitable school funding system. The current Illinois GSA (general state aid) formula maintains an efficient but unequitable system of funding public schools. Redistribution of school funds from higher funded schools to lower funded schools may be an option. Parents and students residing in higher funded schools may have concern over loss of benefits. In exploring redistribution of school revenue on the economic well-being of families, Mahoney (2013) notes “school spending does not have an undesirable impact on horizontal equity or re-ranking for this population. Rather, the decrease in income inequality results mostly from a desirable improvement in vertical equity – or the shrinking of income gaps between these households” (p. 752-753).

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Table 1.1

Hierarchical Linear Regression Models for ACT Math Relative to Per-Pupil Revenue

		ACT Math							
		(1)		(2)		(3)		(4)	
	Variable	β	*p*	β	*p*	β	*p*	β	*p*
	Intercept	20.181		20.881		20.731		20.915	
District	Per-Pupil Revenue	0.747	**	0.895	**	0.722	**	0.925	**
Student	Female			-0.654	**	-0.651	**	-0.664	**
	American Indian/Alaskan Native			-2.763	**	-2.737	**	-2.672	**
	Black			-3.026	**	-2.911	**	-2.827	**
	Latino			-2.29	**	-2.266	**	-2.168	**
	Asian			1.375	**	1.382	**	1.336	**
	White								
	Parent's Income			0.426	**	0.428	**	0.38	**
School	Percent Minority					-0.387	**	-0.465	**
	ITAC					0.757	**	0.742	**
Interaction & 2nd Order Terms	American Indian/Alaskan Native							-0.006	
	Black							-0.457	**
	Latino							-0.412	**
	Asian							0.226	**
	White								
	PPR^2							-0.141	**
	$Income^2$							-0.007	*
	N=	92,771		69,397		69,397		69,397	

(*p < .05. **p < .01)

Table 1.2

Hierarchical Logistic Regression Models for Four-year Enrollment Relative to Per-Pupil Revenue

		Four-year Enrollment							
		(1)		(2)		(3)		(4)	
	Variable	Odds	*p*	Odds	*p*	Odds	*p*	Odds	*p*
	Intercept	0.581		0.697		0.662		0.696	
District	Per-Pupil Revenue	1.271	**	1.317	**	1.251	**	1.239	**
Student	Female			1.393	**	1.395	**	1.395	**
	American Indian/Alaskan Native			0.347	**	0.351	**	0.349	**
	Black			0.87	**	0.92	*	0.925	*
	Latino			0.529	**	0.537	**	0.541	**
	Asian			1.34	**	1.345	**	1.372	**
	White								
	Parent's Income			1.163	**	1.164	**	1.164	**
School	Percent Minority					0.892	**	0.956	**
	ITAC					1.224	**	1.222	**
Interaction & 2nd Order Terms	American Indian/Alaskan Native							1.155	
	Black							0.982	
	Latino							0.962	
	Asian							0.967	
	White								
	N=	92,771		69,397		69,397		69,397	

(*p < .05. **p < .01)

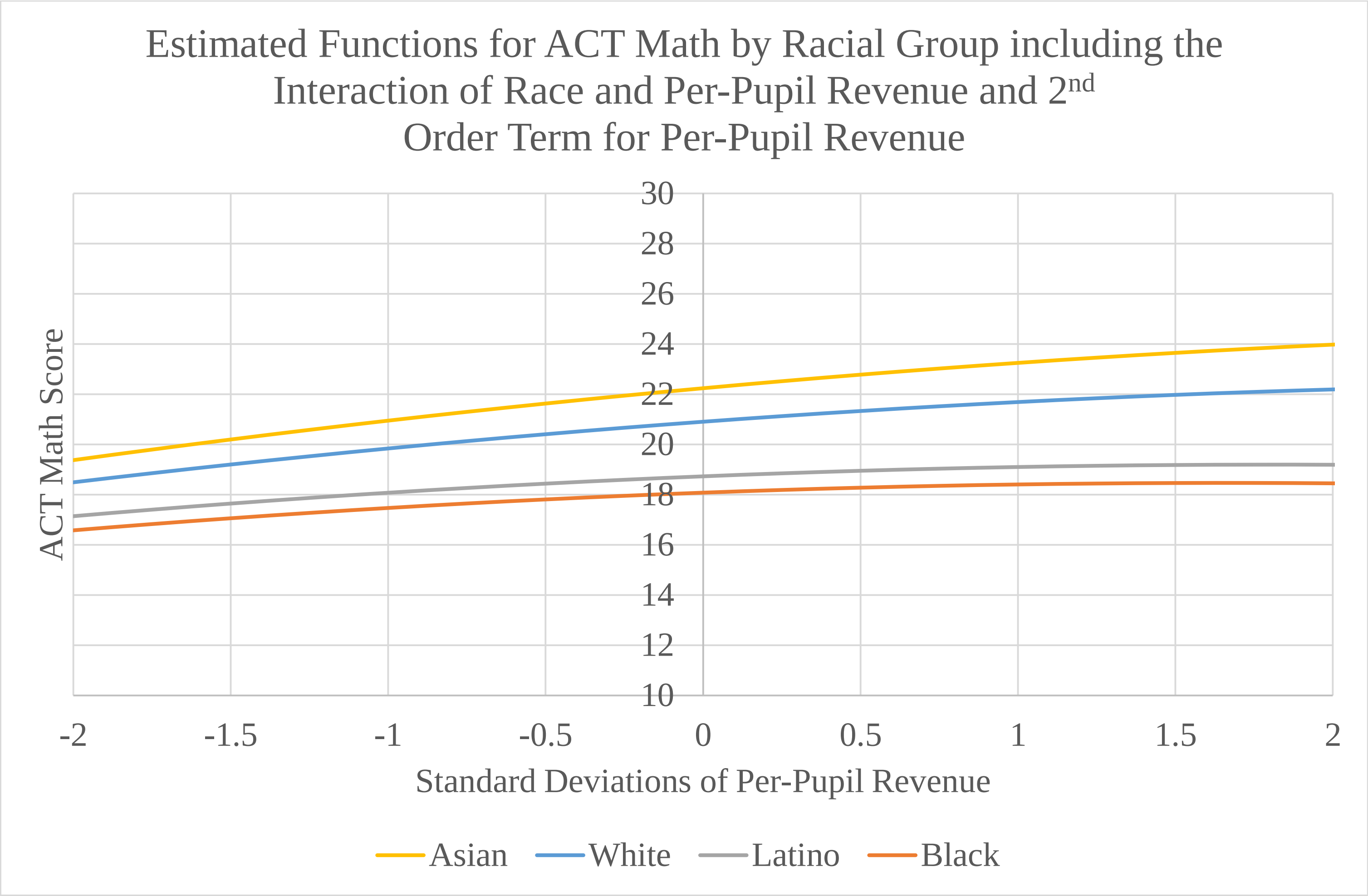
Table 1.3

Hierarchical Logistic Regression Models for Bachelor's Degree Attainment Relative to Per-Pupil Revenue

		Bachelor's Degree							
		(1)		(2)		(3)		(4)	
	Variable	Odds	*p*	Odds	*p*	Odds	*p*	Odds	*p*
	Intercept	1.892	**	1.592	**	1.485	**	1.476	**
District	Per-Pupil Revenue	1.149	**	1.195	**	1.118	**	1.142	**
Student	Female			1.465	**	1.476	**	1.478	**
	American Indian/Alaskan Native			0.331	**	0.340	**	0.327	**
	Black			0.415	**	0.506	**	0.516	**
	Latino			0.495	**	0.527	**	0.537	**
	Asian			1.24	**	1.257	**	1.341	**
	White								
	Parent's Income			1.128	**	1.130	**	1.131	**
School	Percent Minority					0.842	**	0.828	**
	ITAC					1.276	**	1.275	**
Interaction & 2nd Order Terms	American Indian/Alaskan Native							1.182	
	Black							0.881	*
	Latino							0.955	
	Asian							0.883	*
	White								
	N=	37,533		33,229		33,229		33,229	

(*p < .05. **p < .01)

Graph 1.1



Estimated Functions for ACT Math by Racial Group including the Interaction of Race and Per-Pupil Revenue and 2nd Order Term for Per-Pupil Revenue
ACT Math Score
30
28
26
24
22
20
18
16
14
12
10
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Standard Deviations of Per-Pupil Revenue
Asian
White
Latino
Black

Paper II

Teacher Quality and Educational Mobility for African American & Latino Students in Illinois

Abstract

This study explores the within-group relationship between enrollment in schools with, on average, higher teacher quality, as approximated by the index of teacher academic capital (ITAC)[15], and educational outcomes for Black and Latino students in Illinois public schools. It seeks to better understand the extent to which attending schools with above average teacher quality matters relative to educational outcomes for Black and Latino students in Illinois. To do this, I utilize quasi-experimental design techniques (propensity-score matching) to estimate the average-treatment-on-the-treated, the within-group benefit of attending a school with above average ITAC scores for Black and Latino students in Illinois. Utilizing longitudinal data for the Illinois high school graduating cohort of 2003, I show significant and positive relationships between attending a school with high-quality teacher and educational outcomes for both Black and Latino students. Specifically, increases of a half point for Black students and a full point for Latino students in ACT math scores and a 30% increase in the probability of four-year post-secondary enrollment for both Black and Latino students are associated with attending schools with, on average, higher teacher quality.

Introduction

School funding inequalities in the state of Illinois have been noted for years. For Illinois public schools, recent reports note that spending per student is higher in school districts with the fewest poor and minority students (Martire, 2014). Differential public school funding is associated with access to differential levels of school resources that are relative to factors that impact student mobility, specifically educational achievement and attainment. One of those school level resources affected by differential school funding is teachers or the relative quality of teachers within a school. From pre-kindergarten to middle school to high school and through college, attending schools with higher quality teachers[16] have been shown to increase the

[15] The ITAC measure was developed by White, Presley, and DeAngelis (2008) as a way to compare the average level of teacher quality of Illinois public schools. The development of the ITAC measure is discussed further in the Introduction section of the manuscript.
[16] Teacher quality refers to teacher academic preparation as measured by standardized test scores, basic skills exam scores, competitiveness of undergraduate college attended, or if the teacher holds proper certification.

likelihood of increased educational outcomes, both attainment and achievement, of students. Recent studies that focused on Illinois student populations show that, when examining within race group differences, the majority of Black and Latino students attend schools that, on average, have lower quality teachers. Specifically, the study notes that for the 2008 graduating cohort of Illinois public school students, 88 percent of Black and 67 percent of Latino students attend Illinois public schools with below-average teacher quality. Previous studies utilizing the same cohort, and in line with Martire (2014), note that Black and Latino students are much more likely to attend schools in which the poverty rate is high. Although it has been shown that Black and Latino students are more likely to attend schools are high in poverty and have lower quality teachers, their educational outcomes in relation to these conditions has yet to be explored and, thus, the focus of this article.

Illinois public schools, like the majority of schools across the country, are funded utilizing local property taxes. Of all states, the ratio of locally generated revenue to state financial assistance for Illinois public schools is greater than 2 to 1; equating to approximately 62 percent of public school funds drawn from local revenue, 30 percent of public school funds drawn from state financial assistance, and the remaining 8 percent drawn from federal grant aid. Property poor school districts are less likely to generate as much revenue for their local school districts compared to school districts that pull from more prosperous property, creating a disparity in the per-pupil funding available to property-poor and property-rich school districts. Increases in per-pupil funding have had mixed association with increased educational outcomes. Research on the differences in per-pupil funding have pointed out the need to understand how and where the revenue was spent, particularly on instruction. School funding research has shown that increases in per-pupil funding are associated with an increase in the total quality of teachers within the school district, measured by college entrance standardized test scores, teacher certification and licensure exams, the quality of teacher preparation programs attended, and the number of in-service years. Thus, state funding policy, combined with the hypersegregation among Black and Latino students in Illinois, has helped create condition where the majority of Black and Latino students in the state of Illinois are more likely to attend a school that employs teachers that have lower college entrance exam scores, fewer certifications, attended less selective teacher preparation programs, and have fewer tenured teachers.

In 2005, researchers with the Illinois Education Research Council (IERC) released a report that explored "the distribution of teacher quality in Illinois" (DeAngelis, Presley, and White, 2005) public schools for the 2002-2003 school year. Utilizing the *Teacher Quality Index (TQI)*, an average of the teacher quality within each school, the researchers found that majority-minority schools and majority low-income schools were more likely to have lower TQI ratings. In a follow-up report, the same researchers used a revised teacher quality index, *the Index of Teacher Academic Capital (ITAC)*, to explore the how the distribution of teacher quality changed between the 2000-2001 and the 2005-2006 school years White, Presley, and DeAngelis (2008). The results were similar to the initial report. Schools that were majority minority and majority low-income were more likely to have lower, read worse, ITAC scores. Schools with a higher percentage of low-income students and students of color are less likely to be able to rely on the local property tax base to generate revenue relatively equal to schools in which the majority of the student population is not low-income and not minority.

In Illinois, Black and Latino students are more likely to attend schools that are under-resourced in two ways, school funding (Lichtenberger & Dietrich, 2011) and teacher quality (DeAngelis, Presley, and White, 2005; White, Presley, & DeAngelis, 2008). As previously mentioned, prior studies have shown that, in aggregate, schools with higher quality teachers matter in the educational achievement and attainment of students. For this study, I would like to know the extent to which attending a school with, on average, higher quality teachers matter for Black and Latino students in Illinois public high schools. Thus, the purpose of this study is to assess the causal effect of attending schools with, on average, high teacher quality compared to attending schools with, on average, low teacher quality[17] on the educational achievement and attainment of Black and Latino students in Illinois.

The following research questions guide this study:

1. For Black students that attend Illinois public high schools, how does attending a school with above average ITAC scores compared to attending a school with below average ITAC scores relate to a) academic achievement, as measured by ACT math subject test scores; and b) academic attainment, as measured by enrollment in a four-year college or university?
2. For Latina/o students that attend Illinois public high schools, how does attending a school with above average ITAC scores compared to attending a school with below average ITAC scores relate to a) academic achievement, as measured by ACT math subject test scores; and b) academic attainment, as measured by enrollment in a four-year college or university?

This research paper is organized around the following four sections: (1) a review of the literature related to school resources, teacher quality measurement, and teacher quality indices relative to educational outcomes; (2) a discussion of the data and methods used to address the research

[17] High teacher quality is being used as the treatment for this paper.

questions; (3) an overview and then discussion of the results; and, finally, (4) identification of the limitations of the study and concluding remarks.

Review of the Literature

Understanding how and why better teachers tend to gravitate towards low-minority, low-poverty schools and school districts has been of constant interest for many years. Additionally, understanding the school resources that impact educational outcomes for students can be traced back to the oft-cited Coleman Report (Coleman et al., 1966). Although the research and research methods have been highly critiqued, Coleman et al. did conclude, among one of their conclusions, that there are a number of school inputs that can influence the educational outcomes of students. Specific to teachers as a school resource, there is an extensive research base that has explored the definition of teacher quality and how it is measured. From teacher background characteristics to their belief in the students that are being taught to post-hoc measures of quality, there has not been a consensus on how to measure teacher quality. As such, an expansive body of research has used different definitions and measures of teacher quality to assess the relationship between teacher quality and different educational outcomes for students. The literature review is organized as follows: a concise discussion on how different school resources relate to educational outcome; a brief consideration of research on measuring teacher quality; an overview of the literature that has used a composite index as a measurement of teacher quality and how the indices relate to educational outcomes.

School Resources and Educational Outcomes

The 1966 Coleman Report, more formally known as the Equality of Educational Opportunity Study, is highly regarded by many educational scholars as a foundational empirical study in the field of sociology of education. The study was the first of its kind in that it surveyed a nationally representative sample of students, teachers, and principals, amounting over 600,000 cases. The comprehensive survey included student socioeconomic status, school social and racial composition, school quality, community orientation, and educational achievement. The results of the study found little association between school quality and academic achievement and suggested that the differences in educational outcomes between Black and white students were more of a cause of family background and innate ability (Coleman et al., 1966). Using the same data and more nuanced statistical methods, Borman and Dowling (2010), over forty years after the initial report, found that "fully 40% of the differences in achievement can be found between schools" (p. 1201). Furthermore, Borman and Dowling (2010) concluded that school quality does matter to educational outcomes, specifically noting that "going to a high-poverty school or a highly segregated African American school has a profound effect on a student's achievement outcomes, above and beyond the effect of individual poverty or minority status" (p. 1202).

Another way to examine the relationship between school quality and educational outcomes is by assessing the relative rate of return on education for a group of individuals. Card and Krueger (1992) conducted an analysis that estimated "the effects of school quality-measured by pupil teacher ratio, average term length, and relative teacher pay on the rate of return to education for men born between 1920 and 1949" (p. 1). Specifically, Card and Krueger (1992) utilized 1980 census data to assess the quality of state school systems and its relationship to the shift in rates of return on education. After accounting for "a cohort and state of birth effect and a cohort and region of residence effect" (Card and Krueger, 1992, p. 4), average weekly earnings were used to measure rate of return for each individual. Card and Krueger (1992) reported that the results suggest that average teacher term length and relative teacher wage are significant and positively related to returns on education, while pupil teacher ratio was significant but negatively related to returns on education. In particular, “an increase in school quality raises schooling levels, particularly in the lower tail of the education distribution” (Card and Krueger, 1992, p. 33).

Another method to examine the relationship between school funding and educational outcomes is to assess the relationship between teacher quality and educational outcomes. Ferguson (1991) utilized Texas school district data to conduct this type of study. As the measure for teacher quality, Ferguson (1991) used the results of a teacher certification examination administered in 1986, number of years of teaching experience, and the teacher’s highest degree attained. Among the results, Ferguson (1991) reported that most of the estimated effect of schooling was due to a single measure of teacher quality (teacher certification examination scores). Furthermore, years of teaching experience produced “higher student test scores, lower dropout rates, and higher rates of taking the SAT” (Ferguson, 1991, p. 476). Also, Ferguson (1991) found that a district’s socioeconomic status is related to educational inequities and suggested that “districts of higher average socioeconomic status find it easier, with any given salary scale, to attract teachers with strong skills and experience” (p. 466). Ferguson (1991) showed that a district’s (in)ability to hire and retain the most qualified teachers is directly related to school funding and how the funds are allocated to instructional spending. This study provides an example of how the effect of school funding on educational outcomes is mediated through teachers.

Greenwald, Hedges, and Laine (1996), in conducting a meta-analysis of education production functions, concluded that “school resources are systematically related to student achievement and that these relations are large enough to be educationally important” (p. 384). More specifically, Greenwald et al. (1996) found increases in per-pupil expenditures, smaller class sizes, and, most specific to this study, "resource variables that attempt to describe the quality of teachers (teacher ability, teacher education, and teacher experience)" (p. 384) were all positively related to student achievement. School resources are also related to student aspirations. In defining teachers and teacher attributes as a school resource, Greene, Huerta, and Richards (2007) found that an increase in the average number of teachers with post-baccalaureate degrees is associated with an increase in the college aspirations of all students, noting specifically that "a 10% increase in both advanced degree rates is associated with almost a 19% increase in the percentage of students aspiring to a four-year college" (p. 62).

The interrelation of school resources can create an indirect impact on educational outcomes for students. Adamson and Darling-Hammond (2012) assessed how funding disparities between schools effects the distribution of teachers in two states. The researchers used state-level data to show how school funds are allocated and district data to the situations in which teachers have to deal with in order to make decisions about where to work. Adamson and Darling-Hammond (2012) note that, in California and New York, the highest-salaried school districts are more likely to have lower percentages of the following: low-income students, teachers without permanent credentials, teachers with a BA + 30 units or lower, and teachers with fewer than three years of teaching. Additionally, they note that schools with the highest percentages of low-income and students of color are more likely to have a higher percentage of teachers with a BA or lower, teachers with less than three years of experience, newly hired teachers, and teachers without credentials (Adamson & Darling-Hammond, 2012). Utilizing ordinary least-squares regression, Adamson and Darling-Hammond concluded "that teacher qualifications are related to overall student achievement at the district level, both before and after controlling for student characteristics" (p. 30).

Measuring Teacher Quality

In a 2007 report, Goe (2007) discusses a multifaceted model of the inputs to measuring teacher quality. This is based on a substantial review of empirical research that assessed the influence of teacher quality inputs on standardized test outcomes. The "Framework for Teacher Quality", discussed by Goe (2007), includes inputs (teacher qualifications, teacher characteristics), processes (teacher practices), and outcomes (teacher effectiveness). Darling-Hammond and Youngs (2002), too, conducted a research synthesis of the ways to measure teacher quality. Both Goe (2007) and Darling-Hammond and Youngs (2002) concluded that there is not one singular measure or attribute that best accounts for teacher quality. However, Goe (2007) notes that there are some measures of teacher quality that consistently appear in the literature as being significantly related to educational outcomes of students. Specifically, relevant to mathematics education, Goe (2007) writes "the effects of teachers with degrees in mathematics and appropriate certifications, and possibly higher level mathematics courses, appear to be strongly and consistently related to student achievement in mathematics" (p. 3). Secondly, teacher experience is also positively related to educational outcomes but the impact of the experience levels off after the first five years (Goe, 2007). Teacher preparation, including student-teaching and methodological coursework, also helped define a quality teacher (Darling-Hammond & Youngs, 2002).

Teacher Quality Indices and Educational Outcomes

Teacher quality has been operationalized in many forms across K-12 education research to examine the relationship between teacher quality and student educational outcomes: certification (Goldhaber & Brewer, 2000; Goldhaber & Anthony, 2007), teacher education (Darling-Hammond, 2000; Wenglinsky, 2000), evaluation (Borman & Kimball, 2005), examination scores (Darling-Hammond, 2000), experience (Wenglinsky, 2000), wages (Card & Krueger, 1992). Most relevant to this study are research studies that have use a composite measure or index of teacher quality. In discussing a way to analyze the American educational system, Mood (1969) mentions several indices that should be used in constructing a quantitative model to assess the student educational outcomes. Mood (1969) noted that the study of the factors that contribute to the educational growth of students is multifaceted and the parts are highly interrelated. Based on discussions within the United States Department of Education Mood (1969) discusses a theoretical hierarchy and statistical model to assess student educational achievement. The theoretical hierarchy shows the nested structure of education and, thus, the interrelated structure that influences education. He utilized this hierarchy to inform the construction of his statistical model, which forms the foundation of the use of a composite teacher quality index. Specific to teachers, Mood (1969) suggests that a teacher index should include "belief in educability of the pupils, competence in organizing and managing classroom, knowledge of field in which teaching, knowledge of educational technology, ability to communicate with students, and ability to motivate" (p. 773). Subsequently, Mood (1969) specifies that the teacher index measure quality, as part of the theoretical model. The index of teacher quality is one input and inferred to be positively correlated to a student's educational accomplishments. The suggested construction method, of the teacher index, along with the other indices, is to use "the major determinants as independent variables rather than orthogonal variables derived from the components by factor analysis" because the "model is intended not just for research workers but for educational administrators and for laymen who sit on school boards and in legislative bodies" (p. 776). One can argue for or against the necessity of Mood's suggestion in constructing a teacher index. Statistically, the use of a principal components analysis (PCA) to construct an index provides a linear weighted combination of the variables used, explaining the most of the variance of the data (Abdi & Williams, 2010). Thus, using PCA in index construction creates a more precise measure of the combined variables. The ITAC measure, constructed by IERC staff, was made in this way. Thus, the use of an index to relate teacher inputs to student outcomes is supported by Mood (1969). However, the method of construction differs because of the assumption of the need to simplify the measures.

A number of reviewed empirical studies mention that individual teacher measures are used as indices of teacher quality <insert citation>. Although theoretically powerful as discussed by Mood (1969), the construction of a teacher quality index has applicable limitations due to data restrictions. The majority of studies previously reviewed have only one or two variables that are related to teacher quality. Thus, the construction of a teacher quality index requires multiple measures of teacher quality.

The most closely related work to this study is the research, under the auspices of the Illinois Education Research Council (IERC), that discuss the construction and use of the Teacher Quality Index (TQI) for Illinois public schools (DeAngelis, Presley, and White, 2005); Presley, White, & Gong, 2005) and the Index of Teacher Academic Capital (ITAC) for Illinois public schools (White, Presley, & DeAngelis, 2008). Using principal components analysis, DeAngelis et al. (2005) combined six teacher attributes, averaged at the school level, to form the TQI for all public schools in Illinois for the 2003[18] school year. Utilizing the same statistical techniques and similar data that spanned five more years, White et al. (2008) used five of the six original teacher attributes to construct the ITAC, a refinement of the TQI.

[18] The year for school year is the spring semester year.

Presley et al. (2005) found that there was a high negative correlation between TQI and both the poverty level and percent minority of Illinois public schools. When the poverty level and percent minority are looked at together, Presley et al. (2005) found that schools that are highest percent minority and highest percent poverty have the lowest TQI scores. Relative to educational outcomes aggregated to the school level for schools that are high minority and high poverty, moving from the lowest TQI quartile to the second lowest TQI quartile was associated with an average increase in the percentage of students meeting or exceeding state standards. Utilizing student data that was aggregated to the school level, Presley et al. (2005) specifically note that the TQI "influence is most important at the high school level, where an increase of 1.0 in TQI (in this case one standard deviation) is related to an increase of 5.9 percentage points in the percent of students meeting or exceeding" state standardized test benchmarks (p. 14).

In addition, the single ITAC score for the 2003 school year, White et al. (2008) assessed the relative change in school ITAC scores across a six-year period for all Illinois public schools. Using the 2003 school year as a baseline, White et al. (2008), like Presley et al. (2005), found that "there is a positive link between the academic backgrounds of teachers and student achievement" (p. 4). Specifically, ITAC scores are negatively correlated with school poverty but the measured gap, between ITAC scores of the high poverty and low poverty schools, over the six years decreased (White et al., 2008). ITAC scores are also negatively related to percent minority levels but the gap in ITAC scores between the highest minority and lowest minority schools decreases over the six-year period. Using regression analysis, when combining the seven years of data, White et al. (2008) found that ITAC was positively related to the average achievement levels on standardized tests for all school levels but "has a larger impact on achievement levels in high schools than in elementary and middle schools" (p. 34). White et al.

(2008) do note that, relative to a school's minority and poverty concentrations, ITAC has a measure smaller impact. This suggests that teacher quality, as measured by ITAC, does not fully capture the educational outcome difference between schools and that there are other factors related to the educational outcomes of students. Over the six-year period, White et al. (2008) found that "schools that show gains in their teacher academic capital also show gains in student achievement" (p. 4).

In addition to the empirical studies produced by IERC that use either the TQI or ITAC, two studies have used a composition of weighted teacher input variables to construct a teacher quality index and statistically relate a teacher quality index to educational outcomes, broadly defined.

Lankford, Loeb, and Wyckoff (2002) used extensive administrative data from the state of New York to examine how teachers are sorted among New York public schools over a fifteen year period. To measure the quality of teachers within each school, the researchers combined a number of teacher related variables in to a teacher quality index using principal components analysis, with the index being at the teacher level They found a high correlation between teacher quality and student characteristics within the school that the teacher taught in. Lankford et al. (2002) note that "with the exception of the Utica-Rome region, urban schools have teachers with lesser qualifications" (p. 44). Additional findings show that there is a disparity in teacher quality across New York. In particular, Lankford et al. (2002) find that "nonwhite students experience less skilled teachers than white students, poor students experience less skilled teachers than non-poor students, and students with limited English proficiency experience less skilled teachers than non-LEP students" (p.44). Though this study was highly descriptive, the correlations suggests that the teacher quality index was related to educational inequalities and a similar measure could be incorporated in more nuanced statistical estimations.

As part of a research program in Pakistan, Behrman, Ross, and Sabot (2008) used a data set consisting of individual, household, and school data to assess the benefit of improving school quality compared to increasing the quantity of schools. The researchers constructed a teacher quality index that used a weighted average of “the teachers' cognitive scores, schooling attainment, reasoning ability, training, in-service training, and being born in the village” (Behrman et al., 2008, p. 97). Behrman et al. (2008) used the teacher quality index to define high and low quality schools within the specific data and concluded that an increase in the quality of school raised the cognitive skills at the primary level. The three point increase was about two-thirds the gain a student, that attended a low-quality primary school would have gained upon completing middle school (Behrman et al., 2008).

Based on this literature, I conclude that using a composite index to represent teacher quality, specifically the ITAC measure, is justified and ITAC may be a good indicator of average teacher quality within an Illinois public high school. A discussion of the data used in this study, along with the statistical methods used to answer the research questions, follows.

Data

The study utilizes a longitudinal data set comprised of both student-, school-, and district-level information regarding the Illinois high school class of 2003 (IERC:03). Data, accessed through shared data agreements with the Illinois Board of Higher Education (IBHE) and American College Testing (ACT), was compiled by the Illinois Education Research Council (IERC). Additionally, higher education enrollment data, received from the National Student Clearinghouse (NSC), and employment data, received from the Illinois Department of

Employment Security (IDES), was merged by IERC with the aforementioned data, resulting in a comprehensive statewide longitudinal data set that tracks the Illinois high school class of 2003 from high school to college and/or the workforce. (Lichtenberger & Dietrich, 2012).

In 2001, as part of the required Prairie State Achievement Examinations (PSAE), the state of Illinois required all high school juniors to take the American College Testing (ACT) examination. As such, the graduating class of 2003 was the second full cohort of students to sit for the exam. Prior to 2001, sitting for the ACT exam was optional for students, and, therefore, the results of the examination were not fully representative of all Illinois high school students. (Lichtenberger & Dietrich, 2012). Therefore, the strength of the IERC:03 data is that it provides data for the entire population of Illinois high school students from the class of 2003 and not just a sample. Issues associated with sampling error, weights, etc. don't apply; offering a distinct advantage over using accessible national and state based representative data.

The entire IERC:03 data consists of 115,676 cases, including student data from both private and public high schools. For the purposes of the proposed study, only data from students that attended public schools (n=628) and identified as African-American (n=8,906), American Indian/Alaskan Native (n=411), White (non-Latino) (n=58,004), Latino (n=7,460), or Asian/Pacific Islander (3,625) will be used (n=78,406). Of the 628 public high schools, 483 operate in unitary districts and the remaining 145 operate in high school districts[19].

Additionally, the study utilizes student data obtained from the optional ACT Student Interest Profiler survey administered during the examination along with post-secondary

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[19] Unitary districts are comprised of both elementary and secondary schools where high-school districts are only comprised of secondary schools. The difference is made here because the revenue data available is at the district level and not the individual school. Revenue allocation decisions to each school are made at the district level. Per-pupil revenue is averaged across all students in a district. For unitary districts, where some students are in elementary schools, average per-pupil revenue for high-school students will be underestimated.

enrollment data provided by the NSC. The data collected contains self-reported student data including demographic information, self-reported high school transcript information, and information related to the student's post-high school academic and/or professional trajectory. The post-secondary enrollment information contains information regarding the type of post-secondary institution initially attended, if any, and the characteristics of the institution. Furthermore, the study utilizes high school data associated with each student. The high school data consists of information regarding the school's enrollment, funding and expenditure levels, standardized test (PSAE) averages and ranges, and teacher characteristics. A list of the variables and their descriptions can be found in tables D.1 and D.2 of Appendix D.

ITAC

ITAC is a variable that was created by White, Presley, and DeAngelis (2008) to assess the varying levels of teacher quality among Illinois public schools. The ITAC is a weighted combination of five school level attributes "that were found to be most theoretically and statistically similar" White, Presley, & DeAngelis, 2008, p. 9). The five measures that comprise the ITAC are: "1. The mean ACT composite score of teachers at the school; 2. The mean ACT English score of teachers at the school; 3. The percentage of teachers at the school who failed the Illinois Basic Skills test on their first attempt; 4. The percentage of teachers at the school who were emergency/provisionally certified; 5. The mean Barron's competitiveness ranking of the undergraduate institutions attended by the school's teachers (Barron's, 2003)" (White, Presley, & DeAngelis, 2008, p. 9-10). These five components were chosen based on a two studies (Rice, 2003; Wayne & Youngs, 2003) that reviewed the "measureable attributes of teachers, such as their number of years of teaching, experience, and student outcomes" (DeAngelis, Presley, &

White, 2005, p. 4). Principal component analysis was used to construct ITAC[20]. A table of the components and weights can be found in Appendix E.

Methodology

In order to better assess the effect of a treatment, such as enrollment in a high-ITAC school, using non-experimental data, one must try to address the inherent bias found in the data. Use of data matching techniques, propensity score matching being one, is one way to help reduce selection bias within data. The use of propensity score matching addresses the bias issue by weighting the counterfactual, in this case not having access to higher quality teaching, to create a relatively balanced sample of students in the constant case compared to the test case.

There are a number of reasons why there could be differences in why some Black and Latino students attend schools with better teachers than others. Black and Latino students in Illinois are more likely to attend schools that are more homogenous by race and socioeconomic status, particularly majority minority and majority low-income compared to White students. Schools that are majority minority and majority low-income have been associated with being under-resourced financially and, on average, are more likely to have teachers that are newer, less subject specific certified, and have fewer education credentials, all of which positively correlate with increased educational attainment and achievement. Specific to Illinois, White et al (2008), in discussing all public K-12 schools in Illinois, notes that “schools with 99 to 100 percent minority students have much lower ITAC averages than other schools” (p. 19). From the IERC:03 data, 81% of African American students and 65% of Latino students attended a high school whose average ITAC score was in the bottom half of all public Illinois schools.

[20] The ITAC construction was based on previous work done by DeAngelis et al. (2005). A discussion on the methods used to construct the ITAC can be found in both DeAngelis et al. (2005) and White et al. (2008).

When comparing the within-group relationship[21] between attending a high-ITAC school and educational outcomes, the resulting effect sizes produced using ordinary least-squares regression may underestimate the relationship. Thus, for efficient causal inference, it is best to compare groups that are similar as possible notes Stuart (2010). Comparing groups that are as similar as possible should also be the case for descriptive or correlational inference. For this study, inverse-probability-of-treatment-weighting (IPTW) is used to separately re-weight the group of African American and the group of Latino students based on each student's predicted probability of attending a high-ITAC school. The probability is calculated using logistic regression with attending a high-ITAC school being the dependent variable and a vector of observed variables, which are assumed to be independent of the final educational outcomes[22].

Upon on re-weighting the samples, standard OLS and logistic regression techniques are used to assess the relationship between the dependent variables (ACT mathematics score and four-year college enrollment) and high-ITAC school attendance along with other covariates. In re-weighting the sample of students in both groups that are not enrolled in high-ITAC schools and conducting the regression analysis, I estimate the average-treatment-effect-on-the-treated (ATT). The ATT equation can be written as the following:

$$E\langle Y_{1i} - Y_{0i} | T_i = 1\rangle = E\langle Y_{1i} | T_i = 1\rangle - E\langle Y_{0i} | T_i = 1\rangle.^{23} \quad (2.1)$$

Rosenbaum (2005) summarizes this equation, noting that "the treated-minus-control differenced in mean outcomes is an unbiased and consistent estimate of the average effect of the treatment on

[21] This refers to the specific examination of the effect of attending a high-ITAC school on educational outcomes within the sample population of Black students in Illinois and then within the sample population of Latino students in Illinois.
[22] The predicted probabilities of the logistic regression are considered the propensity scores for each student.
[23] See Holland (1986).

the subjects in the experiment" (p.3). For this study, the ATT for Black and Latino students estimates the within-group average effect for students enrolled in high-ITAC schools.

There are three assumptions that are made when using IPTW or any quasi-experimental design. First is the conditional-independence (CI) assumption. The CI assumption states that the outcome (ACT math score and four-year-college enrollment) is independent of the treatment (high-ITAC school enrollment) conditional on a set of pre-treatment variables (Rosenbaum & Rubin, 1983). The second assumption is that the sample independent and identically distributed (i.i.d). If the (i.i.d.) assumption holds, the treatment and outcome conditions for each student is unrelated to the treatment and outcome conditions of other students. Finally, use of IPTW assumes that there is overlap of the propensity to receive the treatment for the population included in the analysis and sets the region of common support. The region of common support for this data are where students who enrolled in high-ITAC schools can be matched to students who did not enroll in high-ITAC schools.

Method

Propensity score matching using IPTW

I use quasi-experimental design to recreate an experiment and estimate the counterfactual. Using IPTW, instead of reweighting the entire population of each group, I reweight the control group (students that attend low-ITAC schools) based on their probability of attending a high-ITAC school. To estimate ATT, the treatment group (students that attend high-ITAC schools) is not reweighted. More specifically, the treatment group is assigned a weight of one. As previously mentioned, the control groups for both the African American and Latino populations are larger than their respective treatment groups. So, the control group groups are reweighted down in number. The resulting OLS and logistic regression effect sizes are then compared to the non-weighted regression output.

The following OLS regression model is used to address the research questions related to college readiness:

$$Y_i = \alpha + \left[\sum_{j=0}^{1} \beta_{j-1} I_j \{t_i = T_j\}\right] + X_i' \delta + e_i. \text{ (2.2)}$$

where Y_i is the outcome (e.g. ACT math score) of student i, α is a constant term, t_i is the ITAC category for the students, T_j is the j^{th} ITAC category the model is predicting membership in (e.g. T_j is the category "high ITAC enrollment"), I_j is an indicator variable (evaluating the truth of the argument in {…}) taking on the value of 1 for students of that ITAC category (and 0 otherwise), X_i' is a vector of student and school characteristics, and Y_i is an error term.

The following logistic regression model is used to address the research questions related to four-year college enrollment:

$$P_i = \frac{e^{\left[\sum_{j=0}^{1} \beta_{j-1} I_j \{t_i = T_j\}\right] + X_i'}}{1 - e^{\left[\sum_{j=0}^{1} \beta_{j-1} I_j \{t_i = T_j\}\right] + X_i'}}. \text{ (2.3)}$$

where P_i is the outcome (e.g. probability of four-year college enrollment) of student i, t_i is the ITAC category for the students, T_j is the j^{th} ITAC category the model is predicting membership in (e.g. T_j is the category "high ITAC enrollment"), I_j is an indicator variable (evaluating the truth of the argument in {…}) taking on the value of 1 for students of that ITAC category (and 0 otherwise), X_i' is a vector of student and school characteristics, and Y_i is an error term.

$$Pr\langle t_i = T_j | X \rangle = \frac{e^{X_i' \delta}}{1 - e^{X_i' \delta}}, \text{where } X_i' \delta = 0. \text{ (2.4)}$$

The weights are constructed as:

$$W_j = \left\langle \frac{1}{\widehat{\Pr}(t_i = T_j)} \middle| (t_i = T_j) \right\rangle, \text{(2.5)}$$

where $\widehat{\Pr}(t_i = T_j)$ is the predicted probability of student *i* being a member of category *j*. The final estimation models will look the same as Equations (1) and (2), but each student is reweighted by the student's W_j found in Equation (4).

Results

The estimated coefficients for the IPTW OLS regression models for each group can be found in tables 2.5 and 2.6. The estimated coefficients for the IPTW logistic regressions models can be found table 2.7 and 2.8.

Teacher Quality and ACT Math Scores

The average ACT math score among the matched sample for African American students is 17.4 and is 18.2 for Latino students. For both African American and Latino students, enrollment in a school with higher than average ITAC is associated with an increase of approximately one point for both populations (tables 2.5 and 2.6).

When student characteristics are added to model 2 for both African American and Latino students (tables 2.5 and 2.6), attending a school with high ITAC remained statistically significant and is associated with approximately a one-point increase in ACT math score. A one standard deviation increase in parent's income is statistically significant and associated with an increase of just over one point for both African American and Latino students. For both African American and Latino students, disability status is associated with a decrease average ACT math score of approximately one point or one-fifth of a standard deviation for ACT math[24]. For Latino

[24] The standard deviation in ACT math score is 5.5 points for the public school population in the IERC:03 data.

students, those that selected that English is their first language had on average an increase of one-half a point.

The addition of education related variables in Model 3 for both African American and Latino students (tables 2.5 and 2.6) does not produce surprising results. The addition of all four variables resulted in statistically significant effect sizes. The effect sizes for the education content variables were very similar for both Latino and African American students. A one standard deviation increase in the reported high school grade point average was associated with a one and one-half point increase in the average ACT math score for African American and Latino students, respectively. For both African American and Latino students, enrollment in a college preparatory curriculum or on a college preparatory track is associated with a one point increase in ACT math scores. Previous or current enrollment in algebra 2 for both African American and Latino students was associated with just over a one point increase in the average ACT math score. Additionally, previous or current enrollment in an advanced placement (AP) math course was associated with a two point increase in the average ACT math score for both groups. After accounting for education and curriculum related variables, the effect size of attending a high ITAC school remained significant for both African American and Latino students, with an associated increase of just over one point for both groups.

School context also matters to educational outcomes. In model 4 (tables 2.5 and 2.6), school funding and school racial composition variables were added. For African American students, a one standard deviation increase in per-pupil revenue was associated with a quarter point increase in ACT math score and a one standard deviation increase in the percentage of white students was associated with a half point increase in ACT math scores. For Latino students, an increase in the percentage of white students in the school was associated with approximately a half point increase in ACT math score. In the full model, the effect size of attending a school with, on average, high ITAC remained statistically significant for both African American and Latino students, a one-half point increase for African American students and a one point increase for Latino students.

Teacher Quality and 4-Year Enrollment

In addressing the second part of each research question, logistic regression was used to estimate the relative probability of enrolling in a four-year college or university at any time post high school. Tables 2.7 and 2.8 provide the model structure and output for African American and Latino students. Attending a high ITAC high school was associated with an increase in the probability of attending a four-year college of twenty-four percent for African American students and twenty-nine percent for Latino students relative to not attending a four-year college for each population (Tables 2.7 and 2.8, model 1). The effect size of ITAC in the null model was significant for both groups.

When student characteristics are added to model 2 (see Tables 2.7 and 2.8), attending a school with high ITAC remained a statistically significant predictor of attending a four-year college. For African American students, attending a high ITAC school increased the probability of attending four-year college by twenty-eight percent and, for Latino students, thirty-seven percent. Women in both populations were associated with an increased probability of attending a four-year college compared to their male counterparts, fifty-two percent more likely for African American women and twenty-four percent more likely for Latinas. A one standard deviation increase in parental income increased the likelihood of attending a four-year college by fifty percent and sixty-two percent for African American and Latino students, respectively. For Latino students, reporting that English was their first language was statistically significant and increased the probability of attending a four-year college by thirty-three percent.

In model 3 (Tables 2.7 and 2.8), academic performance and education curriculum variables are introduced. The effect size of attending a school with high ITAC remained statistically significant for African American and Latino students. African American and Latino students that attended a high ITAC school are twenty-nine percent and forty-two percent, respectively, more likely to enroll in a four-year college compared to comparable students that did not attend a high ITAC school. Of the four education variables added in model 3, a one standard deviation increase in a student's reported GPA is associated with an increase in the likelihood of attending a four-year college by close to one hundred percent for both groups. Enrollment in a college preparatory curriculum or on a college preparatory track increased the likelihood of four-year college enrollment by seventy-three and sixty percent for African American and Latino students, respectively. Students that reported having taken algebra 2 had an increased likelihood of four-year college enrollment of nearly one hundred percent for Latino students and just over fifty percent for African American students compared to those students that reported not taken algebra 2.

Model 4 (Tables 2.7 and 2.8) introduces school context variables to the statistical model, specifically per-pupil revenue and the percent of white students. An increase in per-pupil expenditures by one standard deviation is associated with a twenty-three percent increase in the likelihood of an African American student attending a four-year college. An increase in per-pupil revenue was not statistically significant for Latino students relative to four-year college enrollment and an increase in the percentage of white students was not statistically significant for either group. After introducing the school context variables, the effect size of attending a high

ITAC school remained statistically significant. Attending a high ITAC school is associated with an increase in the likelihood of attending a four-year college by approximately thirty percent for both African American and Latino students.

Limitations

There are some limitations to this study. Firstly, ITAC is at the school level and not the classroom level. The educational course sequence, either by choice or by school tracking, directly impacts a student's college preparation, and, subsequently, the chance for post-secondary entrance (Wimberly & Noeth, 2005). Having the transcript information for each student could help isolate which students are enrolled in college-preparation courses. Although the data are longitudinal, the data lacks information for the preparation of the student up to the junior year in high school. Additionally, measures of achievement are not included beyond the initial year, which limits the ability to assess achievement growth.

Regarding the ACT survey data, the student response data are self-reported. The accuracy of the parent's income has to be accounted for when examining the results of the study. The parent's income variable was measured using a 10-point categorical scale, which can be found in Appendix B. For each of the three models used, the parental income variable was used a continuous variable with the assumption that the difference between each category was the same. The use of ACT math scores as a measure of college readiness is also a limitation, both statistically and theoretically. Understanding the college readiness of a student is multi-faceted. The ACT math score provides a small but significant glimpse into the actual college readiness of a student. ACT math is significant because it, along with the other subject test scores, are used in the admission process to some four-year colleges or universities.

Discussion & Conclusion

To review, this study sought to better understand the extent to which attending a school with, on average, a higher ITAC score is related to students' ACT math subject test scores and likelihood of enrollment in a four-year college or university. The study explored the within-group relationships specifically for Black and Latino students in Illinois public high schools[25].

Based on the results, I have shown that, even after accounting for covariates related to both academic achievement and academic attainment, the relationship between attending a school with high ITAC scores and educational outcomes for both African American and Latino students is statistically significant. The disproportionate distribution of African American and Latino students in schools with low teacher quality impacts the opportunities for educational mobility for each group. Additionally, the findings and the use of the ITAC score as a measure of average teacher quality in schools and provide evidence that the measure can be used in future studies on Illinois public schools. The results of this study should not be taken as causal. However, the statistically significant relationships between attending a school with, on average, higher teacher quality and both an increase in ACT math subject test scores and the likelihood of attending a four-year college should not go unnoticed. Both of the measured outcomes are positively related to the upward mobility of students. Standardized tests, like the ACT, are still used in college admission's decisions in selective schools. An increase in the ACT math subject score could influence the college going decisions of students. Additionally, the ACT math scores are used for academic track placement at some post-secondary schools, with some students being placed in remedial college courses. Students that start in remedial courses, especially in math, are

[25] For clarification, African American students that attended schools with above-average ITAC scores were compared to African American students that attended schools with below-average ITAC scores. The same was done for Latino students.

less likely to persist in a math-oriented major, which decreases the likelihood of a student finishing a degree in Science, Technology, Engineering, and Math (STEM).

A reduction in the likelihood of attending a four-year college may also restrict the likelihood of upward mobility for a student. Although there is a focused effort to increase the college going rate across both 2- and 4-year schools, studies have shown that just attending a four-year college increases the income opportunities. Furthermore, matriculation through a four-year college or university has a higher return than that of matriculation through a two-year college. If a disproportionate number of African American and Latino students are less likely to attend a four-year college based on the quality of teachers in the school they attend, then these same students may also be less likely to graduate from a four-year college. Thus, the chance for upward mobility for these students may be diminished based on factors that are beyond their control.

Although this study does not claim to have a causal link between ITAC and educational outcomes, the highly correlated results should draw attention to the factors that help to create the inequitable distribution of teachers among African American and Latino students in Illinois.

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Table 2.1

Differences between Low-ITAC & High-ITAC Groups for the African American Student Population, in the non-weighted and weighted samples

	Unmatched sample (*N*=5014)				IPTW-matched sample (*N*=5014)			
	Low ITAC	High ITAC	*p*-value on F-Test		Low ITAC	High ITAC	*p*-value on F-Test	
CRSENG9	1.0027	0.00027	0.9035		1.002	0.001	0.556	
CRSENG10	1.0024	-0.0015	0.4422		1.001	0.0001	0.884	
CRSENG11	1.0127	-0.0027	0.53		1.01	0.0002	0.941	
CRSUSHIS	1.016	0.017	0.003	*	1.03	0.003	0.593	
CRS_ALG1	1.059	0.032	0.0074	*	1.099	-0.007	0.518	
CRSBIO	1.042	0.0311	0.002	*	1.08	-0.007	0.487	
CRS_GEOM	1.135	0.038	0.022	*	1.192	-0.019	0.207	
EDOPSERV	1.09	0.015	0.143		1.103	-0.0003	0.965	
CRSWDHIS	1.289	0.104	0	*	1.408	-0.016	0.461	
CRSCHEM	1.34	0.115	0	*	1.466	-0.0222	0.311	
CRGNSCI	1.493	0.226	0	*	1.741	-0.022	0.398	
CRS_ALG2	0.679	0.072	0	*	0.748	0.003	0.787	
LOCALE	0.887	0.644	0	*	1.665	-0.133	0	*
PINCOME	3.357	-0.468	0	*	2.879	0.0103	0.74	

*$p<.05$

Table 2.2

Differences between Low-ITAC & High-ITAC Groups for the Latino Student Population, in the non-weighted and weighted samples

	Non-weighted sample (*N*=3972)				IPTW sample (*N*=3972)			
	Low ITAC	High ITAC	*p*-value on F-Test		Low ITAC	High ITAC	*p*-value on F-Test	
CRSENG9	1.008	0.0023	0.578		1.013	-0.003	0.548	
CRSENG10	1.009	0.001	0.709		1.017	-0.006	0.19	
CRSENG11	1.021	0.006	0.271		1.031	-0.004	0.479	
CRSUSHIS	1.025	0.0018	0.758		1.032	-0.005	0.391	
CRS_ALG1	1.074	0.024	0.055		1.094	0.004	0.766	
CRSBIO	1.054	0.028	0.008	*	1.096	-0.014	0.25	
CRS_GEOM	1.19	0.0596	0.001	*	1.293	-0.043	0.036	*
EDOPSERV	1.132	0.0141	0.206		1.167	-0.0234	0.045	*
CRSWDHIS	1.334	0.0652	0.006	*	1.461	-0.016	0.014	*
CRSCHEM	1.526	0.07	0.009	*	1.618	-0.023	0.401	
CRGNSCI	1.497	0.003	0.906		1.524	-0.0231	0.395	
CRS_ALG2	0.6502	0.0513	0.001	*	0.689	0.0127	0.386	
LOCALE	1.064	0.816	0	*	2.46	-0.582	0	*
PINCOME	3.34	-0.474	0	*	2.73	0.132	0	*

*$p<.05$

Table 2.3

Un-weighted and Weighted Model Variables for African American Students

	Pre-Weighted Variables		Weighted Variables	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Female	0.5832	0.493	0.608	0.488
Per Pupil Expenditures	-0.1472	0.8928	-0.181	0.858
Percent White	1.498	0.9956	-1.48	1.016
Parent Income	-0.718	0.919	-0.697	0.931
HS GPA	-0.456	0.98	-0.314	0.968
Took Algebra 2	0.69	0.463	0.693	0.461
Took AP Math	0.334	0.473	0.367	0.482
English at Home	0.981	0.138	0.983	0.13
Disability Status	0.018	0.132	0.025	0.156
College Prep Curriculum	0.405	0.491	0.44	0.496

Table 2.4

Un-weighted and Weighted Final Model Variables for Illinois Latino students

	Pre-Weighted Variables		Weighted Variables	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Female	0.537	0.499	0.562	0.496
Per Pupil Expenditures	-0.083	0.895	-0.04	0.896
Percent White	-0.946	1.06	-0.802	1.05
Parent Income	-0.607	0.888	-0.547	0.901
HS GPA	-0.408	1.03	-0.249	1.107
Took Algebra 2	0.66	0.474	0.671	0.47
Took AP Math	0.286	0.452	0.306	0.461
English at Home	0.521	0.5	0.556	0.497
Disability Status	0.009	0.094	0.011	0.103
College Prep Curriculum	0.334	0.472	0.386	0.487

Table 2.5
ATT IPW estimates of multiple OLS regression analysis of factors related to ACT mathematics scores for African American students in Illinois

Variables	Model 1			Model 2			Model 3			Model 4		
	β	SE	p	β	SE	p	β	SE	p	β	SE	p
ITAC	1.10	0.17	**	1.08	0.17	**	1.19	0.14	**	0.56	0.18	**
Female				-0.32	0.18		-1.10	0.15	**	-1.07	0.14	**
Parent Income				1.29	0.09	**	0.76	0.07	**	0.65	0.07	**
English				0.88	0.50		1.12	0.46	*	1.15	0.43	**
Disability Status				-1.24	0.38	**	-1.13	0.32	**	-1.17	0.31	**
HS GPA							1.51	0.08	**	1.48	0.08	**
Took Algebra 2							1.13	0.13	**	1.18	0.14	**
Took AP Math							2.26	0.16	**	2.46	0.17	**
College Prep Curr.							1.04	0.13	**	1.02	0.13	**
Per Pupil Revenue										0.27	0.07	**
Percent White										0.52	0.08	**
Constant	17.37	0.10	0.00	17.17	0.50	0.00	15.35	0.48	0.00	15.89	0.47	0.00
Observations	5014.00			5014.00			5014.00			5014.00		
R^2	0.02			0.12			0.43			0.44		

*$p < .05$. **$p < .01$

Table 2.6

ATT IPW estimates of multiple OLS regression analysis of factors related to ACT mathematics scores for Latino students in Illinois

Variables	Model 1			Model 2			Model 3			Model 4		
	β	SE	p	β	SE	p	β	SE	p	β	SE	p
ITAC	0.97	0.19	**	1.10	0.18	**	1.15	0.15	**	0.99	0.18	**
Female				-0.37	0.20		-1.14	0.16	**	-1.12	0.16	**
Parent Income				1.18	0.16	**	0.67	0.09	**	0.60	0.09	**
English				0.55	0.19	**	0.46	0.44	**	0.24	0.16	
Disability Status				-1.41	0.57	*	-1.67	0.55	**	-1.76	0.55	**
HS GPA							1.59	0.09	**	1.57	0.09	**
Took Algebra 2							1.44	0.16	**	1.49	0.16	**
Took AP Math							2.24	0.21	**	2.31	0.21	**
College Prep Curr.							1.06	0.18	**	1.12	0.18	**
Per Pupil Revenue										0.01	0.08	
Percent White										0.40	0.09	**
Constant	18.18	0.15	0.00	18.24	0.22	0.00	16.90	0.23	0.00	17.11	0.25	0.00
Observations	3974			3974			3974			3974		
R^2	0.01			0.095			0.44			0.45		

*$p < .05$. **$p < .01$

Table 2.7

ATT IPW estimates of multiple logistic regression analysis of factors related to 4-year enrollment for African American students in Illinois

Variables	Model 1			Model 2			Model 3			Model 4		
	β	SE	p	β	SE	p	β	SE	p	β	SE	p
ITAC	1.24	0.10	**	1.28	0.10	**	1.29	0.11	**	1.32	0.15	*
Female				1.52	0.13	**	1.15	0.10		1.15	0.10	
Parent Income				1.50	0.06	**	1.29	0.06	**	1.28	0.06	**
English				1.19	0.37		1.24	0.39		1.24	0.39	
Disability Status				1.29	0.33		1.37	0.37		1.34	0.37	
HS GPA							1.94	0.10	**	1.95	0.10	**
Took Algebra 2							1.57	0.16	**	1.51	0.15	**
Took AP Math							1.24	0.12	*	1.26	0.12	*
College Prep Curr.							1.73	0.15	**	1.74	0.15	**
Per Pupil Revenue										1.23	0.06	**
Percent White										0.93	0.05	
Constant	0.95	0.04	0.00	0.71	0.22	0.34	0.44	0.16	0.02	0.41	0.14	0.01
Observations	5014.00			5014.00			5014.00			5014.00		

*$p < .05$. **$p < .01$

Table 2.8

ATT IPW estimates of multiple logistic regression analysis of factors related to 4-year enrollment for Latino in Illinois

Variables	Model 1			Model 2			Model 3			Model 4		
	β	SE	p	β	SE	p	β	SE	p	β	SE	p
ITAC	1.29	0.13	*	1.37	0.14	**	1.42	0.16	**	1.30	0.16	*
Female				1.24	0.14	*	0.90	0.10		0.90	0.10	
Parent Income				1.62	0.10	**	1.43	0.09	**	1.14	0.09	**
English				1.33	0.14	**	1.30	0.15	*	1.27	0.15	*
Disability Status				1.25	0.82		1.31	1.00		1.24	0.88	
HS GPA							2.19	0.14	**	2.18	0.14	**
Took Algebra 2							1.92	0.25	**	1.89	0.25	**
Took AP Math							1.25	0.16		1.28	0.17	
College Prep Curr.							1.60	0.20	**	1.63	0.20	**
Per Pupil Revenue										1.09	0.07	
Percent White										1.07	0.07	
Constant	0.52	0.05	0.00	0.40	0.05	0.00	0.24	0.04	0.00	0.26	0.05	0.00
Observations	3974			3974			3974			3974		

$*p < .05$. $**p < .01$

Paper III

How Much Does School Quality Matter:
Exploring Heterogeneous Effects of School Quality across Socioeconomic Status

Abstract

One of the factors that influence the enrollment of students in post-secondary education is high school preparation and the conditions of the schools in which the students are prepared to succeed beyond high school. Seeking to estimate the within-SES-group effect of attending a high-quality school, this study draws on the restricted-use version of the Educational Longitudinal Study of 2002 (ELS:2002), nationally representative, longitudinal data. Using a school quality index (SQI) as a measure of school quality, the study finds that school quality is positively related to an increase in the likelihood of two-year post-secondary attendance for students from the lowest socioeconomic background. Furthermore, within socioeconomic status group, attending a high school with an above-average SQI score is related to an increase in the likelihood of four-year post-secondary enrollment for students from the lowest socioeconomic backgrounds.

Introduction

For students born in the 1960's, as family income increased, the percentage of students entering post-secondary education increased. Similar patterns existed two decades later. Although more students were entering post-secondary education, the relationship between family income and post-secondary enrollment remained. Students born between 1979 and 1982 from the top quartile of income were 2.5 times more likely to enroll in post-secondary education. Regarding persistence, for the same cohort of students, students born between 1979 and 1982 that were in the top quartile of income were 5 times more likely to finish college than students in the bottom quartile of income earners (Bowen, Kurzweil, and Tobin, 2005). More recent data shows that this trend continues, and, for some educational outcomes, the gap in educational outcomes between students from low-socioeconomic backgrounds and high-socioeconomic backgrounds has increased (Reardon, 2011; NCES, 2015). The positive relationship between increasing socioeconomic status and increasing educational outcomes is not a new phenomenon.

Although the actual numbers have improved, the relative gap between the wealthiest students and poorest students in college enrollment and still remains. The most recent *Condition of Education 2015* highlights the continued gaps in enrollment and persistence between the wealthiest and poorest students in our country. The gaps in enrollment in and matriculation through post-secondary education between students from low-socioeconomic backgrounds and high-socioeconomic backgrounds remains even though the numbers of students graduating from high school has increased for all income and racial categories (Kena et al., 2015).

One of the factors that influence the enrollment of students in post-secondary education is high school preparation and the conditions of the schools in which the students are prepared to succeed beyond high school. The *Condition of Education 2015* report brings to light a startling fact that the relationship between school quality and the equality of educational opportunities is inversely related to the proportion of poor and minority students enrolled in the school. This is not a new fact but the longstanding persistence of inequalities of educational opportunities based on school demographics should be concerning. Prior research has shown that positive attributes of school quality are related to increased educational outcomes, specifically post-secondary enrollment (Palardy, 2013). One discussion that has received limited empirical attention is trying to better understand the relationship between school quality, student socioeconomic background, and educational attainment[26].

Specifically, would students from lower socioeconomic backgrounds that attend higher quality schools experience increased educational outcomes compared to students from similar backgrounds that attend lower quality schools? Schwartz (2010) addresses a similar question by

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[26] Educational attainment is operationalized as an indicator of entry or exit at different along the education pipeline (see Barro & Lee, 1993, 2001, 2013. In this case, educational attainment refers to entry into two- or four-year post-secondary education.

relating school socioeconomic composition to the educational achievement of low-income students. Schwartz (2010) concluded that low-income students that attended low-poverty elementary schools outperformed their low-income peers in both math and reading. Although research has shown a high correlation between school quality and school composition, the components of school quality, reviewed by Phillips and Chin (2004), should not be dependent on the socioeconomic and/or racial composition of the school. Thus, this study attempts to statistically quantify school quality and, subsequently, assess the relationship between school quality and educational attainment.

The following research questions guide this study:

1. Using a constructed school-quality index, is the distribution of school quality by race and socioeconomic status consistent with prior literature?
2. For students in public education and within socioeconomic sub-group, does attending a higher-quality high school increase the probability of four-year post-secondary enrollment?

In order to try to address this question, I take advantage of the breadth and depth of the restricted-use version of the Educational Longitudinal Study of 2002 (ELS:2002), nationally representative, longitudinal data that is representative of the high school graduating class of 2004. The sample (N=8,368) has been restricted to public school students that were enrolled in the same high during the base year and first follow-up. Utilizing a single-factor school quality index (SQI)[27], the study finds that school quality increases the likelihood of four-year post-secondary attendance for all students and the students from higher socioeconomic backgrounds benefit more compared to students from lower socioeconomic backgrounds. Additionally, within

[27] The SQI is an author-calculated measure of school quality relative to other schools in the data. The methods used to construct the SQI are discussed later in the paper.

socioeconomic status group[28], attending a high-quality high school increases the probability of four-year post-secondary enrollment for three of the four SES groups, including the lowest SES group.

The paper is organized in the following way. The literature review discusses prior research on the relationship between school quality and educational outcomes while also addressing the use of multiple-measure indexes to measure school quality. The data and methods section discusses in more detail the ELS:2002 data and the multiple indexes used. The methods section explains the use of multilevel logit modeling to account for nested data and the use of propensity-score matching to estimate the causal relationship of attending a high-quality school. The results section expounds upon the findings mentioned above and addresses the three research questions. The discussion section explains how this study adds to the expansive research on school quality relative to educational outcomes and the limited research the benefits of higher-school quality for students from low-socioeconomic backgrounds. The limitations and future research section discusses the limitations of nationally representative data possible drawbacks of using nationally representative data to address inequality of educational opportunity and the possibilities of using state longitudinal data systems (SLDS) to better explore the relationship between school quality and educational outcomes for students from different socioeconomic backgrounds.

Review of the Literature

School Quality and Educational Outcomes

[28] Socioeconomic status is a continuous, composite variable constructed by NCES. The SES groups are quartiles of the continuous variable. The distribution of the sample is approximately even in each quartile. Additional discussion of the socioeconomic status composite variable can be found in the Data section of the paper.

The 1966 Coleman Report, more formally known as the Equality of Educational Opportunity Study, is highly regarded by many educational scholars as a foundational empirical study in the field of sociology of education. Commissioned by the US Department of Education in response to the Civil Rights Act of 1964, Coleman and colleagues set out to understand educational equality and demonstrate that "unequal school achievement by students from different social origins was a function of unequal educational opportunity" (Hurn, 1993, p. 133). The study was the first of its kind in that it surveyed a nationally representative sample of students, teachers, and principals, amounting over 600,000 cases. The comprehensive survey included student socioeconomic status, school social and racial composition, school quality, community orientation, and educational achievement. The results of the study found little association between school quality and academic achievement and suggested that the differences in educational outcomes between Black and white students were more of a cause of family background and innate ability (Coleman et al., 1966). Using the same data and more nuanced statistical methods, Borman and Dowling (2010), over forty years after the initial report, found that "fully 40% of the differences in achievement can be found between schools" (p. 1201). Furthermore, Borman and Dowling (2010) concluded that school quality does matter to educational outcomes, specifically noting that "going to a high-poverty school or a highly segregated African American school has a profound effect on a student's achievement outcomes, above and beyond the effect of individual poverty or minority status" (p. 1202).

Another way to examine the relationship between school quality and educational outcomes is by assessing the relative rate of return on education for a group of individuals. Card and Krueger (1992) conducted an analysis that estimated "the effects of school quality-measured by pupil teacher ratio, average term length, and relative teacher pay on the rate of return to education for men born between 1920 and 1949" (p. 1). Specifically, Card and Krueger (1992) utilized 1980 census data to assess the quality of state school systems and its relationship to the shift in rates of return on education. Card and Krueger (1992) reported that the results suggest that average teacher term length and relative teacher wage are significant and positively related to returns on education, while pupil teacher ratio was significant but negatively related to returns on education. In particular, "an increase in school quality raises schooling levels, particularly in the lower tail of the education distribution. These gains in education offset the apparent losses associated with the shift in the earnings schooling function, leaving individuals in the lower tail of the earnings distribution approximately as well off and individuals in the mid and upper portions of the earnings distribution better off" (Card and Krueger, 1992, p. 33). Dearden, Ferri, and Meghir (2002) also conducted a study that assessed the relationship between measures of school quality and both educational qualifications and wages. Dearden et al. (2002) utilized national data from England to estimate the extent to which pupil-teacher ratio and school selectivity increased educational qualifications and wages for men and women at two time points, ages 23 and 33. The findings suggest that high school selectivity is associated with higher wages for men at age 33 and that pupil-teacher ratio was positively related to women's wages at age 33.

School funding. Sebold and Dato (1981) sought to analyze the disparities in school funding and student achievement across school districts in California. Similar to the Coleman Report, the study utilized data from multiple grade levels (2^{nd}, 3^{rd}, 6^{th}, 12^{th}), across the largest 100 school districts in California. The results of the study found that the four expenditure variables had varying influences on academic achievement. Most notably, general/instructional expenditures were found to have a small but positive and significant influence on academic achievement across all grade levels. In summary, Sebold and Dato (1981) noted that "the direct implication of the study is that the equalization of expenditures per ADA across school district would have a statistically significant, although quantitatively fairly small, impact on the examination scores of students in primary and secondary systems of California" and reaffirmed that equalization of funds alone is not "sufficient to provide educational equity" (p. 103).

The effects of school funding on educational outcomes can be enhanced by socioeconomic factors. Payne and Biddle (1999) examined the effects of inequitable school funding and child poverty on math achievement. Payne and Biddle (1999) found that total annual per-pupil funding and average level of curriculum were significant and positively related to the average math achievement in the district; percent of child poverty was significant and negatively related to the average math achievement in the district. Payne and Biddle (1999) note that "both types of inequity affect student achievement in the United States, that such effects are largely independent of one another, that these effects are substantial, and that they are largely independent of the impact of other factors (such as curriculum and race) that may also affect achievement" (p. 11).

Examining state or district level school funding provides quality examples of how it affects educational outcomes but analysis at the school level can provide a finer understanding of the affects. Condron and Roscigno (2003) examined the relationship between different types of school expenditures, among other variables, and multiple academic outcomes measured by state proficiency examinations. The results of the study suggest that instructional per-pupil spending, the physical condition, and order/consistency of the school are significantly and positive predictors of higher proficiency scores across all subjects (reading, writing, math, science, and citizenship). For example, Condron and Roscigno (2003) note that "$1000 increase in local instruction spending per student leads to from about 6 percent to about 10 percent more students passing the proficiency test, except for writing" (p. 30).

School quality and national data. Nationally representative data have been examined to assess the relationship between multiple measures of school quality and educational outcomes. Using ELS:2002, Engberg and Wolniak (2010) estimated the relationship between multiple student- and school-level variables and the probability of post-secondary enrollment. The authors did not specifically refer to any of the school-level variables as measures or indicators of school quality. However, a number of variables that are considered indicators of school quality were reported to be statistically significant relative to post-secondary enrollment. Engberg and Wolniak (2010) found that average socioeconomic composition, average grade-point-average average number of advanced placement courses, and the percentage of prior-year students that attended 4-year colleges were all significant and increased the probability of attending a four-year college.

Using ELS:2002, as well, Bowers and Urick (2011) addressed the relationship between school facility quality and student achievement. Facility quality can be representative of the financial resources available to a school in order to properly maintain the building. Also, facility quality may indirectly impact the quality of education received within the school. Bowers and Urick (2011) did not find a statistically significant relationship between school-facility quality and 12th grade math achievement. However, included in the statistical model were other measures of school quality, including school socioeconomic composition (percent free lunch), location, and enrollment size. Bowers and Urick (2011) reported significant relationships between percent free lunch (negative relationship), urban locale (positive relationship), and small class sizes (positive relationship) relative to 12th grade math achievement, after controlling for 10th grade math achievement.

Palardy (2013) also used ELS:2002. The author utilized ELS:2002 to examine how school socioeconomic segregation was related to two measures of educational attainment, high-school graduation and college enrollment. The socioeconomic composition of a high school very much reflects the available financial resources of the school because of how public schools are funded. So, utilizing socioeconomic composition is indirectly a proxy for school resources. Unsurprisingly, Palardy (2013), after accounting for a number of student and school factors, found that students attending high-socioeconomic composition schools were 68% more likely to attend four-year colleges compared to students attending low-socioeconomic composition schools. Palardy (2013), upon examining mechanisms that could mediate educational attainment, concluded that the reason behind the association between school socioeconomic composition and college enrollment was due to peer influences, specifically negative peer influences in low-socioeconomic composition schools.

Finally, Levine and Painter (2008) utilized that National Educational Longitudinal Study of 1988 (NELS:88) to assess whether there was a causal relationship between school effects and educational outcomes. Levine and Painter (2008) used non-experimental (ordinary least squares regression) and quasi-experimental (instrumental variables and propensity-score matching) to assess the relationship between school effects and student test scores. As a result of the propensity-score matching analysis, the authors estimated that, for students with similar backgrounds, going to a high school with higher quality increased standardized test scores over a four years. Levine and Painter (2008) concluded that “the results here indicate that parents who pay extra to live near advantaged neighbors are buying valuable improvements in their children's education" (p. 470).

As Card and Krueger (1992) noted, school quality matters. The attention to how increased school quality matters based on the socioeconomic status of the students is limited. Thus, the literature supports further understanding how increased levels of school quality may benefit students regardless of socioeconomic status. The next section will address the uses of school-quality indexes in education research.

Uses of School Quality Indexes

The use of a school quality index is a way to statistically account for multiple school variables at one time and is a way to reduce the complexity of statistical models while also minimizing the effects of multicollinearity[29]. Research on educational outcomes utilizing indexes of school quality is minimal. Utilizing comprehensive, nationally representative longitudinal data (NELS:88), DeLeire and Kalil (2002) constructed an 11-item school-quality index based on the student's caregiver's perception of school quality and concluded that the index was significantly related to college enrollment. Oates (2009), also utilized NELS:88, constructed a 5-item school quality index based on school-level measures, i.e. number of advanced placement courses offered and the percentage of preceding-year graduates enrolled at four-year colleges. The author used the index as part of a structural equation model to estimate difference in the black/white achievement gap. Oates (2009) concluded that "what happens at school matters decisively regardless of what attributes signifying student-preparedness might be" (p. 436).

[29] Multicollinearity is when two or more variables in a statistical model are highly correlated. The problem with multicollinearity is that it "constitutes a threat both to the proper specification and the effective estimation of the type of structural relationship commonly sought through the use of regression techniques" (Farrar & Glauber, 1967, p. 93)

Instead of using school quality as a dependent variable, Davis and Welcher (2013) estimated how class attenuated "the impact of race on school quality" (p. 469). Utilizing the Early Childhood Longitudinal Study, Kindergarten (ECLS-K) and the Common Core of Data[30] (CCD), the authors constructed a 5-item school-quality index that included "measures that represent various aspects of the demographic, academic, and behavioral climate of the school" (p. 475). Davis and Welcher (2013) found "significant racial disparities in school quality that class and resident context cannot account for" (p. 475).

There are studies that have used a school quality index as a control variable to simultaneously account for multiple school quality measures while estimating relationships between the independent variable(s) of interest and the dependent variable(s). Three studies used a school-quality index to reduce model complexity in the assessment of affirmative action policies relative to college admissions (Blume & Long, 2013), student application and enrollment decisions (Long, 2010), and college outcomes for students (Bucks, 2004).

The literature supports the use of a composite measure of school quality in both estimating the relationship between school quality and educational outcomes and as a control variable. The remaining section of the literature review will review two studies that specifically examined the outcomes of students identified as low-income relative to school contexts.

Low-SES Students, Schools, and Educational Outcomes

One study that examines the relationship between a school context, socioeconomic composition in this case, is Schwartz (2010). Taking advantage of a natural experiment, Schwartz (2010) showed that attending a majority high-income school increased the academic gains of students from low-socioeconomic backgrounds relative to their peers that attended a

[30] The Common Core of Data (CCD) is another national data set. The CCD includes financial and demographic information for all public schools.

majority low-income school. Utilizing longitudinal data from Montgomery County, Maryland, Schwartz (2010) was able to assess the results of a natural experiment due to random assignment in housing policies. According to Schwartz (2010),

> "The Housing Opportunities Commission randomly assigns applicants to the public housing apartments. Since almost all of the county's elementary schools have neighborhood-based attendance zones, children in public housing thus are assigned randomly to their elementary schools via the public housing placement process. This feature prevents families' self-selection into neighborhoods and elementary schools of their choice, which in turn allows for a fair comparison of children in public housing in low-poverty settings to other children in public housing in higher-poverty settings within the county" (p. 5).

The natural experiment provided the author with a control group (students that attended lower-income schools) and a treatment group (students that attended higher-income schools). The students, in both groups, were all from the same housing system and came from low-socioeconomic backgrounds. Schwartz (2010) found that "students in public housing who were randomly assigned to low-poverty elementary schools significantly outperformed their peers in public housing who attended moderate-poverty schools in both math and reading" (p. 6). Additionally, for students in public housing that attended low-poverty schools, the achievement gap relative to students from higher-socioeconomic backgrounds that attended the best schools in the district was reduced by half in math and one-third in reading. Although the findings are positive, the study does not utilize a direct measure of school quality, and, at times, makes implications that school socioeconomic composition is a proxy for school quality.

The second study directly addresses the relationship between a measure of school quality and the educational outcomes of low-SES students, specifically relative to their middle- and upper-SES peers. Utilizing longitudinal survey data from Australia combined with international testing data, Lim, Gemici, and Karmel (2014) sought to understand if there was a differential level of effectiveness of higher-quality schools on the likelihood of high school graduation for low-SES students compared to middle-SES and upper-SES students while accounting for the academic achievement of each student. The authors applied a derived school academic quality index in their analysis and interacted the index with student's SES. Lim et al (2014) concluded that low-SES students, regardless of their academic achievement level, that attended higher quality schools were more likely to graduate high school. Specifically, low-achieving, low-SES students attending a school in the 90th percentile of school academic quality was over 40% more likely to graduate high school than a comparable student attending a school in the 10th percentile (Lim et al., 2014). The school academic quality index includes school composition factors in addition to individual measures of school quality, which is problematic. As previously discussed, the quality of the school is not and should not be based, even partially, on school racial and socioeconomic composition. Phillips and Chin (2004) provides a review of inequality in public schools and distinctly separates the school demographic context and the school quality context.

The lack of attention to this question is cause to try to address the question using nationally representative data while also constructing an index of school quality that only includes factors related to the quality of the school and not the composition. A discussion of the data, methods, and methodology used is below.

Data and Methods

Data

The data used in this study was compiled by the National Center for Education Statistics (NCES[31]) under the auspices of the U.S. Department of Education Institute of Education Sciences (IES). According to the NCES, "the Education Longitudinal Study of 2002 (ELS:2002) is designed to monitor the transition of a national sample of young people as they progress from tenth grade through high school and on to postsecondary education and/or the world of work" (NCES, 2015). ELS:2002 is publicly available through the NCES website[32]. For this study, the restricted-use ELS:2002 data was used. The restricted-use data incorporates more specific demographic data, particularly high school origin among other things. To examine the relationship between school context and student outcomes, specific school information like the school racial/ethnic and socioeconomic demographics were needed. The restricted-use ELS:2002 data provided access to both the NCES school district identification number (NCESDI) and the Common Core of Data (CCD[33]) identification number (NCESSI), which was used to match schools in ELS:2002 to the CCD data.

The CCD is a national database of fiscal and non-fiscal data from all public schools in the country. School district financial data and school population data from the 2001 through 2004 schools years were downloaded from the CCD website. Of the financial data available in the CCD, each school district provides information on total per-pupil revenues, national per-pupil revenues, state per-pupil revenues, and local per-pupil revenues. The sum of national, state, and local per-pupil revenues equals the total per-pupil revenue for each school district. School revenues are used to purchase goods and pay personnel salaries. Due to cost-of-living differences between and within states, an examination of school resources that includes revenue should

[31] https://nces.ed.gov
[32] https://nces.ed.gov/surveys/els2002
[33] https://nces.ed.gov/ccd

account for the differences. To account for the differences in cost-of-living, I used the comparative wage index (CWI) to adjust the school-district revenues. For each school district, average per-pupil revenue for each of the four variables over the four school years. These variables, along with school demographics, were merged to the ELS:2002 data. Upon reweighting the revenue variables, a school quality index (SQI) was created based on school level variables. I provide further discussion of the CWI and SQI, along with an NCES-created socioeconomic composite variable (F1SES2), are below.

School Quality Index (SQI). Factor analysis was used to create a single-item factor score, or school quality indicator, for each school. Factor analysis is used to reduce model structure or identify latent variables by combining related observed variables using, in this case, a weighted, linear combination of the observed variables into the factor score. The factor score is based on 76 variables, each of which are associated with one of six school quality constructs identified by Phillips and Chin (2004): curriculum, student outcomes[34], teacher quality, learning climate, financial resources, and physical learning space. A description and summary statistics for the variables used to construct the SQI, and associated factor weights, can be found in Appendix F Table F.4. Each of the variables was standardized to have a mean of 0 and a standard deviation of 1 so that bias was reduced due to large-scale variables[35]. The first factor of the factor analysis was utilized and the eigenvalue of the factor was greater than one. The factor accounted for close to 100% of the variance of the variables. The predicted SQI for each school was calculated using a weighted-linear combination of the factor loadings. The factor score was

[34] The student outcomes measures are based on lagged data. For the ELS:2002 data, the student outcomes measures are based on the graduating class of 2003.
[35] The maximum value for CWI adjusted per-pupil revenue was just over $36,000 and maximum for any of the percent variables was 100. By standardizing, the variables are on the same scale, which limits the influence of larger values.

checked for expected directional correlation between the observed variables. The factor scores were then standardized to have a mean of 0 and standard deviation of 1.

SES Composite. There are four socioeconomic composite variables available in the ELS:2002 data: BYSES1, BYSES2, F1SES1, and F1SES2. The first two variables, BYSES1 and BYSES2, are based on base-year survey data and the second two are based on follow-up year survey data. Each composite variable is constructed using five, equally-weighted and standardized variables: mother's education, father's education, mother's occupation, father's occupation, and family income (NCES, 2004). F1SES2 was used for analysis in this study. The two composite variables for each year differed in how the occupations were ranked, one used the 1961 Duncan SEI index and the other used the 1989 GSS occupational prestige score. F1SES2 was chosen because the GSS occupational prestige score, constructed using the same research design of the Duncan SEI index, covered more occupations, is newer, and was "intended to measure status of occupations that include both male and female incumbents, not merely male workers" (Nakao and Treas, 1992, p. 11).

Comparative wage index (CWI). Dr. Lori L. Taylor, developed the CWI with support from NCES, to help account for cost-of-living differences between regions within states (NCES, 2007). According to NCES (2007), "The CWI reflects systematic, regional variations in the salaries of college graduates who are not educators" with the assumption that "these non-educators are similar to educators in terms of age, educational background, and tastes for local amenities." To accurately compare school-district revenues from different states, the revenue variables for each school district were divided by the associated CWI and then multiplied by the national average CWI. Verstegen (2011) utilized a similar application of the CWI to more accurately compare public school financing systems across the country because "variations in the cost of living or cost of education affect the purchasing power of the dollar across the states" (p. 10).

Variables

Dependent. One outcome variable was chosen for this study, four-year college enrollment. Four-year college enrollment was measured by whether the respondent had enrolled in a four-year college at any time after high school. During the second follow-up survey for ELS:2002, the students were asked the student to report their highest level of post-secondary enrollment. Any entry that was coded as four-year enrollment or higher was recoded to 1 and all others were coded as 0. For the sample population, 48% of the respondents were enrolled in a four-year college. Demographic distributions by race and socioeconomic status are found in Appendix F, Charts F.1 and F.2.

Independent. The main independent variable chosen for this study was SQI, previously discussed. Variables that have been identified to be related student factors relative to college enrollment are also included. Table F.3 in Appendix F provides a list of the variables, along with the summary information for each.

Methodology

In order to better assess the effect of a treatment, such as enrollment in an above-average SQI school, using non-experimental data, one must try to address the inherent bias found in the data. Use of data matching techniques, propensity score matching being one, is one way to help reduce selection bias within data. The use of propensity score matching addresses the bias issue by weighting the counterfactual, in this case not having attending a high-SQI school, to create a relatively balanced sample of students in the constant case compared to the test case.

When comparing the within-group relationship[36] between attending a high-SQI school and educational outcomes, the resulting effect sizes produced using logistic regression may underestimate the relationship. Thus, for efficient causal inference, it is best to compare groups that are similar as possible notes Stuart (2010). Comparing groups that are as similar as possible should also be the case for descriptive or correlational inference. For this study, inverse-probability-of-treatment-weighting (IPTW) is used to separately re-weight the students in each SES group based on each student's predicted probability of attending a high-SQI school. The probability is calculated using logistic regression with attending a high-SQI school being the dependent variable and a vector of observed variables, which are assumed to be independent of the final educational outcomes[37].

Upon on re-weighting the samples, logistic regression is used to assess the relationship between the dependent variable (four-year college enrollment) and high-SQI school attendance along with other covariates. In re-weighting the sample of students in each SES group that are not enrolled in high-SQI schools and conducting the regression analysis, I measure the average-treatment-effect-on-the-treated (ATT). The ATT equation can be written as the following:

$$E\langle Y_{1i} - Y_{0i} | T_i = 1\rangle = E\langle Y_{1i} | T_i = 1\rangle - E\langle Y_{0i} | T_i = 1\rangle. \qquad (3.1)$$

Rosenbaum (2005) summarizes this equation, noting that "the treated-minus-control differenced in mean outcomes is an unbiased and consistent estimate of the average effect of the treatment on the subjects in the experiment" (p.3). For this study, the ATT for students in each SES group estimates the within-group average effect for students enrolled in high-SQI schools.

[36] This refers to the specific examination of the effect of attending a high-SQI school on four-year college enrollment within the sample population of students from low-SES, mid-low-SES, mid-high-SES, and high-SES backgrounds.
[37] The predicted probabilities of the logistic regression are considered the propensity scores for each student.

There are three assumptions that are made when using IPTW or any quasi-experimental design. First is the conditional-independence (CI) assumption. The CI assumption states that the outcome (ACT math score and four-year-college enrollment) is independent of the treatment (high-SQI school enrollment) conditional on a set of pre-treatment variables (Rosenbaum & Rubin, 1983). To test the conditional independence assumption, unweighted and weighted regression models are conducted for each variable used to create the propensity scores relative to SQI for each SES group. If the results of the weighted regression for each variable is not significant, the conditional independence assumption is met for that variable. Given a large number of observable variables, the likelihood of complete independence is unlikely. The unweighted and weighted pre-treatment relationships can be found in Appendix G Tables G.2 through G.5.

The second assumption is that the sample independent and identically distributed (i.i.d). If the (i.i.d.) assumption holds, the treatment and outcome conditions for each student is unrelated to the treatment and outcome conditions of other students. Finally, use of IPTW assumes that there is overlap of the propensity to receive the treatment for the population included in the analysis and sets the region of common support. The region of common support for this data is where students who enrolled in high-SQI schools can be matched to students who did not enroll in high-SQI schools.

Method

Descriptive and inferential statistics are used to answer the first question. For question two, hierarchical logistic regression is utilized to account for the nesting (students within schools) in the data. For question three, inverse-probability-of-treatment-weighting (IPTW) is used. Discussions of hierarchical logistic regression and IPTW are below.

Propensity score matching using IPTW

Using IPTW, instead of reweighting the entire population of each group, I reweight the control group (students that attend low-SQI schools) based on their probability of attending a high-SQI school. To measure ATT, the treatment group (students that attend high-SQI schools) is not reweighted. More specifically, the treatment group is assigned a weight of one. The control groups, students that do not attend high SQI schools, are re-weighted based on their propensity to attend a high-SQI school. The resulting logistic regression effect sizes are then compared to the non-weighted regression output for each SES group.

The following logistic regression model is used to address the research questions related to four-year college enrollment:

$$P_i = \frac{e^{\left[\sum_{j=0}^{1} \beta_{j-1} I_j \left\{t_i = T_j\right\}\right] + X_i'}}{1 - e^{\left[\sum_{j=0}^{1} \beta_{j-1} I_j \left\{t_i = T_j\right\}\right] + X_i'}}. \tag{3.2}$$

where P_i is the outcome (e.g. probability of four-year college enrollment) of student i, t_i is the SQI category for the students, T_j is the j^{th} SQI category the model is predicting membership in (e.g. T_j is the category "high SQI enrollment"), I_j is an indicator variable (evaluating the truth of the argument in {…}) taking on the value of 1 for students of that SQI category (and 0 otherwise), $X_i{}'$ is a vector of student, and Y_i is an error term.

$$Pr\langle t_i = T_j \middle| X \rangle = \frac{e^{X_i'\delta}}{1 - e^{X_i'\delta}}, \text{where } X_i'\delta = 0. \tag{3.3}$$

The weights are constructed as:

$$W_j = \left\langle \frac{1}{\widehat{\Pr}(t_i = T_j)} \middle| (t_i = T_j) \right\rangle, \tag{3.4}$$

where $\widehat{\Pr}(t_i = T_j)$ is the predicted probability of student i being a member of category j. The final estimation models will look the same as Equations (1) and (2), but each student is reweighted by the student's W_j found in Equation (4).

Limitations

There are some limitations to the use of nationally representative data. Although the sampling design was rigorous, the number of students sampled within each school may not be representative of the population of the school. Even though the sample is restricted to students that attended the same school during the base-year and first follow-up, within-school attrition may have occurred. This limits the representativeness of the population. Additionally, missing data occurs throughout ELS. Multiple imputation methods were used to account for the missing data and to not reduce the sample size. Therefore, bias due to missing data may arise.

Results

An examination of the chart F.1 and F.2 in Appendix F reveals that students in the lowest socioeconomic quartile are less likely to enroll in either a two- or four-year post-secondary institution compared to students in the other three socioeconomic quartiles. Specifically, 59% of students in the lowest socioeconomic quartile attended at least a two-year post-secondary institution compared to 93% of students in the highest socioeconomic quartile. Additionally, 29% of students in the lowest socioeconomic quartile attended a four-year post-secondary institution compared to 75% of students in the highest socioeconomic quartiles. Both chart F.1 and chart F.2 of Appendix F indicate that there is an inverse relationship between post-secondary enrollment, regardless of 2- or 4-year, and student socioeconomic background. This finding is similar to prior research that suggests the same (see Kena et al., 2015). Similarly, there is small but inverse relationship between student socioeconomic background and enrollment in an above-average SQI school. Relative to above-average SQI attendance, 46% of students in the lowest socioeconomic quartile were enrolled compared to 51% of students in the highest socioeconomic quartile. The same percentage of students in the two middle socioeconomic attended an above-average SQI school.

As a reminder, the two research questions sought to the understand the relationship between attending an above-average high schools, as measured by the SQI, and the likelihood of enrolling in two- and four-year post-secondary institutions, specifically comparing students within four socioeconomic quartiles: Low SES, Mid-low SES, Mid-high SES, and High SES. To address the research questions, inverse probability treatment weighting (IPTW) was used to help address the selection bias mentioned above. Quasi-experimental design techniques and logistic regression are used to better understand the within-SES-group relationship between SQI and both two- and four-year post-secondary enrollment. For each question, SQI is a dichotomous variable, where the two categories are above-average and below-average. Propensity-score matching usually involves assessing the difference in treated versus un-treated populations. In order to use IPTW, SQI was converted into a dichotomous variable, with treated students being those enrolled in higher-quality schools and un-treated students being those enrolled in lower-quality schools. To further address the research question, the data were split by SES group. Propensity scores were generated for each group to create weights for the IPTW. Sixteen models were fitted to the data for each SES group, four un-weighted and four weighted. Once again, the outcomes are two- and four-year post-secondary enrollment. The estimated odds ratios for each model can be found in tables 3.1 through 3.16, and are organized by SES group.

Likelihood of at Least Two-year Post-Secondary Enrollment

The baseline model for each SES group included only the school quality measure, SQI. For low-SES students (Table 3.4), attending an above-average SQI school was significantly related to two-year post-secondary enrollment. Attending a higher-quality school was found to be related to an increase in the likelihood of two-year post-secondary enrollment or higher for low-SES students by 42%.

When student academic variables are added to each model, the significance of the relationship between attending an above-average SQI school and the likelihood of two-year post-secondary enrollment for low-SES students is no longer significant. Furthermore, the SQI variable is not significantly related to two-year post-secondary enrollment for students in the three other SES quartiles. An increase in student grade-point average (GPA) was found to be significantly related to an increase in the likelihood of two-year post-secondary enrollment across all SES quartiles. Specifically, for a standard deviation increase in GPA, the likelihood of two-year post-secondary enrollment was 1.7 times more likely for low-SES students, 1.8 times more likely for mid-low SES students, 2.6 times more likely for mid-high SES students, and 2.5 times more likely for high SES students[38]. Additionally, an increase in student standardized test score was found to be significantly related to an increase in the likelihood of two-year post-secondary enrollment for low-SES students (1.7 times), mid-high SES students (1.6 times), and high SES students (1.9 times).

The third, and final, model for each SES group, relative to two-year post-secondary enrollment, adds in student and parent aspiration variables. Attending an above-average SQI school was related to an increase in the likelihood of two-year post-secondary enrollment of 1.5 times for low-SES students. Increases in student grade-point average remained significantly

[38] The IPTW logistic regression results for two-year post-secondary enrollment can be found in tables 3.4, 3.8, 3.12, and 3.16.

related to the likelihood of two-year-post-secondary enrollment across all four SES groups. Also, increases in student standardized test scores remained significantly related to the likelihood of two-year-post-secondary enrollment for low-SES, mid-low SES, and high-SES students. For all SES groups, an increase in student aspirations was related to an increase in the likelihood of two-year post-secondary enrollment relative to no two-year post-secondary enrollment. An increase in the parental aspirations reduced the likelihood of two-year post-secondary enrollment for low-SES, mid-low SES, and mid-high SES students relative to the likelihood of no two-year post-secondary enrollment.

Likelihood of Four-year Post-Secondary Enrollment

The second research question is addressed using the same methods as the first question but replacing the outcome variable to the likelihood of four-year post-secondary enrollment. The baseline model for each SES group included only the school quality measure, SQI. For students identified as low-SES (Table 3.2) and mid-low SES (Table 3.6), attending an above-average SQI school was significantly related to four-year post-secondary enrollment. Attending a higher-quality school was found to be related to an increase in the likelihood of four-year post-secondary enrollment for low-SES students by 42% and by 40% for mid-low SES students.

When student academic variables are added to each model, the significance of the relationship between attending an above-average SQI school and the likelihood of four-year post-secondary enrollment for low-SES students remains statistically significant but is no longer statistically significant for mid-low SES students. Furthermore, the SQI variable is not significantly related to four-year post-secondary enrollment for students in both the mid-high and high SES groups. An increase in student grade-point average (GPA) was found to be significantly related to an increase in the likelihood of four-year post-secondary enrollment four students in all SES quartiles. Specifically, for a standard deviation increase in GPA, the likelihood of four-year post-secondary enrollment was 2.4 times more likely for low-SES students, 2.0 times more likely for mid-low SES students, and 2.8 times more likely for both mid-high and high SES students[39]. Additionally, an increase in student standardized test score was found to be significantly related to an increase in the likelihood of four-year post-secondary enrollment for low-SES students (1.9 times), mid-low SES students (1.8 times), mid-high SES students (1.7 times), and high SES students (2.4 times).

The third, and final, model for each group, relative to four-year post-secondary enrollment, adds in student and parent aspiration variables. Attending an above-average SQI school was related to an increase in the likelihood of four-year post-secondary enrollment of 1.6 times for low-SES students. Increases in student grade-point average remained significantly related to the likelihood of four-year-post-secondary enrollment across all four SES groups. Also, increases in student standardized test scores remained significantly related to the likelihood of four-year-post-secondary enrollment for low-SES, mid-low SES, mid-high, and high-SES students. For all SES groups, an increase in student aspirations was related to an increase in the likelihood of four-year post-secondary enrollment relative to no four-year post-secondary enrollment. Specifically, an increase in student aspirations was related to an increase in the likelihood of four-year post-secondary enrollment by 2.0 times for low SES students, 2.8 times for mid-low SES students, 1.8 times for mid-high SES students, and 2.9 times for high SES students. An increase in the parental aspirations reduced the likelihood of four-year post-secondary enrollment for low-SES, mid-low SES, and mid-high SES students relative to the likelihood of no two-year post-secondary enrollment.

[39] The IPTW logistic regression results for two-year post-secondary enrollment tables 3.2, 3.6, 3.10, and 3.14.

Discussion and Conclusion

This study found that attending a higher quality school matters relative to the post-secondary enrollment outcomes for students from the same socioeconomic background. Specifically, for students from low-SES backgrounds, the likelihood enrolling in either a two- or four-year post-secondary institution is higher for students enrolled at a higher quality school relative to students enrolled at a lower-quality school. The benefit of attending a higher quality school held after controlling for a student's GPA, standardized test scores, and student educational aspiration. Attending a higher quality school was not significantly related to post-secondary enrollment for students from the other three SES backgrounds.

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Table 3.1

Logistic Regression – Likelihood of Four-Year Enrollment for Low SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.071	[0.854, 1.343]		0.945	[0.725, 1.233]		0.991	[0.759, 1.293]	
GPA				2.214	[1.941, 2.526]	***	2.088	[1.825, 2.388]	***
Test Comp				2.079	[1.817, 2.378]	***	1.991	[1.733, 2.289]	***
Student Asp.							2.120	[1.627, 2.762]	***
Parent Asp.							0.851	[0.801, 0.904]	***
Constant	0.401	[0.35, 0.458]	***	0.585	[0.499, 0.686]	***	0.443	[0.329, 0.597]	***

**p < .05; **p < .01; ***p < .001*

Table 3.2

IPTW Logistic Regression – Likelihood of Four-Year Enrollment for Low SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.600	[1.119, 2.286]	*	1.623	[1.097, 2.401]	*	1.643	[1.101, 2.45]	*
GPA				2.367	[1.805, 3.103]	***	2.134	[1.624, 2.804]	***
Test Comp				1.883	[1.431, 2.477]	***	1.873	[1.386, 2.531]	***
Student Asp.							2.025	[1.171, 3.5]	*
Parent Asp.							0.848	[0.753, 0.955]	**
Constant	0.292	[0.225, 0.378]	***	0.372	[0.283, 0.49]	***	0.309	[0.173, 0.553]	***

**p < .05; **p < .01; ***p < .001*

Table 3.3

Logistic Regression – Likelihood of at Least Two-Year Enrollment for Low SES Students

	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.033	[0.832, 1.282]		0.931	[0.738, 1.176]		0.998	[0.785, 1.269]	
GPA				1.723	[1.541, 1.925]	***	1.602	[1.428, 1.796]	***
Test Comp				1.883	[1.67, 2.124]	***	1.828	[1.609, 2.077]	***
Student Asp.							1.999	[1.643, 2.432]	***
Parent Asp.							0.815	[0.776, 0.856]	***
Constant	1.405	[1.241, 1.592]	***	2.503	[2.143, 2.924]	***	2.351	[1.841, 3.002]	***

**p < .05; **p < .01; ***p < .001*

Table 3.4

IPTW Logistic Regression – Likelihood of at Least Two-Year Enrollment for Low SES Students

	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.416	[1.03, 1.948]	*	1.375	[0.974, 1.941]		1.530	[1.049, 2.231]	*
GPA				1.702	[1.361, 2.13]	***	1.551	[1.237, 1.945]	***
Test Comp				1.708	[1.354, 2.155]	***	1.777	[1.391, 2.271]	***
Student Asp.							2.004	[1.32, 3.042]	**
Parent Asp.							0.757	[0.68, 0.843]	***
Constant	1.131	[0.906, 1.412]	***	1.766	[1.363, 2.288]	***	2.067	[1.294, 3.302]	**

**p < .05; **p < .01; ***p < .001*

Table 3.5

Logistic Regression – Likelihood of Four-Year Enrollment for Mid-low SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.062	[0.848, 1.329]		0.932	[0.744, 1.167]		0.953	[0.756, 1.202]	
GPA				2.146	[1.887, 2.44]	***	2.012	[1.762, 2.297]	***
Test Comp				1.816	[1.591, 2.072]	***	1.758	[1.533, 2.017]	***
Student Asp.							2.402	[1.869, 3.087]	***
Parent Asp.							0.876	[0.829, 0.925]	***
Constant	0.601	[0.524, 0.69]	***	0.655	[0.566, 0.758]	***	0.435	[0.328, 0.576]	***

**p < .05; **p < .01; ***p < .001*

Table 3.6

IPTW Logistic Regression – Likelihood of Four-Year Enrollment for Mid-low SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.398	[1.026, 1.905]	*	1.300	[0.923, 1.833]		1.361	[0.952, 1.945]	
GPA				2.004	[1.53, 2.626]	***	1.863	[1.423, 2.441]	***
Test Comp				1.776	[1.318, 2.393]	***	1.763	[1.286, 2.417]	***
Student Asp.							2.762	[1.638, 4.66]	***
Parent Asp.							0.839	[0.752, 0.935]	**
Constant	0.501	[0.398, 0.63]	***	0.455	[0.349, 0.593]	***	0.293	[0.165, 0.521]	***

**p < .05; **p < .01; ***p < .001*

Table 3.7

Logistic Regression – Likelihood of at Least Two-Year Enrollment for Mid-low SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.065	[0.839, 1.351]		0.956	[0.75, 1.219]		0.992	[0.775, 1.269]	
GPA				1.881	[1.67, 2.118]	***	1.794	[1.586, 2.029]	***
Test Comp				1.476	[1.299, 1.677]	***	1.415	[1.241, 1.615]	***
Student Asp.							1.922	[1.571, 2.352]	***
Parent Asp.							0.826	[0.785, 0.869]	***
Constant	2.297	[1.989, 2.653]	***	3.139	[2.669, 3.691]	***	3.038	[2.361, 3.909]	***

**p* < .05; ***p* < .01; ****p* < .001

Table 3.8

IPTW Logistic Regression – Likelihood of at Least Two-Year Enrollment for Mid-low SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.241	[0.891, 1.728]		1.128	[0.792, 1.607]		1.188	[0.818, 1.726]	
GPA				1.820	[1.457, 2.272]	***	1.736	[1.382, 2.181]	***
Test Comp				1.269	[0.953, 1.688]		1.213	[0.903, 1.63]	
Student Asp.							2.100	[1.423, 3.097]	***
Parent Asp.							0.811	[0.724, 0.909]	***
Constant	2.051	[1.607, 2.619]	***	2.365	[1.792, 3.123]	***	2.284	[1.461, 3.572]	***

**p* < .05; ***p* < .01; ****p* < .001

Table 3.9

Logistic Regression – Likelihood of Four-Year Enrollment for Mid-high SES Students

	(1)		(2)			(3)		
Variable	O.R.	95% C.I.	O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.107	[0.911, 1.346]	0.982	[0.782, 1.234]		0.957	[0.758, 1.21]	
GPA			2.436	[2.114, 2.806]	***	2.319	[2.003, 2.685]	***
Test Comp			1.814	[1.588, 2.071]	***	1.766	[1.54, 2.025]	***
Student Asp.						2.081	[1.594, 2.718]	***
Parent Asp.						0.870	[0.823, 0.921]	***
Constant	1.049	[0.923, 1.192]	0.932	[0.803, 1.081]		0.680	[0.508, 0.909]	*

**p < .05; **p < .01; ***p < .001*

Table 3.10

IPTW Logistic Regression – Likelihood of Four-Year Enrollment for Mid-high SES Students

	(1)		(2)			(3)		
Variable	O.R.	95% C.I.	O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.149	[0.842, 1.569]	1.093	[0.762, 1.566]		1.045	[0.722, 1.512]	
GPA			2.814	[2.156, 3.672]	***	2.571	[1.953, 3.385]	***
Test Comp			1.739	[1.356, 2.231]	***	1.767	[1.368, 2.283]	***
Student Asp.						1.773	[1.117, 2.813]	*
Parent Asp.						0.837	[0.753, 0.931]	**
Constant	1.006	[0.792, 1.278]	0.767	[0.579, 1.015]		0.696	[0.419, 1.159]	

**p < .05; **p < .01; ***p < .001*

Table 3.11

Logistic Regression – Likelihood of at Least Two-Year Enrollment for Mid-high SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.162	[0.85, 1.588]		1.056	[0.768, 1.452]		1.035	[0.749, 1.429]	
GPA				2.291	[1.961, 2.677]	***	2.134	[1.81, 2.516]	***
Test Comp				1.635	[1.412, 1.894]	***	1.571	[1.352, 1.826]	***
Student Asp.							2.201	[1.724, 2.811]	***
Parent Asp.							0.819	[0.771, 0.87]	***
Constant	3.780	[3.166, 4.512]	***	4.640	[3.835, 5.613]	***	3.995	[2.968, 5.376]	***

**p < .05; **p < .01; ***p < .001*

Table 3.12

IPTW Logistic Regression – Likelihood of at Least Two-Year Enrollment for Mid-high SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.396	[0.95, 2.053]		1.402	[0.908, 2.165]		1.334	[0.869, 2.049]	
GPA				2.567	[1.753, 3.76]	***	2.253	[1.562, 3.251]	***
Test Comp				1.577	[1.102, 2.255]	*	1.609	[1.115, 2.322]	*
Student Asp.							1.756	[1.037, 2.974]	*
Parent Asp.							0.862	[0.747, 0.995]	*
Constant	3.446	[2.593, 4.581]	***	3.813	[2.786, 5.217]	***	3.511	[2.073, 5.948]	***

**p < .05; **p < .01; ***p < .001*

Table 3.13

Logistic Regression – Likelihood of Four-Year Enrollment for High SES Students

	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.244	[0.993, 1.558]		1.108	[0.858, 1.431]		1.088	[0.848, 1.396]	
GPA				2.275	[1.955, 2.647]	***	2.179	[1.869, 2.541]	***
Test Comp				2.606	[2.23, 3.045]	***	2.535	[2.165, 2.968]	***
Student Asp.							2.215	[1.577, 3.112]	***
Parent Asp.							0.886	[0.829, 0.946]	***
Constant	2.632	[2.286, 3.031]	***	0.932	[0.803, 1.081]		1.024	[0.717, 1.464]	

**p* < .05; ***p* < .01; ****p* < .001

Table 3.14

IPTW Logistic Regression – Likelihood of Four-Year Enrollment for High SES Students

	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.186	[0.842, 1.671]		1.173	[0.765, 1.8]		1.153	[0.748, 1.778]	
GPA				2.809	[1.877, 4.204]	***	2.599	[1.754, 3.85]	***
Test Comp				2.409	[1.616, 3.591]	***	2.487	[1.718, 3.599]	***
Student Asp.							2.863	[1.55, 5.29]	**
Parent Asp.							0.884	[0.759, 1.029]	
Constant	2.711	[2.114, 3.476]	***	1.416	[1.038, 1.932]	*	0.706	[0.371, 1.342]	

**p* < .05; ***p* < .01; ****p* < .001

Table 3.15

Logistic Regression – Likelihood of at Least Two-Year Enrollment for High SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.172	[0.833, 1.648]		1.022	[0.71, 1.472]		1.011	[0.695, 1.47]	
GPA				1.770	[1.441, 2.175]	***	1.679	[1.361, 2.071]	***
Test Comp				1.989	[1.619, 2.443]	***	1.899	[1.544, 2.335]	***
Student Asp.							1.729	[1.174, 2.546]	**
Parent Asp.							0.851	[0.782, 0.926]	***
Constant	11.281	[9.044, 14.072]	***	9.618	[7.584, 12.198]	***	8.605	[5.605, 13.209]	***

**p* < .05; ***p* < .01; ****p* < .001*

Table 3.16

IPTW Logistic Regression – Likelihood of at Least Two-Year Enrollment for High SES Students									
	(1)			(2)			(3)		
Variable	O.R.	95% C.I.		O.R.	95% C.I.		O.R.	95% C.I.	
SQI	1.338	[0.79, 2.267]		1.304	[0.734, 2.317]		1.278	[0.712, 2.294]	
GPA				2.516	[1.641, 3.859]	***	2.225	[1.436, 3.447]	***
Test Comp				1.914	[1.297, 2.823]	**	1.867	[1.223, 2.851]	**
Student Asp.							2.867	[1.389, 5.917]	**
Parent Asp.							0.909	[0.754, 1.096]	
Constant	8.634	[5.963, 12.501]	***	6.676	[4.564, 9.765]	***	3.452	[1.617, 7.371]	**

**p* < .05; ***p* < .01; ****p* < .001*

Appendix A

Illinois GSA Formula

Public schools in Illinois are funded, like most states, by a combination of local, state, and federal monies. For the 2011-12 school years, Illinois public schools, on average, relied on revenue generated through local property taxes, approximately 66 percent, with the state of Illinois, by way of distribution through the General State Aid (GSA) funding formula, contributing approximately 21 percent, and the federal government, by way of grant programs and other subsidies, contributing the remaining 13 percent (NEA, 2012). The total allocation from the state is composed of the GSA formula, the formula grant, and the supplemental low-income grant. Each will be discussed below.

The GSA funding formula is three tiered, guaranteeing some state aid to all public schools. The three tiers utilize different are Foundation, Alternate, and Flat Grant. The state of Illinois guarantees a minimum per-pupil expenditure level or Foundation Level for each school based on the school district's average daily attendance. If a school district is unable to meet 93 percent of the Foundation Level with local resources, the state of Illinois makes up the difference between the Foundation Level and what the school district's available local resources. School districts in the Alternate tier have available local resources that meet at least 93 percent but do not exceed 175 percent of the Foundation Level. The Alternate school districts receive between 5 and 7 percent of the state determined per-pupil Foundation level. School districts that have local resources that exceed 175 percent of the Foundation Level are categorized in the Flat Grant tier and receive a flat disbursement per-pupil. The algebraic formulas for each tier can be found in Appendix B.

In addition to the aforementioned three tier funding formula, the current GSA formula, enacted prior to the 1998-99 school years, has additional grants to help better distribute state funds. “GSA grants consist of the formula grant, which is equalized against local resources, and the supplemental low-income grant” (ISBE, 2013, p. 8). The first of the two grants guarantees a school district’s funding if that school district is unable to maintain the spending minimum accustomed to the school district (ISBE, 2013). For some districts that have adopted the Property Tax Extension Law (PTELL), property tax rates are restricted and are lower than the rates used to determine local wealth under the GSA formula. “Thus GSA in some cases assumed greater local wealth than a district could actually collect due to the restrictions of PTELL” (ISBE, 2013, p. 8). In these cases, the extension limitation EAV is used for the GSA formula, resulting in increased state support. The second grant provides additional state funds to school districts to offset “the impact of at-risk pupils in the district” (ISBE, 2013, p.2). The distribution of the special needs grant is “paid based on the ratio of low-income students in a district, regardless of the local wealth of a district” (ISBE, 2013, p. 8).

Appendix B

Table B.1

Description of Model Variables

Level	**Variables**	**Description**
Outcome	act_math	ACT Math subject test score
	FourYearAny	Enrollment in four-year college (0=no, 1=yes)
	Bach_higher	Received at least a bachelor's degree (0=no, 1=yes)
Student	female	Gender (0=male, 1=female)
	pincome_cent	Parental income (0=<$18k, 1=$18k-24k, 2=$24k - 30k, 3=$30k-36k, 4=$36k-42k, 5=$42k-50k, 6=$50k-60k, 7=$60k-80k, 8=$80k-100k, 9=More than $100k)
	race	Race (1=Black, 2=American Indian/Alaskan Native, 3=White, 4=Latino, 5=Asian/Pacific Islander)
School	z_itac	Standardized index of teacher capital
	z_percentminority	Standardized percentage of minority students within a school
	schoolid	School identifier
School District	z_perpupilrevenue	Standardized total state and local revenue for each school district
	leaid	School district identifier

Appendix C

Table C.1
Illinois General State Aid Formulas

Terms Used in the Calculation of General State Aid	
ADA – Greater of the Prior Year Best Three Months Average Daily Attendance or Prior Three-Year Average	**ALR** – Available Local Resources = (GSA EAV x RATE + CPPRT) / ADA
CPPRT – Corporate Personal Property Replacement Taxes	**DCR –** district concentration of low-income pupils
EAV – Equalized Assessed Valuation	**ELEAV –** Extension Limitation EAV = Prior Year EAV x ELR
ELR – Extension Limitation Ratio = (Budget Year EAV x Budget Year Limiting Rate) / (Prior Year EAV x Prior Year OTR)	**FLEVEL** – Foundation Level = $6,119 for FY2014; $4,560 for FY2002 & FY2003
GSA – General State Aid	**GSA EAV** – smaller of Budget Year EAV & Extension Limitation EAV
LIP – low-income pupils	**LP** – Local Percentage = (Available Local Resource) / FLEVEL
OTR – Operating Tax Rate	**RATE** – 2.30% if Elementary District; 1.05% if High School District; 3.00% if Unit District

$$Foundation\ Formula\ = (FLEVEL - ALR\ per\ pupil)\ x\ ADA$$

$$Alternate\ Formula\ = FLEVEL\ x\ ADA\ x\ (.07 - \left[\frac{(LP -\ 0.93)}{0.82}\right] x\ 0.02)$$

$$Flat\ Grant\ Formula\ = ADA\ x\ \$218$$

$$Supplemental\ Low - Income\ Grant\ Formula\ = [\$294.25 + \$2{,}700\ x\ DCR^2]\ x\ LIP$$

Table C.2
ITAC Components and Weights

ITAC Component	**Weight**
Teachers' Mean ACT Composite Score	0.91
Teachers' Mean ACT English Score	0.90
% of Teachers Failing the Basic Skills Test on Their First Attempt	-0.36
% of Teachers with Emergency/Provisional Certification	-0.50
Teachers' Mean Undergraduate College Competitiveness Ranking	0.45
Source: White, Presley, & DeAngelis, 2008	

Figure C.1
Hierarchical Linear Model – ACT Math Score

Level 1 (student): $(Math\ ACT\ score)_{ijk} = \pi_{00j} + \pi_{01j}(female)_{ijk} + \pi_{02j}(parent\ income)_{ijk} + \pi_{03j}(race)_{ijk} + R_{ijk}$

Level 2 (school): $\pi_{0jk} = \gamma_{00j} + \gamma_{01j}(percent\ minority)_{ij} + \gamma_{02j}(ITAC)_{ij} + r_{0jk}$

Level 3 (school district): $\beta_{00k} = \gamma_{000}(revenue) + u_{00k}$
$\beta_{2j} = \gamma_{20}$
$\beta_{3j} = \gamma_{30}$
$\beta_{4j} = \gamma_{40}$
$\beta_{5j} = \gamma_{50}$

Figure C.2
Hierarchical Logit Model – Four-Year Enrollment

Level 1 (student): $ln(P(enroll\ four - year)/P(not\ enroll\ four - year)\ )_{ij} = \pi_{00j} + \pi_{1jk}(female) + \pi_{02j}(parent\ income) + \pi_{3jk}(race) + e_{ijk}$

Level 2 (school): $\pi_{0jk} = \gamma_{00j} + \gamma_{01j}(percent\ minority)_{ij} + \gamma_{02j}(ITAC)_{ij} + r_{0jk}$

Level 3 (school district): $\beta_{00k} = \gamma_{000}(revenue) + u_{00k}$
$\beta_{2j} = \gamma_{20}$
$\beta_{3j} = \gamma_{30}$
$\beta_{4j} = \gamma_{40}$
$\beta_{5j} = \gamma_{50}$

Figure C.3
Hierarchical Logit Model – Bachelor's Degree

Level 1 (student): $ln(P(Bach. Degree)/P(No\ Bach. Degree)\ )_{ijk} = \pi_{00j} + \pi_{1jk}(female) + \pi_{02j}(parent\ income) + \pi_{3jk}(race) + e_{ijk}$

Level 2 (school): $\pi_{0jk} = \gamma_{00j} + \gamma_{01j}(percent\ minority)_{ij} + \gamma_{02j}(ITAC)_{ij} + r_{0jk}$

Level 3 (school district): $\beta_{00k} = \gamma_{000}(revenue) + u_{00k}$
$\beta_{2j} = \gamma_{20}$
$\beta_{3j} = \gamma_{30}$
$\beta_{4j} = \gamma_{40}$
$\beta_{5j} = \gamma_{50}$

Appendix D

Table D.1
ITAC Distribution by Race of the Population

	Low & Mid-Low ITAC	Mid-High & High ITAC
African American	9524	2178
American Indian/Alaskan Native	302	233
Asian/Pacific Islander	1362	3237
Latino	6132	3377
White (Non-Hispanic)	28787	39084

Table D.2
ITAC Percentage Distribution by Race of the Population

	Low & Mid-Low ITAC	Mid-High & High ITAC
African American	81.4%	18.6%
American Indian/Alaskan Native	56.4%	43.6%
Asian/Pacific Islander	29.6%	70.4%
Latino	64.5%	35.5%
White (Non-Hispanic)	42.4%	57.6%

Table D.3

Distribution of Students by Race in the Un-Weighted and Weighted ITAC Models

	Un-Weighted ITAC Distribution		Weighted ITAC Distribution	
	Low & Mid-Low ITAC	Mid-High & High ITAC	Low & Mid-Low ITAC	Mid-High & High ITAC
African American	9524	2178	4017	997
Latino	6132	3377	2342	1632

Table D.4

Percentage Distribution of Students by Race in the Un-Weighted and Weighted ITAC Models

	Un-Weighted ITAC Percentage Distribution		Weighted ITAC Percentage Distribution	
	Low & Mid-Low ITAC	Mid-High & High ITAC	Low & Mid-Low ITAC	Mid-High & High ITAC
African American	81.4%	18.6%	80.1%	19.9%
Latino	64.5%	35.5%	58.9%	41.1%

Appendix E

Table E.1

ITAC Components and Weights

ITAC Component	Weight
Teachers' Mean ACT Composite Score	0.91
Teachers' Mean ACT English Score	0.90
% of Teachers Failing the Basic Skills Test on Their First Attempt	-0.36
% of Teachers with Emergency/Provisional Certification	-0.50
Teachers' Mean Undergraduate College Competitiveness Ranking	0.45
Source: White, Presley, & DeAngelis, 2008, p. 10	

Appendix F

Table F.1

Population Demographics by Race within SES group

Race	Low SES	Mid-Low SES	Mid-High SES	High SES	Total
White	807	1285	1413	1450	4955
	16%	26%	29%	29%	
Black	404	336	261	182	1183
	34%	28%	22%	15%	
Latino	622	292	201	131	1246
	50%	23%	16%	11%	
Asian	290	185	206	303	984
	29%	19%	21%	31%	
Total	2123	2098	2081	2066	8368

Table F.2

Population Demographics by Gender within SES group

Gender	Low SES	Mid-Low SES	Mid-High SES	High SES	Total
Male	996	1020	1047	1031	4094
	24%	25%	26%	25%	
Female	1158	1094	1045	1048	4345
	27%	25%	24%	24%	
Total	2154	2114	2092	2079	8439

Table F.3

Summary of Standardized Variables Used in Analysis

Variable	N	Mean	Std. Dev.	Min	Max
SES	8,800	-0.02491	0.716	-2.12	1.97
GPA	8,178	0.009	1	-3.039	1.563
Std. Test	8,729	0.004	1.003	-2.984	3.010
Fin. Aid	4,321	0.746586	0.435016	0	1
Student Aspirations	7,575	0.869967	0.336362	0	1
Parent Aspiration	8,527	0.749619	0.433258	0	1

Table F.4

Description & Summary of Variables Used for SQI with the Factor Weight

Variable	Description	N	Mean	Std. Dev.	Min	Max	Factor Weight
bya24a	% full-time teachers are certified	8995	96.759	10.422	2	100	0.1955
bya25a	% full-time teachers teach out of field	7599	3.781	15.275	0	100	0.0011
bya38a	Control access to buildings during school hours	8119	0.753	0.431	0	1	0.0292
bya38b	Control access to grounds during school hours	8068	0.443	0.497	0	1	-0.0687
bya38c	Require students pass through metal detector	8124	0.025	0.158	0	1	-0.2053
bya38d	Random metal detector checks on students	8034	0.118	0.323	0	1	-0.1447
bya38e	Close campus for students during lunch	8090	0.682	0.466	0	1	-0.0121
bya38f	Random dog sniffs to check for drugs	8124	0.503	0.500	0	1	0.1805
bya38g	Random sweeps for contraband	7992	0.264	0.441	0	1	0.0429
bya38h	Require drug testing for any students	8066	0.142	0.349	0	1	0.1307
bya40a	Use paid security at any time during school hours	8097	0.736	0.441	0	1	-0.2995
bya40b	Use paid security as students arrive or leave	8097	0.688	0.463	0	1	-0.2383
bya40c	Use paid security at school activities	8061	0.929	0.256	0	1	-0.1453
bya40d	Use paid security outside of school hours/activities	8061	0.262	0.440	0	1	-0.1696
bya40e	Use paid security at other time	8079	0.119	0.324	0	1	-0.1373
bya49a	How often tardiness a problem at school	7767	1.082	0.409	1	4	0.0513
bya49b	How often absenteeism a problem at school	7767	1.077	0.417	1	4	0.0513
bya49c	How often class cutting a problem at school	7712	1.773	1.032	1	4	0.4714
bya49d	How often physical conflicts a problem at school	7768	3.462	0.798	1	5	0.5582
bya49e	How often robbery/theft a problem at school	7782	3.684	0.614	1	5	0.5184
bya49f	How often vandalism a problem at school	7782	3.840	0.562	1	5	0.5284
bya49g	How often use of alcohol a problem at school	7782	3.863	0.701	1	5	0.498
bya49h	How often use of illegal drugs a problem at school	7782	3.797	0.735	1	5	0.5244
bya49i	How often students on drugs/alcohol at school a problem	7755	3.851	0.661	1	5	0.5102
bya49j	How often sale of drugs near school a problem	7720	3.829	0.782	1	5	0.5278

Table F.4 (cont.)

bya49k	How often possession of weapons a problem at school	7747	4.246	0.509	1	5	0.4322
bya49l	How often physical abuse of teachers a problem at school	7732	4.764	0.444	2	5	0.4086
bya49m	How often racial tension among students a problem at school	7735	4.257	0.544	1	5	0.295
bya49n	How often student bullying a problem at school	7708	3.544	0.792	1	5	0.386
bya49o	How often verbal abuse of teachers a problem at school	7745	3.670	0.705	1	5	0.4667
bya49p	How often disorder in classrooms a problem at school	7766	4.529	0.658	1	5	0.3938
bya49q	How often student disrespect for teachers a problem at school	7769	3.507	0.887	1	5	0.4107
bya49r	How often gang activity a problem at school	7782	4.455	0.681	1	5	0.5219
bya49s	How often cult/extremist group activities a problem at school	7740	4.752	0.453	2	5	0.4404
bya50a	Learning hindered by poor condition of buildings	7770	1.593	0.816	1	4	-0.4201
bya50b	Learning hindered by poor heating/air/light	7758	1.754	0.858	1	4	-0.4313
bya50c	Learning hindered by poor science labs	7788	1.779	0.888	1	4	-0.3985
bya50d	Learning hindered by poor fine arts facilities	7740	1.906	0.960	1	4	-0.2975
bya50e	Learning hindered by lack of space	7732	1.919	0.952	1	4	-0.3853
bya50f	Learning hindered by poor library	7694	1.688	0.805	1	4	-0.3546
bya50g	Learning hindered by lack of texts/supplies	7767	1.538	0.699	1	4	-0.4648
bya50h	Learning hindered by too few computers	7772	1.927	0.885	1	4	-0.3547
bya50i	Learning hindered by lack of multi-media	7750	1.862	0.827	1	4	-0.3975
bya50j	Learning hindered by lack of discipline/safety	7778	1.502	0.584	1	4	-0.5183
bya50k	Learning hindered by poor voc/tech equipment/facilities	7753	1.821	0.865	1	4	-0.4622
cp04stro	Student/teacher ratio-2003/04 CCD/PSS (restricted)	8502	17.507	3.943	6.1	32.6	-0.3917
f1a07a	Years of English coursework required to graduate	8677	6.920	0.271	6	7	0.0966
f1a07b	Years of mathematics coursework required to graduate	8649	5.856	0.628	4	7	0.1258
f1a07c	Years of science coursework required to graduate	8655	5.688	0.633	4	7	0.1147
f1a07d	Years of history/social studies coursework required to graduate	8422	6.142	0.634	4	7	0.0929
f1a07e	Years of computer coursework required to graduate	8224	3.059	0.991	1	6	0.1517
f1a07f	Years of foreign language coursework required to graduate	8284	3.135	1.357	1	7	0.0255

Table F.4 (cont.)

f1a07g	Years of fine arts coursework required to graduate	8472	3.557	1.043	1	7	0.0418
f1a07h	Years of physical education/health coursework required to graduate	8609	4.672	1.222	1	7	0.0649
f1a19a	% of 2003 graduates went to 4-year colleges	8536	4.265	1.059	1	6	0.4758
f1a34a	% of full-time teachers have state/advanced professional certificate	8263	90.531	14.785	3	100	0.233
f1a37d	% of excellent teachers	8026	35.949	24.371	0	100	0.1584
f1a38a	Student morale is high	8104	3.893	0.748	1	5	0.2888
f1a38c	Teacher morale is high	8031	3.691	0.886	1	5	0.285
f1a40a	How often physical conflicts a problem at school	8068	3.514	0.725	1	5	0.5059
f1a40b	How often robbery/theft a problem at school	8077	3.659	0.664	1	5	0.4297
f1a40c	How often vandalism a problem at school	8015	3.815	0.588	2	5	0.4715
f1a40d	How often use of alcohol a problem at school	8030	3.879	0.623	2	5	0.4023
f1a40e	How often use of illegal drugs a problem at school	7966	3.750	0.696	1	5	0.3501
f1a40f	How often students on drugs/alcohol at school a problem	8053	3.832	0.658	1	5	0.3255
f1a40g	How often sale of drugs near school a problem	7941	3.811	0.762	1	5	0.2893
f1a40h	How often possession of weapons a problem at school	7992	4.290	0.477	3	5	0.3462
f1a40i	How often physical abuse of teachers a problem at school	8002	4.806	0.395	4	5	0.407
f1a40j	How often racial tension among students a problem at school	7941	4.272	0.571	2	5	0.1708
f1a40k	How often student bullying a problem at school	8059	3.488	0.824	1	5	0.2485
f1a40l	How often verbal abuse of teachers a problem at school	8031	3.588	0.880	1	5	0.4477
f1a40m	How often disorder in classrooms a problem at school	8079	4.527	0.650	2	5	0.3001
f1a40n	How often student disrespect for teachers a problem at school	8079	3.340	1.008	1	5	0.3755
f1a40o	How often gang activity a problem at school	8050	4.475	0.638	2	5	0.4688
f1a40p	How often cult/extremist group activities a problem at school	8058	4.834	0.372	4	5	0.2486
totlocppr~04	2004 Adjusted Local Total Per Pupil Revenue	9244	4413.363	2636.399	291.9357	35969.36	0.1326

Chart F.1

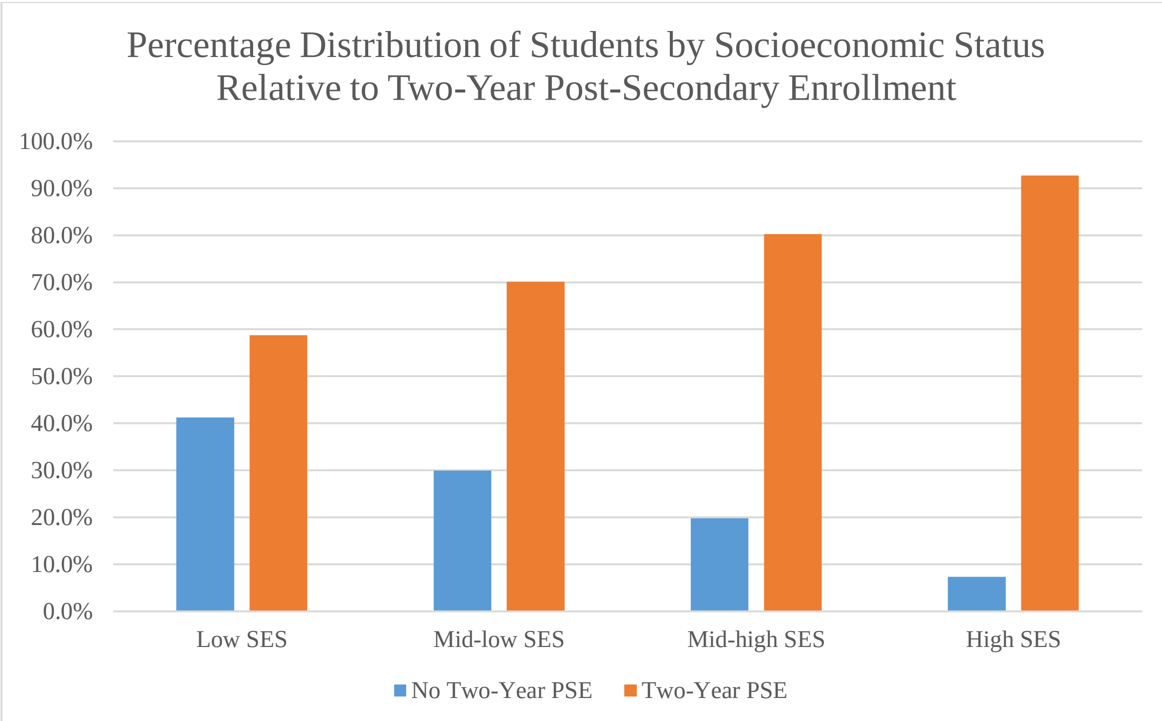


Chart F.2

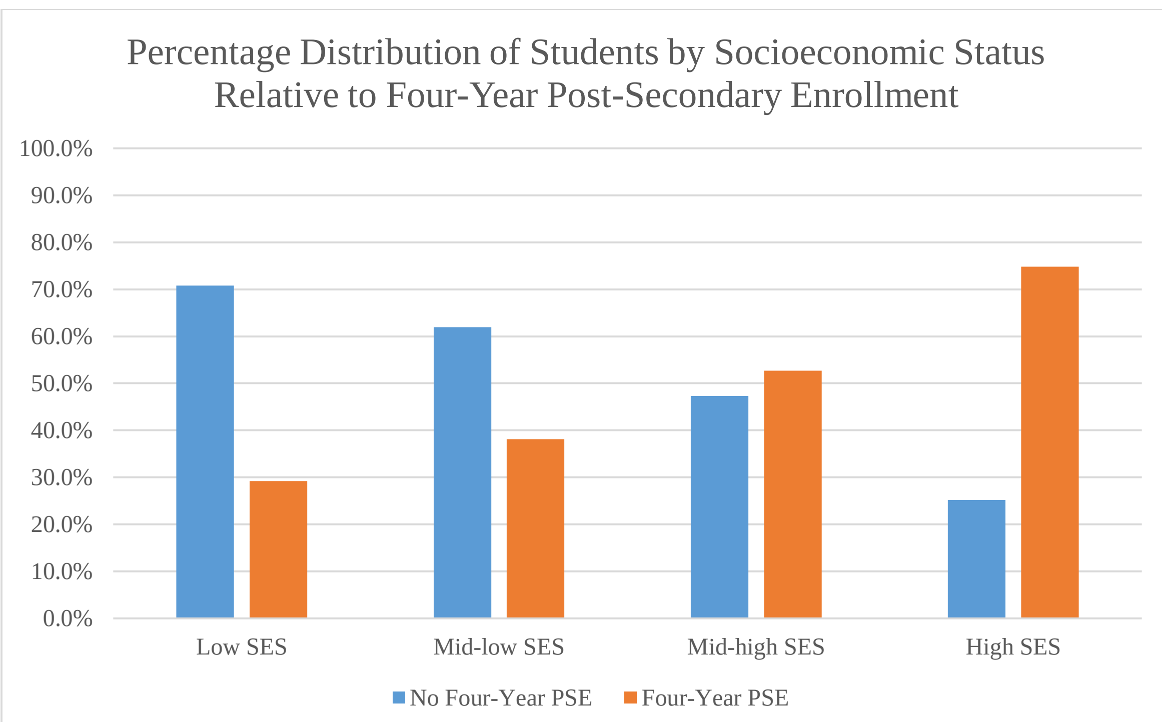


Chart F.3

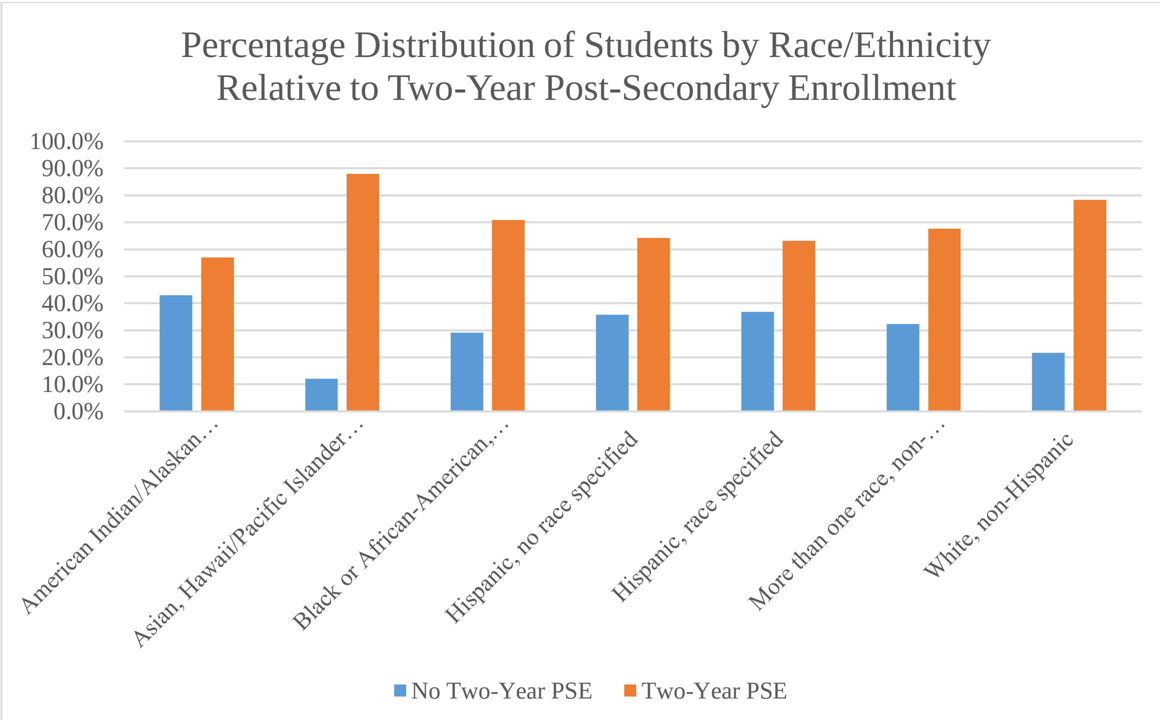


Chart F.4

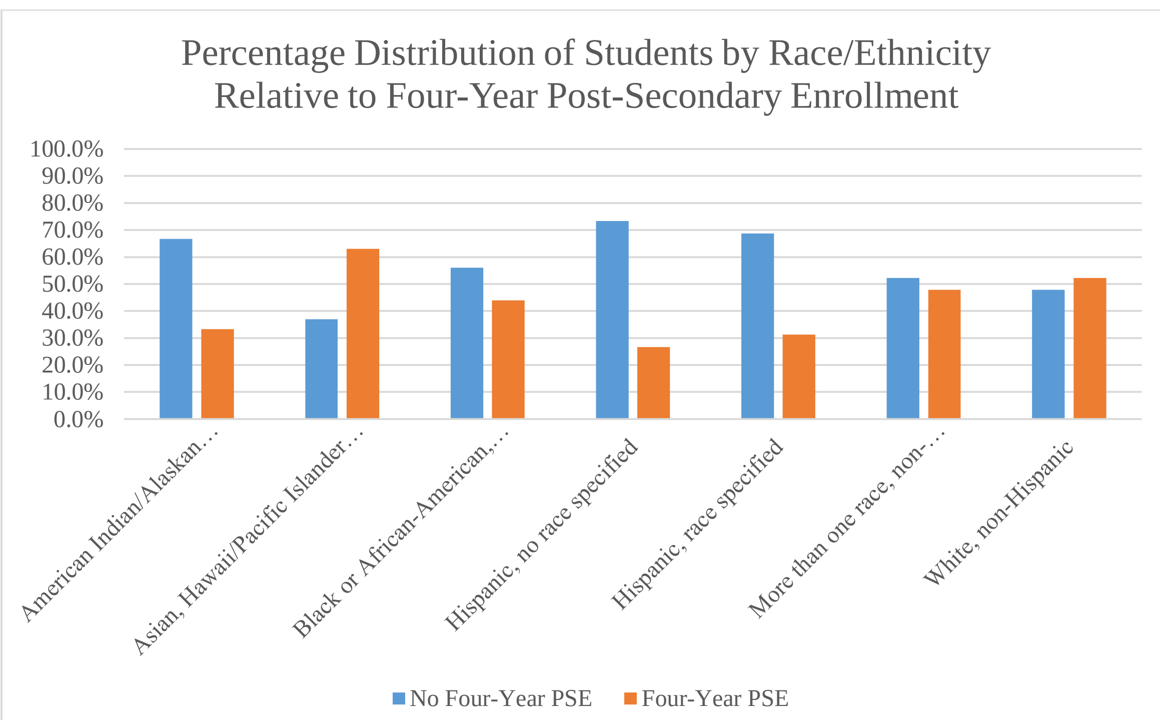
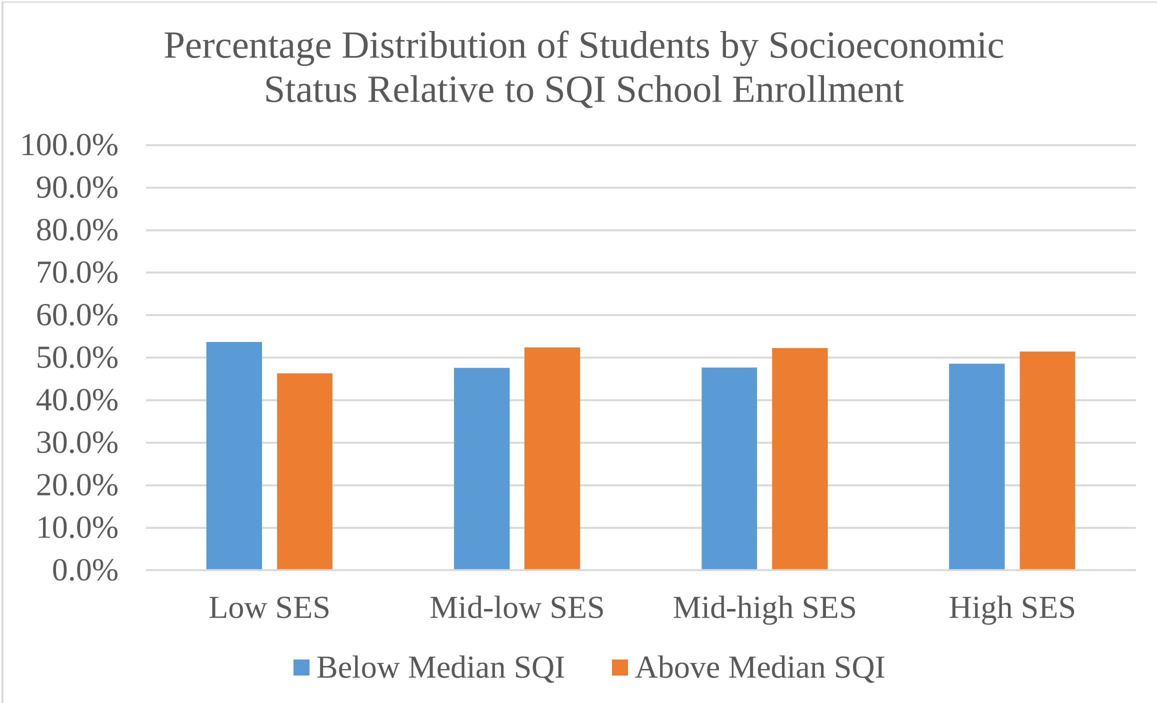


Chart F.5



Percentage Distribution of Students by Socioeconomic Status Relative to SQI School Enrollment
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Low SES
Mid-low SES
Mid-high SES
High SES
Below Median SQI
Above Median SQI

Appendix G

Table G.1

Description of Variables used for IPTW

Variable	Description
bysex	Sex-composite
bystlng2	Sample member's English fluency
bygrdrpt	Number of grades repeated (K-10)
byparasp	How far in school parent wants 10th grader to go-composite
byschprg	High school program reported by student-composite
bytxmstd	Math test standardized score
byg10er	Grade 10 enrollment-2001/02 school roster (restricted)
byg10ep	Grade 10 enrollment-2001/02 school roster-categorical
byfcomp	Family composition
bypared	Parents' highest level of education
bymothed	Mother's highest level of education-composite
byfathed	Father's highest level of education-composite
byoccum	Mother/female guardian's occupation-composite
byoccuf	Father/male guardian's occupation-composite
bystexp	How far in school student thinks will get-composite
byxtracu	Number of school-sponsored activities participated in 01-02
bys28	How much likes school
bys34a	Hours/week spent on homework in school
bys34b	Hours/week spent on homework out of school
bys37	Importance of good grades to student
bys54a	Importance of being successful in line work
bys54c	Importance of having lots of money
bys56	How far in school student thinks will get
byhmwrk	BY hours per week spent on homework (in and out of school)
bys20a	Students get along well with teachers
bys20b	There is real school spirit
bys20c	Students friendly with other racial groups
bys20d	Other students often disrupt class
bys20h	In class often feels put down by teachers
bys20i	In class often feels put down by students
bys20k	Disruptions get in way of learning
bys20l	Misbehaving students often get away with it
bys20n	Racial/ethnic groups often fight
bys21a	Everyone knows what school rules are
bys21e	Students know punishment for broken rules
bys22a	Had something stolen at school
bys22b	Someone offered drugs at school

Table G.1 (cont.)

bys22c	Someone threatened to hurt 10th grader at school
bys22d	Got into a physical fight at school
bys22e	Someone hit 10th grader
bys22f	Someone forced money/things from 10th grader
bys22g	Someone damaged belongings
bys22h	Someone bullied or picked on 10th grader
bys23a	Won an academic honor
bys23b	Recognized for good attendance
bys23c	Recognized for good grades
bys23d	Received community service award
bys23e	Participated in science/math fair
bys23f	Participated in voc/tech skills competition
bys24a	How many times late for school
bys24b	How many times cut/skip classes
bys24c	How many times absent from school
bys24d	How many times got in trouble
bys24e	How many times put on in-school suspension
bys24f	How many times suspended/put on probation
bys24g	How many times transferred for disciplinary reasons
bys27a	Classes are interesting and challenging
bys54b	Importance of marrying right person/having happy family
bys54d	Importance of having strong friendships

Table G.2

Pre-treatment relationships in unmatched and matched samples for High-SES Students

	Unmatched Sample			IPTW-matched Sample		
	Coefficient	*p*-value on *F*-test		Coefficient	*p*-value on *F*-test	
bysex	0.008	0.744		0.005	0.846	
bystlng2	0.218	0.000	*	0.059	0.011	*
bygrdrpt	-4.086	0.003	*	-1.571	0.220	
byparasp	-0.085	0.068		-0.019	0.644	
byschprg	0.015	0.584		0.025	0.315	
bytxmstd	2.283	0.000	*	1.414	0.000	*
byg10er	-71.617	0.000	*	-64.539	0.000	*
byg10ep	-0.481	0.000	*	-0.507	0.000	*
byfcomp	-0.180	0.038	*	-0.095	0.181	
bypared	0.182	0.001	*	-0.031	0.535	
bymothed	0.130	0.116		-0.109	0.121	
byfathed	0.255	0.002	*	0.067	0.356	
byoccum	0.344	0.194		-0.302	0.108	
byoccuf	0.085	0.632		-0.022	0.894	
bystexp	0.046	0.024	*	0.013	0.463	
byxtracu	0.012	0.885		0.086	0.148	
bys28	-0.039	0.298		0.027	0.315	
bys34a	0.089	0.746		0.496	0.025	*
bys34b	-0.164	0.636		0.732	0.011	*
bys37	-0.027	0.445		0.045	0.175	
bys54a	0.011	0.553		-0.006	0.682	
bys54c	-0.077	0.016	*	-0.098	0.001	*
bys56	0.185	0.064		0.085	0.308	
byhmwrk	-1.057	0.366		1.918	0.027	*
bys20a	-0.059	0.032	*	-0.078	0.089	
bys20b	0.003	0.943		-0.157	0.013	*
bys20c	0.033	0.332		-0.049	0.152	
bys20d	0.056	0.139		0.068	0.048	*
bys20h	0.019	0.592		0.068	0.030	*
bys20i	0.035	0.245		0.014	0.739	
bys20k	0.171	0.013	*	0.076	0.062	
bys20l	0.044	0.230		0.034	0.365	
bys20n	0.253	0.000	*	0.081	0.024	*
bys21a	-0.033	0.376		-0.062	0.046	*
bys21e	0.051	0.179		-0.024	0.465	
bys22a	-0.042	0.248		0.021	0.461	
bys22b	0.069	0.035	*	-0.034	0.378	
bys22c	-0.002	0.957		-0.053	0.114	
bys22d	0.006	0.760		-0.012	0.455	

Table G.2 (cont.)

bys22e	0.019	0.573		-0.071	0.023	*
bys22f	-0.004	0.758		-0.006	0.499	
bys22g	0.027	0.319		-0.010	0.678	
bys22h	-0.002	0.964		-0.044	0.370	
bys23a	0.009	0.708		0.056	0.018	*
bys23b	-0.024	0.363		-0.024	0.409	
bys23c	0.049	0.051		0.045	0.054	
bys23d	0.001	0.969		0.004	0.804	
bys23e	0.026	0.205		0.014	0.456	
bys23f	-0.010	0.499		0.019	0.128	
bys24a	-0.090	0.057		-0.002	0.962	
bys24b	-0.161	0.000	*	-0.054	0.168	
bys24c	0.001	0.981		-0.075	0.144	
bys24d	-0.060	0.112		-0.058	0.143	
bys24e	-0.058	0.024	*	0.014	0.518	
bys24f	-0.033	0.019	*	0.005	0.694	
bys24g	0.000	0.955		0.000	0.984	
bys27a	0.041	0.287		-0.064	0.101	
bys54b	0.029	0.301		0.016	0.479	
bys54d	0.027	0.121		0.032	0.057	

Notes: (*p < .05)

Table G.3

Pre-treatment relationships in unmatched and matched samples for Mid-high-SES Students

	Unmatched Sample			IPTW-matched Sample		
	Coefficient	*p*-value on *F*-test		Coefficient.	*p*-value on *F*-test	
bysex	-0.015	0.568		-0.048	0.043	*
bystlng2	0.212	0.000	*	0.013	0.550	
bygrdrpt	-5.085	0.002	*	-1.721	0.259	
byparasp	-0.150	0.008	*	0.007	0.903	
byschprg	0.009	0.759		0.006	0.822	
bytxmstd	2.846	0.000	*	2.502	0.000	*
byg10er	-84.612	0.000	*	-81.598	0.000	*
byg10ep	-0.594	0.000	*	-0.606	0.000	*
byfcomp	-0.252	0.003	*	-0.036	0.653	
bypared	0.057	0.465		0.093	0.184	
bymothed	-0.028	0.694		0.003	0.970	
byfathed	0.129	0.144		0.067	0.422	
byoccum	0.117	0.695		0.270	0.261	
byoccuf	0.350	0.133		0.128	0.521	
bystexp	0.031	0.136		0.002	0.935	
byxtracu	-0.014	0.858		-0.026	0.644	
bys28	-0.103	0.000	*	-0.051	0.045	*
bys34a	0.137	0.595		-0.018	0.936	
bys34b	-0.254	0.350		-0.263	0.305	
bys37	-0.104	0.001	*	-0.014	0.666	
bys54a	0.004	0.829		0.046	0.011	*
bys54c	-0.056	0.285		-0.012	0.686	
bys56	0.149	0.142		-0.019	0.849	
byhmwrk	-0.604	0.570		-1.538	0.092	
bys20a	-0.084	0.044	*	-0.068	0.017	*
bys20b	0.033	0.514		-0.083	0.037	*
bys20c	0.070	0.153		0.026	0.399	
bys20d	-0.008	0.875		0.045	0.231	
bys20h	0.004	0.907		0.025	0.462	
bys20i	-0.008	0.875		0.064	0.070	
bys20k	0.106	0.016	*	0.054	0.139	
bys20l	0.024	0.606		0.035	0.368	
bys20n	0.223	0.000	*	0.199	0.000	*
bys21a	0.015	0.626		-0.070	0.032	*
bys21e	0.081	0.039	*	-0.020	0.561	
bys22a	-0.018	0.620		-0.025	0.379	
bys22b	0.087	0.086		-0.009	0.782	
bys22c	0.046	0.149		0.015	0.598	
bys22d	0.016	0.417		-0.002	0.928	

Table G.3 (cont.)

bys22e	0.034	0.370		-0.002	0.941	
bys22f	-0.003	0.781		-0.019	0.117	
bys22g	0.029	0.219		-0.042	0.066	
bys22h	0.085	0.040	*	-0.042	0.181	
bys23a	-0.018	0.436		0.019	0.405	
bys23b	-0.044	0.061		0.004	0.832	
bys23c	0.015	0.520		0.045	0.089	
bys23d	-0.016	0.404		-0.005	0.711	
bys23e	0.006	0.746		0.009	0.601	
bys23f	-0.023	0.113		0.022	0.071	
bys24a	-0.099	0.064		-0.038	0.448	
bys24b	-0.164	0.000	*	-0.118	0.003	*
bys24c	0.088	0.224		0.026	0.625	
bys24d	-0.003	0.937		0.009	0.815	
bys24e	-0.064	0.017	*	-0.032	0.091	
bys24f	0.002	0.913		-0.013	0.384	
bys24g	0.012	0.295		0.003	0.624	
bys27a	0.116	0.001	*	0.045	0.210	
bys54b	0.052	0.133		0.008	0.733	
bys54d	0.030	0.150		0.013	0.480	

Notes: (* $p < .05$)

Table G.4

Pre-treatment relationships in unmatched and matched samples for Mid-low-SES Students

	Unmatched Sample			IPTW-matched Sample		
	Coefficient	*p*-value on *F*-test		Coefficient.	*p*-value on *F*-test	
bysex	0.007	0.814		0.022	0.369	
bystlng2	0.279	0.000	*	0.116	0.000	*
bygrdrpt	-5.477	0.019	*	-7.325	0.000	*
byparasp	-0.309	0.009	*	-0.250	0.000	*
byschprg	-0.020	0.583		-0.054	0.091	
bytxmstd	2.495	0.000	*	0.969	0.020	*
byg10er	-124.348	0.000	*	-121.926	0.000	*
byg10ep	-0.925	0.000	*	-0.955	0.000	*
byfcomp	-0.201	0.057		-0.142	0.108	
bypared	-0.125	0.079		-0.115	0.097	
bymothed	0.019	0.793		-0.020	0.759	
byfathed	-0.055	0.522		-0.032	0.636	
byoccum	-0.070	0.771		0.212	0.437	
byoccuf	-0.151	0.434		-0.215	0.315	
bystexp	-0.034	0.269		-0.051	0.038	*
byxtracu	-0.031	0.670		0.051	0.396	
bys28	-0.087	0.001	*	-0.028	0.292	
bys34a	0.580	0.024	*	0.462	0.077	
bys34b	0.007	0.982		-0.142	0.599	
bys37	-0.137	0.000	*	-0.077	0.033	*
bys54a	-0.008	0.680		-0.010	0.577	
bys54c	-0.099	0.002	*	-0.076	0.012	*
bys56	-0.062	0.641		-0.145	0.178	
byhmwrk	0.781	0.386		0.431	0.658	
bys20a	-0.076	0.043	*	-0.076	0.009	*
bys20b	-0.018	0.680		-0.062	0.136	
bys20c	0.057	0.151		0.064	0.068	
bys20d	0.023	0.565		0.047	0.195	
bys20h	0.007	0.829		-0.022	0.521	
bys20i	-0.021	0.574		-0.040	0.264	
bys20k	0.168	0.009	*	0.081	0.065	
bys20l	0.043	0.337		0.039	0.366	
bys20n	0.273	0.000	*	0.149	0.000	*
bys21a	-0.044	0.212		-0.070	0.023	*
bys21e	0.002	0.957		-0.053	0.128	
bys22a	-0.035	0.182		-0.052	0.100	
bys22b	0.038	0.280		-0.021	0.481	
bys22c	0.040	0.185		-0.022	0.475	
bys22d	0.001	0.952		-0.011	0.616	

Table G.4 (cont.)

bys22e	0.028	0.369		0.000	0.994	
bys22f	-0.008	0.404		-0.006	0.440	
bys22g	0.026	0.183		-0.017	0.428	
bys22h	0.068	0.058		0.043	0.178	
bys23a	-0.018	0.484		-0.002	0.926	
bys23b	-0.049	0.038	*	-0.026	0.228	
bys23c	-0.004	0.890		0.033	0.184	
bys23d	-0.001	0.972		0.013	0.374	
bys23e	-0.011	0.550		-0.016	0.357	
bys23f	0.001	0.925		-0.001	0.967	
bys24a	-0.206	0.028	*	-0.259	0.000	*
bys24b	-0.209	0.000	*	-0.181	0.000	*
bys24c	0.052	0.354		0.009	0.861	
bys24d	-0.017	0.687		-0.052	0.213	
bys24e	-0.069	0.097		-0.032	0.128	
bys24f	-0.038	0.092		-0.015	0.305	
bys24g	-0.002	0.793		-0.002	0.746	
bys27a	0.145	0.006	*	0.066	0.080	
bys54b	0.033	0.232		0.038	0.148	
bys54d	0.045	0.019	*	0.035	0.087	

Notes: (*$p < .05$)

Table G.5

Pre-treatment relationships in unmatched and matched samples for Mid-high-SES Students

	Unmatched Sample			IPTW-matched Sample		
	Coefficient	*p*-value on *F*-test		Coefficient	*p*-value on *F*-test	
bysex	0.029	0.270		-0.025	0.315	
bystlng2	0.534	0.000	*	0.353	0.000	*
bygrdrpt	-0.085	0.967		-1.543	0.426	
byparasp	-0.347	0.000	*	-0.267	0.000	*
byschprg	-0.017	0.596		-0.083	0.014	*
bytxmstd	2.078	0.000	*	1.716	0.000	*
byg10er	-156.849	0.000	*	-147.823	0.000	*
byg10ep	-1.117	0.000	*	-1.193	0.000	*
byfcomp	0.001	0.995		-0.084	0.423	
bypared	0.130	0.094		0.017	0.790	
bymothed	0.228	0.004	*	0.107	0.075	
byfathed	0.090	0.190		0.032	0.577	
byoccum	0.998	0.006	*	0.279	0.335	
byoccuf	0.055	0.777		-0.235	0.246	
bystexp	-0.015	0.638		-0.025	0.360	
byxtracu	0.068	0.351		0.081	0.221	
bys28	-0.155	0.000	*	-0.100	0.001	*
bys34a	0.352	0.193		1.076	0.000	*
bys34b	-0.345	0.265		-0.210	0.478	
bys37	-0.168	0.000	*	-0.188	0.000	*
bys54a	0.026	0.220		-0.001	0.952	
bys54c	-0.046	0.232		-0.037	0.233	
bys56	0.049	0.725		-0.020	0.874	
byhmwrk	-0.242	0.835		1.697	0.136	
bys20a	0.012	0.768		-0.046	0.149	
bys20b	0.010	0.824		-0.014	0.747	
bys20c	0.120	0.003	*	0.118	0.001	*
bys20d	-0.012	0.784		0.031	0.392	
bys20h	-0.036	0.429		-0.071	0.062	
bys20i	-0.034	0.530		-0.103	0.011	*
bys20k	0.161	0.001	*	0.133	0.009	*
bys20l	0.018	0.696		0.010	0.807	
bys20n	0.242	0.000	*	0.213	0.000	*
bys21a	-0.032	0.413		-0.064	0.084	
bys21e	0.028	0.516		-0.043	0.274	
bys22a	0.016	0.706		0.026	0.403	
bys22b	0.080	0.060		0.063	0.057	
bys22c	0.089	0.024	*	0.066	0.029	*
bys22d	0.029	0.252		0.027	0.222	

Table G.5 (cont.)

bys22e	0.075	0.046	*	0.086	0.005	*
bys22f	0.006	0.578		0.003	0.790	
bys22g	0.043	0.092		0.049	0.030	*
bys22h	0.094	0.030	*	0.078	0.020	*
bys23a	-0.012	0.555		-0.020	0.422	
bys23b	-0.023	0.363		-0.020	0.401	
bys23c	-0.016	0.549		0.002	0.949	
bys23d	-0.008	0.570		-0.020	0.183	
bys23e	-0.010	0.537		-0.008	0.670	
bys23f	0.012	0.385		0.063	0.000	*
bys24a	-0.189	0.001	*	-0.132	0.017	*
bys24b	-0.162	0.001	*	-0.116	0.026	*
bys24c	0.105	0.090		0.053	0.328	
bys24d	0.065	0.098		0.108	0.017	*
bys24e	-0.053	0.065		-0.014	0.614	
bys24f	-0.050	0.010	*	-0.037	0.037	*
bys24g	0.007	0.537		-0.009	0.250	
bys27a	0.253	0.000	*	0.205	0.000	*
bys54b	0.067	0.128		0.070	0.014	*
bys54d	0.057	0.029	*	0.038	0.107	

Notes: (*$p < .05$)

Appendix H

Figure H.1

IPTW Logistic Regression Model – Two-Year Enrollment

$$
\begin{aligned}
&ln(P(enroll\ two - year)/P(not\ enroll\ two - year)\ )_{ij} \\
&\qquad = \beta_{0j} + \beta_{1j}(female) + \beta_{2j}(SES) + \beta_{3j}(GPA)_{ij} + \beta_{4j}(Test\ Score)_{ij} \\
&\qquad + \beta_{5j}(Student\ Aspirations)_{ij} + \beta_{6j}(Parent\ Aspirations)_{ij} \\
&\qquad + \beta_{7j}(Financial\ Aid)_{ij} + e_{ij}
\end{aligned}
$$

Figure H.2

IPTW Logistic Regression Model – Four-Year Enrollment

$$
\begin{aligned}
&ln(P(enroll\ four - year)/P(not\ enroll\ four - year)\ )_{ij} \\
&\qquad = \beta_{0j} + \beta_{1j}(female) + \beta_{2j}(SES) + \beta_{3j}(GPA)_{ij} + \beta_{4j}(Test\ Score)_{ij} \\
&\qquad + \beta_{5j}(Student\ Aspirations)_{ij} + \beta_{6j}(Parent\ Aspirations)_{ij} \\
&\qquad + \beta_{7j}(Financial\ Aid)_{ij} + e_{ij}
\end{aligned}
$$