THE UNIVERSITY OF CHICAGO

EFFECTS OF ACADEMIC MATCH ON STUDENT OUTCOMES IN COLLEGE

A DISSERTATION SUBMITTED TO

THE FACULTY OF THE DIVISION OF THE SOCIAL SCIENCES

IN CANDIDACY FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

DEPARTMENT OF SOCIOLOGY

BY

SANJA JAGEŠIĆ

CHICAGO, ILLINOIS

MARCH 2016

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Page

LIST OF EQUATIONS

ACKNOWLEDGEMENTS

I would like to thank:

My dissertation committee, Ross M. Stolzenberg (Chair), Andrew D. Abbott, and Sara Ray Stoelinga.

The agencies that have provided funding for my graduate education, The Paul & Daisy Soros Fellowship, The National Science Foundation, Wellesley College, and the University of Chicago Social Sciences Division.

The Institute for Education Sciences for access to its restricted data files.

Friends, family, and mentors who have provided support and guidance over the years.

ABSTRACT

Prior studies have established that the academic performance of college students varies with both their individual academic ability and with peer ability, or the mean ability of other students who attend the same postsecondary institution. However, there is no consensus on whether academic match— defined here as the difference between student ability and peer ability— has an effect on a student's college outcomes. In this dissertation I ask: on average and other things equal, does the statistical effect of student SAT score on college outcomes vary with the mean SAT score of students at the same college? The college outcomes I consider in this dissertation are: bachelor's degree completion, months to bachelor's degree completion, cumulative college grade point average, Science, Technology, Engineering, and Mathematics (STEM) major selection, and decline in educational aspirations. I use a sample of students from the Beginning Postsecondary Students Longitudinal Study 2004-2009 (BPS) and institutional data from the Integrated Postsecondary Education Data System (IPEDS) to determine if and how the effect of student SAT on the different college outcomes considered varies across institutions with different mean SAT scores. The analyses presented in this dissertation provide an insight into why prior research on the effect of academic match on educational outcomes in postsecondary education has yielded conflicting results. The effects of academic match on college outcomes vary so that researchers focusing solely on institutions where the mean student SAT score is high, or solely on institutions where the mean student SAT score is low, will yield paradoxical results.

CHAPTER 1

ACADEMIC MATCH AND STUDENT OUTCOMES IN COLLEGE

Prior studies have established that the academic performance of college students varies with both their individual academic ability and with peer ability, or the mean ability of other students who attend the same postsecondary institution.[1] However, there is no consensus on whether academic match— defined as the difference between student ability and peer ability— has an effect on a student's college outcomes. This chapter first defines academic match as it is used in research on postsecondary education, explains how students are sorted into postsecondary institutions and why this sorting is an area of concern, describes some of the mechanisms that drive the effects of peer and student ability on student outcomes, and establishes the ways in which the literature on the effects of academic match in postsecondary education requires further research.

DEFINING ACADEMIC MATCH

"Academic under match occurs when students' academic credentials permit them access to a college or university that is more selective than the postsecondary alternative they actually choose" (Smith, Pender, and Howell 2012, page 247). On the other hand, academic overmatch occurs when the opposite happens and students' academic credentials are not as competitive as those of the majority of students attending the institution they choose. Both of these scenarios constitute an academic credential mismatch between the student and the postsecondary

[1] Loury and Garman 1993, 1995, Light & Strayer 2000, Long 2008, Alon & Tienda 2005, Black and Smith 2005, Melguizo 2008, Griffith 2009, Arcidiacono, Aucejo, and Hotz 2013.

institution that he is attending. Academic credentials in the case of college admissions include secondary school record and college entrance exam (SAT/ACT)[2] scores.

High school grades and SAT scores have a strong (r=0.49, BPS:96/01) positive correlation. While both play an important part in college admissions, high school grades are numerically not comparable across admitted students within a postsecondary institution. Students apply from a wide variety of high schools with disparate course offerings and academic standards that result in numerically same grade point averages conveying drastically different information about a student's ability and preparation (Jencks and Phillips 1998). In the context of college admissions, high school grades are evaluated as a measure of the extent to which students took advantage and excelled within the bounds of the schooling environment they were placed in (Alon and Tienda 2007). The SAT is currently the only[3] academic credential that can be used as a common yardstick to evaluate students across different high schools (Jencks and Phillips 1998).[4] When determining the extent to which a student's academic credentials are matched to that of peers attending the postsecondary institution he has chosen to attend, researchers have

[2] Currently the two college entrance exams in use in the United States are the ACT and SAT. All four-year colleges in the US accept both test scores. According to ACT developers, "the ACT is an achievement test, measuring what a student has learned in school. The SAT is more of an aptitude test, testing reasoning and verbal abilities" (ACT 2013). Until recently, the SAT has been the primary college entrance exam in the United States. This is changing as students are now increasingly taking both the SAT and ACT (Lewin 2013). Because most students who do not participate in both exams still take the SAT, I will use the SAT as a point of reference for college entrance exams throughout this study. Additional information on dealing with SAT versus ACT scores in terms of the data used for this study can be found in Chapter 2.

[3] There are additional tests (Advanced Placement (AP) test or SAT Subject Tests) that are standardized and administered nationally but these are not mandatory for college applications. Furthermore, these tests are content specific and students choose what subject they want to be tested in. Also, as mentioned above, the ACT is becoming more widely used and has in 2013 caught up to the SAT so that now roughly 51 percent of graduating high school students are taking the ACT and 51 percent of graduating high school students are taking the SAT. This is likely because Colorado, Illinois, Michigan, Kentucky, Tennessee, Wyoming have made ACT testing of high school students mandatory (ACT 2013).

[4] There are several controversies as to what the SAT measures and the extent to which it is biased. This will be discussed in further detail in a later section of this Chapter.

most frequently solely focused on the SAT[5] and discounted the high school record in order to avoid the complications that arise comparing student records from different high schools (Alon and Tienda 2005, Griffith 2009, Long 2008, Melguizo 2008, Arcidiacono, Aucejo, and Hotz 2013).[6] In this study I will take a similar approach. The academic credential match between the student and the postsecondary institution he is attending will be defined by the difference between the student's SAT[7] score and the mean institutional SAT for the year in which the student was admitted. Because the academic credential match in this study is defined by a student's SAT score, the more specific question that I aim to address is: On average and other things equal, does the statistical effect of student SAT score on college outcomes vary with the mean SAT score of students at the same college?

SORTING OF STUDENTS IN POSTSECONDARY EDUCATION

Students sort into colleges primarily by their academic credentials, i.e. SAT score and high school record (Hoxby 1997, Light and Strayer 2000, Black and Smith 2005). However, circumstances beyond academic credentials do play a role in college admissions decisions, which result in imperfect sorting in terms of the student and mean institutional SAT score match. The College Board (2013) has determined that the characteristics that admissions decisions are based on include: college entrance exam scores, high school record, extracurricular activities, recommendation letters, and special circumstances such as legacy status, race, and socioeconomic class (College Board 2013). The inclusion of factors outside of academic credentials in admissions decisions means that some students will attend colleges where their

[5] Some researchers have used other standardized test scores available in their dataset. For instance Light and Strayer (2000) and Black and Smith (2005) use Armed Services Vocational Aptitude Battery (ASVAB) scores.
[6] I am aware of two studies that make use of both high school record and SAT scores to determine the extent to which student's academic credentials match the school's academic credentials: Roderick, Cocoa, and Nagaoka 2011, Smith, Pender, and Howell 2013. This method requires rich high school transcript data not available in the dataset used for this study.
[7] The method for this calculation will be explained in greater detail in Chapter 2.

SAT scores are significantly lower, and others will attend colleges where their scores are significantly higher than those of their peers.

The situation of academic overmatch, where students have lower SAT scores than the student body at the college they attend, is systematically exacerbated for certain subgroups of students whose applications receive preferential status in college admissions. Receiving preference in college admissions means that the standards for these groups are lower in regards to academic credentials such as high school record and SAT scores (Espenshade and Chung 2005). According to Espenshade and Chung (2005) there is evidence that preference is given to applicants who are: (1) children of alumni,[8] (2) have special talents that can serve the institution such as athletic ability, (3) increase the institution's racial and/or socioeconomic diversity.[9] The first two groups of applicants benefit the institution tangibly though added financial resources, while the third aids the institution through the creation of a diverse learning environment[10] (Bowen and Bok 1998, Espenshade and Chung 2005). Creating a diverse environment on college campuses has increasingly been an important goal for universities to attract both racially diverse and white students (Pippert 2013). Studies have shown that a diverse learning environment has positive effects on student cognitive outcomes (Hurtado, Guillermo-Wann, 2013). Aside from the cognitive development benefit of diversity, Urciuoli argues "admissions recruiters are betting

[8] Children of alumni make up 10 to 25 percent of the student body at selective institutions. At institutions that explicitly do not give preference to children of alumni that number is 2 percent (Kahlenberg 2010). It is important to note, however, that legacy admissions are only an issue at selective institutions. Over 60 percent of four-year postsecondary institutions are not selective and thus do not encounter the same problems with making decisions between legacy and non-legacy applicants.

[9] "African-American applicants receive the equivalent of 230 extra SAT points (on a 1600-point scale), and being Hispanic is worth an additional 185 SAT points. Other things equal, recruited athletes gain an admission bonus worth 200 points, while the preference for legacy candidates is worth 160 points" (Espenshade and Chung 2005, page 293). According to Espenshade and Chung (2005), there is evidence that students whose SAT score is above 1500 (pre-2006 scale) are also given some preference in that they are able to get in with lower high school grades.

[10] Studies have cited that increasing diversity in learning environment leads to positive outcomes for all students such as being more aware of global and social issues. A diverse learning environment also has a positive effect on minority student achievement and retention (Hurtado, Guillermo-Wann, 2013).

that smart white prospectives will choose a place with ‘a lot of diversity’ because that reflects how the white students see themselves as good citizens – a rationale coherent with that of the college presidents (Urciuoli 1999, p 292)”. The marketability of diversity thus aids both the students who benefit from lowered admission standards as well as the institution.

Extending admissions to traditionally underrepresented groups is understood as a way of correcting for inequality in access to educational opportunities. Students from high-income families are exposed to higher quality education in PreK-12.[11] Access to quality education in turn influences how well a student will score on standardized tests. Approximately ten percent of the variation in SAT scores can be explained by differences in family income (College Board 2009). In addition to score differences by socioeconomic background, prior work also demonstrates the extent to which the SAT is culturally biased to favor White and Asian students (Massey & Denton 1993, Dixon-Roman, Everson, and McArdle 2013). Due to the statistically significant and positive correlation between SAT scores and socioeconomic status (r=0.42, College Board 2009) and race[12] basing postsecondary admissions primarily on academic ability as measured by entrance exam scores generates a highly stratified system and excludes less fortunate students from attending the most competitive universities (Espenshade and Chung 2005). To take into account this inequality in educational opportunity, students from traditionally underserved backgrounds, either those of low-income or minority origin are one of the groups of students given an advantage in the college admissions process (Espenshade and Radford 2009).

[11] For a review of the literature on the relationship between family income and PreK-12 education see Selcuk R. Sirin, “Socioeconomic Status and Academic Achievement: A Meta-Analytic Review of Research,” Review of Educational Research 75, no. 3 (2005): pages 417-453. Also, it is important to note that in addition to having access to better PreK-12 education, high-income students are also more likely to participate in additional SAT preparation programs. Additionally, there are racial differences in SAT preparation strategies (Buchmann, Condron, and Roscigno 2010, Alon 2010).

[12] The SAT score gap by race has been extensively documented in Jencks and Phillips (1998). The effects of family income on SAT scores are nearly twice as large for Black students (Dixon-Roman, Everson, and McArdle 2013).

Because of the particular history of racial exclusion from educational opportunity in the United States, minority students are 28 percent more likely than low-income students to be given an advantage in college admissions (Bowen, Kurzweil, and Tobin 2006).[13]

WHY SORTING MATTERS

As established in the previous section, there are roughly three groups of applicants that are given advantage in college admissions and are thus more likely to experience a difference between their own academic credentials and the academic credentials of students attending their school. This academic mismatch is of interest because studies have found that the location of a student's measured ability within the ability distribution of his peers affects the student's academic outcomes (See Table 1.1 and 1.2 for summary of this research).

The relationship between the effects of peer ability and student ability on student educational outcomes has been found at all levels of education from pre-school to postgraduate. Table 1.1 summarizes the findings of this research by education level for large-scale studies conducted since 2000 on PreK-12 students. As the summary of this research in Table 1.1 shows, there is general, though not complete, consensus that the interaction between peer ability and student ability has some effect on the student's educational outcomes, but the extent to which this effect is positive or negative, and how it affects students of varying ability levels differentially, is not entirely clear. Additionally, in the cases where positive or negative effects have been found, it is important to note that the size of the effects of the interaction between peer and individual ability on individual student outcomes have been modest.

[13] Bowen, Kurzweil, and Tobin 2006 find that some highly selective institutions do not give any advantage to low-income students in the college admissions process.

Table 1.1. Sampling of Recent (since 2000) Literature on the Effects of the Interaction of Peer and Student Ability on Student Learning Outcomes in PreK-12, organized by grade

	Citation	Summary
Pre-school/Kindergarten	Mashburn, Justice, Downer, and Pianta 2009; Justice, Petscher, Schatschneider, and Mashburn 2011	Students with lower than average language skill for their age (as measured by number of vocabulary words used) benefit from being in a classroom where the average language skill is in the top quartile.
Grade 3-6	Hoxby 2000	An increase of 1 point in peers (classroom) reading scores raises a student's own score between 0.15 and 0.4 points.
Grade 3-6	Angrist & Lang 2004	Being surrounded by peers who score 1 point higher in reading raises a student's own score by 0.3 to 0.8 points.
Grade 3-6	Hanushek, Kain, Markman, & Rivkin 2003	A 0.1 standard deviation increase in peer average mathematics achievement leads to a roughly 0.02 increase in student's mathematics achievement.
Grade 3-8	Hoxby and Weingarth 2005	Low-scoring students benefit from higher scoring students only when they are not too far ahead. Students whose scores place them in the top quintile experience a decrease on their test scores when placed in classrooms where the average achievement is below the 45^{th} percentile.
Grade 3-10	Burke and Sass 2006	In terms of elementary school Math, for every one-point increase in the mean peer fixed effect a student's score increases by 0.044. Students located in the lower half of a test score distribution, gain in achievement when surrounded by peers located in the top quartile of the distribution.
Grade 9-12	O'Mara and Marsh 2007; Marsh and Hau 2003	Students at very selective high schools whose grades are below average develop lower self-esteem which continues to be lower than the self-esteem of similarly able students attending less selective high schools up to four years after graduation.
Grade 9	Lavy, Silva, and Weinhardt 2009	A large fraction of low achieving peers at school – as identified by students in the bottom 5% of the ability distribution – negatively and significantly affects the cognitive performance of other students. The share of high achieving peers – as identified by students in the top 5% of the ability distribution – does not affect the educational outcomes of other students.
Grade 9	Vardardottir 2012	Random assignment to a high-ability classroom increases academic achievement by 0.23 standard deviations controlling for student ability.

Source: Table by author

Two recent studies exemplify the general conclusions of this research in PreK-12 education. Controlling for classroom changes and teacher quality measures for grades 3 through 10, Burke and Sass (2006) find that "for elementary school mathematics, for every one-point increase in the mean peer fixed effect the individual experiences an increase of 0.044 points in her current gain score" (Burke and Sass 2006, page 25). Hoxby and Weingarth (2005) find a similar pattern, but suggest that low-scoring students benefit from higher scoring students "as long as the higher scoring students are not too far ahead" (Harris 2010, page 1185). Furthermore, Hoxby and Weingarth (2005) also find that students whose scores place them in the top quintile experience a 0.04 point decrease on their standardized math test scores when placed in classrooms where the average achievement is below the 45th percentile. These research highlights from Table 1.1 indicate the extent to which studies on the effects of academic ability match between students and their peers on the student's academic achievement show that peer and student ability interactions require a delicate calibration to achieve optimal learning for each individual student.

Matching student academic achievement with peer academic achievement at the postsecondary education level is an especially pertinent topic. In PreK-12 students are, for the most part, sorted into schools by their location (Katz 1987). For postsecondary education this is not the case. Attending college is not mandatory and there are significant differences in terms of the economic return a student gains on his investment in postsecondary education depending on the quality[14] of institution attended (Hoxby 1997, Bowen and Bok 1998, Black and Smith 2005, Dale and Krueger 2002, Long 2008). Because of the differences in return on investment, there is considerable interest in attending colleges of highest quality. The high interest in attending the highest quality institutions has prompted debate about the fact that students with certain characteristics, legacies, athletes and minority/underrepresented applicants, receive admissions preference and are able to get admission to more selective colleges than students not part of these groups (Espenshade and Radford 2009).[15]

[14] Postsecondary institution quality has been defined in several ways. Long (2008) has looked at the effects of mean SAT scores (i.e. selectivity), faculty-to-student ratio, tuition cost, graduate program availability, faculty salary, and a combination of all these variables finding that all these quality measures are highly correlated and have a positive effect on student wages conditional on student ability. Black and Smith (2005) report similar finding using a college quality index.

[15] While the benefits given to all three groups have been debated and questioned at one point or another, the advantage given to minority students in the college admissions process has been subject to legal action and greater scrutiny than the advantage given to any other group of students. For a review of the legal history of racial preferences in college admissions see: David Skrentny, Ed., *Color Lines: Affirmative Action, Immigration and Civil Rights Options for America* (Chicago, Ill.: University of Chicago Press, 2001).

One of the arguments against having lower college entrance exam score standards for any type of student is that the higher ability of peers attending the institution will have negative consequences for the student's own achievement in college (Sowell 1972, 2004). The student is in danger of lower achievement because he will be taking courses where his peers on average have higher measured academic ability. According to Christopher Jencks, the difference in instruction between elementary/secondary education and postsecondary education is that courses in college are not designed to ensure that all students are prepared for certain academic benchmarks (Jencks and Phillips 1998). This means that students of lower ability have to take on the responsibility of fully understanding the material taught in classes that are catering to students who have had considerably greater amounts of preparation. Sowell, among others, argues that these lower ability students would be more likely to have positive learning outcomes at institutions that serve students of similar ability where the courses taught would be at their academic level (Sowell 1972, 2004, Nieli 2004, Light and Strayer 2000).[16]

In response to the argument that differential college admissions standards result in detrimental outcomes for students who are given admissions preference, researchers have studied how a student's ability, usually as measured by SAT scores, interacts with peer ability, measured by the mean on median SAT score of the institution, affects a variety of student college outcomes. The studies have primarily considered college completion (Dale & Krueger 1999/2002, Light & Strayer 2000, Alon & Tienda 2005, Roderick et all 2011, Long 2008), but also to a lesser extent college grade point average (Griffith 2009, Loury and Garman 1995), wages (Dale & Krueger 1999/2002, Long 2008, Black and Smith 2005), and indirectly, the

[16] Sowell has focused his argument especially on students receiving racial preference arguing that for minority students in particular, receiving admissions preference can instill lower standards and academic-self-esteem.

likelihood of completing a Science, Technology, Engineering, or Math (STEM) major (Arcidiacono, Aucejo, Hotz 2013). The summary of this research is presented in Table 1.2.

Table 1.2. Review of Literature on the Effects of the Interaction of Peer and Student Ability on Student Learning Outcomes in Postsecondary Education, organized by year published

Citation	Measure of Ability	Summary	Data
Loury and Garman 1995	SAT	Students who are at the bottom of the SAT distribution had 0.2-0.4 lower college grade point averages than high SAT scorers. Black students whose scores are significantly below the institutional median are more likely to drop out.	National Longitudinal Study (NLS) of the High School Class of 1972
Bowen and Bok 1998	SAT	Holding ability constant, students who attended highly selective institutions (mean SAT score of 1300 +) were three times more likely to graduate than those who attended less selective institutions (mean SAT scores below 1150), and that students who attended selective institutions (average SAT scores between 1150 and 1299) were 21 percent more likely to graduate than those in less selective institutions.	College and Beyond
Dale and Krueger 1999	SAT	Students attending colleges with high ability peers do not earn significantly more post-graduation than students of similar ability who attended colleges with lower ability peers.	College and Beyond, National Longitudinal Survey of the High School class ok 1972
Light and Strayer 2000	Armed Forces Qualifying Test (AFQT)	Students whose standardized exam scores place them in the bottom quartile of the academic ability distribution at their college are six times more likely to complete college if attending an institution whose mean SAT score places the institution in the bottom, versus the top, quartile of postsecondary institutions. Students whose performance on a standardized test (ASVAB) places them in the top quartile of the academic ability distribution at their college, are four percent more likely to graduate from a top quartile than a bottom quartile postsecondary institution	National Longitudinal Study of Youth 1979
Sacerdote 2001	SAT	A 0.10-point increase in roommate GPA is associated with a 0.11 increase in own GPA. There is no significant relationship between own outcome and freshman year roommate outcome for graduating in more than 4 years.	Dartmouth College Roommate Assignment Data
Alon and Tienda 2005	SAT	In High School & Beyond data, students attending selective institutions are 31 percent more likely to graduate than similar students attending less selective institutions. In NELS1992 data students attending selective institutions are 20.7 percent more likely to graduate than similar students attending less selective institutions. In College and Beyond data, students attending most selective institutions are 9 percent more likely to graduate.	College and Beyond, National Education Longitudinal Study 1988
Long 2008	Predicted SAT	Going from the bottom-quartile to the top-quartile of the college test score distribution raises the likelihood of earning a bachelor's by 17 percent. A one standard deviation increase in peers' median SAT score raises annual earnings by over $3,000 for men and over $1,000 for women.	National Education Longitudinal Study 1988
Griffith 2009	SAT	Students whose SAT scores are above the institutional median, for each additional SAT point the student's own score is higher than the institutional median, the multinomial log odds of dropping out are expected to increase by 0.389 units. For each additional SAT point the student's own score is below than the institutional median, the multinomial log odds of dropping out are expected to increase by 0.057 units.	National Longitudinal Survey of Freshmen (NLSF), National Education Longitudinal Study of 1988 (NELS 88)

Table 1.2., continued

Black and Smith 2005	Armed Services Vocational Aptitude Battery (ASVAB)	Going from the 25th to the 75th percentile of the quality college raises wages by about 7.2 percent for men and 3.5 percent for women.	National Longitudinal Survey of Youth 1979
Arcidiacono, Aucejo, and Hotz 2013	SAT	Students with SAT scores that are high relative to the campus average are more likely to persist in a science major and graduate with a science degree. This is especially true for minority students.	University of California System data

Source: Table by author

The conclusions of this research have thus far been contradictory, especially in the case of bachelor’s degree completion. Light and Strayer (2000) find that students whose standardized exam scores place them in the bottom quartile of the academic ability distribution at their college are six times more likely to complete college if attending an institution whose mean SAT score places the institution in the bottom, versus the top, quartile of postsecondary institutions. On the other hand, students whose performance on a standardized test (ASVAB) places them in the top quartile of the academic ability distribution at their college, are four percent more likely to graduate from a top quartile than a bottom quartile postsecondary institution (Light & Strayer 2000). The later finding is counterintuitive, as students whose academic ability places them in the top quartile should find it easier to complete the academic work at the lowest ranked institutions.

Arcidiacono, Aucejo, Coate and Hotz (2012) examined University of California graduation rates before and after the use of racial preferences in admission. The use of racial preference in college admissions increased the number of students whose SAT scores were below the institutional average on campus. They find that better matching of minority students after the ban on racial preference in college admission, increased minority graduation rates by eight percent. Other studies, using different methods and data, have come to contradicting findings. Analyzing the effects of enrolling at colleges that have high (greater than 1050) versus low (less than 1050) mean SAT scores, Alon and Tieda (2005) find that students are approximately 20 percent more likely[17] to graduate from institutions that have greater than 1050 college mean SAT scores regardless of their own SAT score. Melguizo (2008) also found a positive effect of mean school SAT on a student's likelihood of graduation. Counter intuitively, Griffith (2009) finds that for students whose SAT scores are above the institutional median, for each additional SAT point the student's own score is higher than the institutional median, the multinomial log odds of dropping out are expected to increase by 0.389 units. For each additional SAT point the student's own score is below than the institutional median, the multinomial log odds of dropping out are expected to increase by 0.057 units. These results indicate that students who have higher measured ability than their peers are less likely to complete their education.

In research studying outcomes beyond college completion, the findings are not as contradictory though the research is also not as plentiful. Griffith (2009) finds that students have 0.084 higher first-year college grade point average for each point their SAT scores are greater than the median SAT score of their college. Griffith (2009) notes that the relationship becomes insignificant when looking at cumulative grade point average. Loury and Garman (1993) find that students whose SAT scores are in the bottom quartile complete college with grade point averages in the bottom quartile.

Arcidiacono, Aucejo, and Hotz (2013) studied the effects of racial preference in college admissions on minority students' likelihood of completing a STEM major using data from the University of California system. They find that students "with SAT scores that are high relative

[17] This result depends on the dataset Alon & Tienda (2005) used. In High School & Beyond data, students attending selective institutions are 31 percent more likely to graduate than similar students attending less selective institutions. In NELS1992 data students attending selective institutions are 20.7 percent more likely to graduate than similar students attending less selective institutions. In College and Beyond data, students attending most selective institutions are 9 percent more likely to graduate than similar students attending selective institutions.

to the campus average are more likely to persist in a science major and graduate with a science degree" (Arcidiacono, Aucejo, and Hotz 2013, page 2). They note that this is especially true for minority students. Several studies have been conducted on the effects of student and peer ability interactions on student wages post-graduation (Dale and Krueger 2002, Black and Smith 2005, Long 2008). Dale and Krueger (2002) find that the interaction between peer ability and student ability has an insignificant effect on student wages approximately 19 years after college matriculation. [18] Dale and Krueger, however, used data that included a limited set of institutions. Using datasets that include a wider sample of postsecondary institutions Black and Smith (2005) "estimate that going from the 25th to the 75th percentile of the [college] quality index raises wages [approximately 20 years after college matriculation] by about 7.2 percent for men and 3.5 percent for women (Black and Smith 2005, page 15)" controlling for student ability and other relevant confounding factors. Long (2008) finds similar effects.

From the research review summarized in Table 1.2 it is evident that SAT scores play a significant role in college admissions but also in research evaluating the effects of academic match on student outcomes. Because of the importance of the SAT in admissions and research on postsecondary outcomes, it is important to explain what the test is, what it is designed to measure, and how it is used to evaluate student ability preparedness for college studies.

THE SAT: WHAT IS IT AND WHAT DOES IT MEASURE?

The SAT is a college entrance exam that has been in use since 1926. Initially administered to a select group of students, its importance in the college sorting process has been continuously increasing since 1944 (Hubin 1988). The increase in the use of the SAT is mostly

[18] Dale and Krueger (2002) find that the only institutional factor that has a small, but significant effect on future wages after controlling for student background, academic preparation, and ability is college tuition cost.

due to the rise of individuals pursuing postsecondary education and student's reorientation from location to reputation based college preference (Hoxby 1997).[19] Until the mid 1980s, the SAT was an acronym for Scholastic Aptitude Test and was promoted as a measure of a student's innate aptitude for learning. The test was developed from early IQ tests and initially advertised as a tool to identify academically talented underprivileged students (Hubin 1988, Jencks and Phillips 1998). According to Hubin (1988) this view of the SAT as measuring innate aptitude began to shift in the late 1960s with the development of organizations such as Kaplan, which provided coaching services for the exam. Services demonstrating that students can increase their performance by studying for the exam raised questions about the extent to which the SAT was able to capture a student's innate aptitude (Hubin 1988). In 1972 the College Board, the developers of the SAT, released the first report confirming that students participating in SAT coaching can experience "statistically and practically significant score gains" (College Board 1972, page 1).

To reflect the notion that SAT performance can be improved with practice, the College Board has since 1994 officially taken the position that the SAT does not measure aptitude, but "developed reasoning" (College Board 1995, page 1).[20] SAT continues to be the name used for the test but it is no longer considered an acronym for anything. The change in wording used to describe the test has meant that it has come to be understood as a test of something that can be learned and not innate intelligence (Jencks and Phillips 1998). Despite the fact that the makers of the SAT have steered away from defining the SAT as a test of aptitude, the SAT is unlike many

---

[19] In the first quarter of the 20th century many postsecondary institutions administered their own admissions tests to interested students (Hubin 1988).

[20] There have been several changes in both content and format of SAT since 1926. It is, however, not the changes in content of the test that have resulted in the decision to change the conceptualization of the SAT from a measure of innate aptitude to college preparedness (Hubin 1988).

standardized tests that students are exposed to in high school**.** Unlike many state mandated standardized tests, or the competing college entrance exam ACT, the SAT does not focus on specific school subjects or curriculum[21] but instead measures cognitive skills used in learning such as logic and reasoning (Jencks and Phillips 1998). It requires no content specific knowledge. Furthermore, while the College Board has steered away from defining the test as a measure of aptitude, other organizations, and to some extent the general population, continue to do so (Atkinson 2001). The creators of the ACT, for instance, explicitly cite that the difference between the ACT and the SAT is that the ACT measures achievement while the SAT measures aptitude (ACT 2013).

To demonstrate the benefits of utilizing SAT scores in college admissions, the College Board has conducted a series of studies showing that the correlation of SAT and first year college GPA is strong (0.35). They argue that this relationship makes SAT scores valuable for postsecondary institutions in determining which students are ready for the rigors of college level work (College Board 2012). They note however that with a correlation of 0.36 between high school grade point average and first year college grade point average controlling for family background, high school grades have similar power in terms of predicting first-year college grade point average.[22] This fact has incited calls for postsecondary institutions to disregard SAT scores in favor of high school grades. High school grades are better able to capture student effort and motivation than SAT scores. Despite the various controversies surrounding what the SAT measures and the potential to use high school grades as a proxy for ability, it has been shown to

[21] Standardized tests that do focus on a particular curriculum that students learn in school are defined as achievement tests because they can demonstrate growth in learning in a particular subject area. A study conducted by the University of California demonstrated that achievement tests are better predictors of academic outcomes in college than the SAT (Atkinson 2001).

[22] The extent to which SAT does or does not have an effect on cumulative grade point average in college is still debated. Kuncel and Hazlett (2010) find that the SAT has an effect on cumulative grade point average, as well as that it is not biased.

increasingly play a part in college admissions, especially at the most competitive institutions (Steinberg 2003).[23]

Christopher Jencks notes that the heavy reliance on the SAT in college admissions stems from the absence of a national curriculum and a national standardized test for high school graduates (Jencks 1999). The material that students are exposed to in secondary education varies significantly across the nation as do grading rubrics (Katz 1987).[24] The SAT is currently the only common yardstick that can be used to compare students from vastly different educational backgrounds on at least one common academic measure. The number of college applications received by selective institutions has rapidly increased in just the recent decade (Muska, de Oliveira, Dwane, and Cohen 2011). For instance, in the case of the University of Chicago, a highly selective postsecondary institution, the number of applications received has increased from 13,564 in 2009 to 30,369 in 2013, though the university did not increase the number of slots available for freshmen (University of Chicago 2013). Sifting through this large volume of applicants from across the nation is made vastly simpler with a common yardstick measure such as the SAT (Muska, de Oliveira, Dwane, and Cohen 2011).

As is evident in the research review presented in Table 1.2, the SAT is frequently used as a measure of student academic ability in research on postsecondary outcomes. Just as the SAT is being used as a common yard stick by college admissions committees, the SAT is used as a measure of student ability by researchers simply because it is frequently the only academic measure available that is comparable across students. Defining ability in such a way is

[23] There has been a movement by small selective liberal arts or specialty institutions to move away from using SAT/ACT scores in admissions. While some of these colleges have turned to an SAT/ACT optional strategy for admissions, there has been evidence indicating that these institutions are not as score blind as they suggest (Muska, de Oliveira, Dwane, and Cohen 2011).

[24] The United States has no national right to education. The legal responsibility to provide education rests with each of the 50 states, which means that states, for the most part, develop schooling guidelines. There are some federal guidelines that states must follow (Sciarra 2009).

problematic because, while the SAT may be useful as a common yardstick in admissions, it is unclear what it measures.[25] Research on cognitive ability and human potential suggests that an SAT score provides limited insight into an individual's cognitive ability and provides no information on a wide range of skills and innate talents (Sternberg 1979, 1984, Deary 2000, Sawyer 2012). In his research on human intelligence Howard Gardner (1983/2011) finds that there are nine types of intelligences, from logistical-mathematical ability to spatial ability and that these are not highly correlated.[26] In addition to the existence of different types of intelligence, the extent to which any ability or intellect is innate and not a product of environment or experience has spawned much research and discussion without many conclusive findings. [27] The few unquestioned findings of this research are that nutrition and health have an impact on intelligence (Behrman 1996), and that better quality education leads to better quality academic output (Rothstein 2004). Furthermore, in order to become aware of certain abilities a person must have been exposed to certain experience. An innate talent for music may go undeveloped if a person is never exposed to any kind of musical instrument (Howe, Davidson, and Sloboda 1998).

Despite all of these uncertainties regarding the SAT's capability to adequately capture academic ability, it's narrow definition of ability, and the uncertainty as to what constitutes ability, the SAT remains a crucial feature of American higher education and research as it is the

[25] The same criticism can be applied to all the standardized tests used as a proxy for ability in postsecondary research that I am aware of. Military tests (ASVAB) used by Black and Smith (2005) and Light and Strayer (2000) share a similar origin to SAT in that they were developed from early IQ tests and focus on a narrow range of skills (Hubin 1988).

[26] Gardner's theory of multiple intelligence has faced criticism because there is lack empirical evidence that each of his nine proposed intelligence areas exists independently of others. Other social psychologists have found higher correlations between the different types of intelligences. Gardner suggests that there might be something such as general intelligence, frequently referred to as *g*.

[27] The nature vs. nurture debate is especially divided in the case of human intelligence. For a review of the debate on whether or not intelligence is innate or a product of environment see John Dowling. 2007. *The Great Brain Debate*. Princeton, NY: Princeton University Press.

primary way in which students can currently be compared in terms of academic skills at a national level (Jencks 1999). Because of this feature, I, in line with previous researchers, will use student SAT score as synonymous with student ability, and mean institutional SAT score as synonymous with peer ability.

MECHANISMS THROUGH WHICH PEERS AFFECT STUDENT LEARNING

The mechanisms through which the relationship between a student's own ability and that of his peers influences student academic outcomes have gotten less attention in research than the magnitude of the effects themselves (Harris 2010). "The most common perspective is that peers, like families, are the sources of motivation, aspirations, and direct interactions in learning" (Hanushek, Kain, Markman, and Rivkin 2003, page 3). The theories of mechanisms through which peer ability interacts with student ability to affect learning outcomes can be separated into three categories: those arguing that more able peers are beneficial for student's own outcomes (epidemic/contagion, cognitive, institutional-expectations, and disruption), those arguing that similarly able peers are beneficial to student's own outcomes because more/less able peers are harmful (relative deprivation, oppositional culture, self-concept, signaling and focus-boutique), and those arguing that peers have no influence on individual students (home influences). A summary of these mechanism theories is presented in Table 1.3.

The epidemic/contagion theory of peer influence suggests that advantaged students have positive effects on disadvantaged students because disadvantaged students will emulate the behaviors of more advantaged students if those are in the majority. Advantage can be defined in a variety of ways; in this case it would be academic ability. Peer effects in epidemic/contagion theory operate through a process in which individual's conform to whatever they perceive to be group norms (Jencks and Mayer 1990).

Table 1.3. Summary of Mechanisms through which Peer and Student Ability Interact to Affect Student Outcomes

More Able Peers Lead to Most Positive Outcomes		**Similarly Able Peers Lead to Most Positive Outcomes**		**More Able Peers Lead to Negative Outcomes**	
Mechanism	Definition	Mechanism	Definition	Mechanism	Definition
Epidemic/contagion theory (Jencks and Mayer 1990) Bad apple/shining light (Hoxby and Weingarth 2005)	Disadvantaged students will emulate the behaviors of more advantaged students if those are in the majority.	Focus/boutique theory (Hoxby and Weingarth 2005)	Students perform better academically when placed in classroom of homogenous ability because teachers are more able to tailor their teaching to the student's level of learning.	Big fish, little pond effect (Marsh 1984), Relative deprivation theory (Jencks and Mayer 1990) Individuous comparison theory (Hoxby and Weingarth 2005)	Higher ability peers frustrate average students in their attempt to learn and cause lower-self esteem and academic interest/aspirations.
Cognitive development theory (Gurin et al. 2002) or rainbow (Hoxby and Weingarth 2005)	Interacting with peers that are differently abled promotes cognitive development because students have to invest greater amounts of cognitive activity in interactions.			Oppositional culture/ cultural conflict (Ogbu 2003)	Students that are at the bottom of the social hierarchy in terms of whatever the majority values (i.e. high ability) will unite and explicitly reject those values.
Institutional-expectations theory (Fordham 1996, Ogbu 2003)	Higher ability students create an external environment of higher expectations that all students become subject to.				

Source: Table by author

If a student finds himself at a college where the enrolled students are above average in terms of academic orientation, that student is likely to become more academically oriented than had he attended an institution where the students have average academic orientation.[28] Cognitive development (Gurin et al. 2002) or rainbow (Hoxby and Weingarth 2005) theory promoters

[28] Hoxy and Weingarth (2005) suggest a similar mechanism, which they name the bad apple/shining light, where one very strong or very poor student can have an effect on the larger group if he exerts influence that is valued by the group.

suggest that interacting with peers that are different in terms of ability or any other characteristic promotes cognitive development because students have to invest greater amounts of energy in these interactions as opposed to interactions with individuals who are more similar to themselves. They argue that this need to work harder cognitively to interact with different individuals is the mechanism through which interacting with peers of different ability improves student outcomes.

Institutional-expectations theory suggests that the mechanisms through which more advantaged peers influence students are not through the actions of, or interactions with, the peers themselves, but through the action of surrounding actors. For instance, Ogbu (2003) has found that teachers change what and how they teach based on their expectations of the students. If a teacher believes that they are in a classroom where student ability is greater than average they will teach more complicated material and engage students in higher-level learning activities. In a similar vein, others have suggested that peer ability effects student learning through classroom manageability. Students of higher ability cause fewer distractions in class (Fordham 1996, Ogbu 2003), which allows for more focused time teachers can spend on teaching. Here the peer ability in itself is not what influences individual student learning, but it is the classroom environment that makes a difference. In a classroom that consists of students that have higher ability on average, teachers may have higher expectations of students which could also trickle down to the low performing students in the classroom and increase learning. In contrast, researchers have also posited that students may suffer if placed in classrooms with students of significantly different academic ability. Hoxby and Weingarth (2005) theorize that students perform better academically when placed in classroom of homogenous ability because teachers are more able to tailor their teaching to the student's level of learning. This has been called the focus or boutique theory (Hoxby and Weingarth 2005).

A different set of theories suggests that there are mechanisms through which higher peer ability has a negative effect on student outcomes. A prominent theory in psychology that explains the ways in which peer ability and the positioning of the individual within the group ability distribution in particular affects individual learning is self-concept theory, commonly called the "big fish, little pond" effect. In sociology this mechanism is called relative deprivation theory (Jencks and Mayer 1990). In economics it is individuous comparison theory (Hoxby and Weingarth 2005). According to these theories students "may simply become more frustrated and put forth less effort in the presence of advantaged peers because their relative social position is lower" (Harris 2010, page 1170). If students feel that they are continuously having to work hard to catch up they will become too discouraged to try and improve academically. As the academic goals and aspirations that students set for themselves are influenced by what they see students in their surroundings achieving, performing poorly relative to his peers will lead a student to set less ambitious goals for himself. A related theory, called oppositional culture or cultural conflict, has been proposed by Ogbu (2004). He argues that students who are low on the social hierarchy in a group will create a subculture with others low in the social hierarchy and will openly rebel against the rules of the dominant group.

There is no unified and universally accepted theory on the mechanisms through which peer, or group, ability and the relative position of a student's ability in the group affects individual learning. The mechanisms posited here can potentially lead to positive, negative, or null effects on student learning. As is usually the case, it is likely that these mechanisms are concurrently at play, which makes the identification of which mechanism causes what outcomes difficult.

Additionally, the comparison peer group that is best to use for research on the effects of the combination of peer and student ability on student outcomes is not always clear. Peer effects have been studied with students in small groups within classrooms (for example see Webb and Farivar 1999), classrooms (for example see Cohen 1994), or entire institutions (for example see Light and Strayer 2000). The most appropriate definition of peer group is to some extent determined by the educational context. Elementary school students usually spend the entire school day with one teacher in one classroom, while college students usually have different teachers and different peers for each class. Furthermore, at the postsecondary level, student ability varies more across institutions than within institutions (Hoxby 1997). In this study, as in the majority of previous work on peer effects in United States postsecondary education (Dale and Krueger 1999, 2002, Light and Strayer 2000, Alon and Tienda 2005, Black and Smith 2005, Long 2008, Griffith 2009), the peer group will be defined as the entire student body of an institution.[29]

WHY DO THE EFFECTS OF SORTING MECHANISMS IN POSTSECONDARY EDUCATION REQUIRE FURTHER STUDY?

As reviewed in previous sections, there has been a considerable amount of research on the effects of the academic ability match between students and peers on college completion, (Light & Strayer 2000, Alon & Tienda 2005, Long 2008) grade point average (Griffith 2009, Loury and Garman 1995), choice of major (Arcidiacono, Aucejo, Hotz 2013), and post-college wages (Dale & Krueger 1999/2002, Long 2008, Black and Smith 2005). These outcomes are

[29] An exception to this is Sacerdotes' (2001) study of Dartmouth students and the effects of having a certain type of roommate on students' own behavior.

important indicators of student success and future opportunity but there are additional college outcomes that could be affected by the sorting of students into postsecondary institutions which have received less attention. Furthermore, in the case of outcomes that have already been studied the findings are contradictory, utilize imprecise measures of academic mismatch,[30] and in many cases use data collected prior to 1990. The field of higher education has experienced considerable changes in the last three decades (Hartle 2013).[31] These industry specific changes in combination with the wider changes in social trends make it plausible that the ways in which students are affected by their peers has changed since the 1970s and 1980s, when the population of most of datasets currently used to evaluate the effects of peer and student ability match on student outcomes attended college. In the following sections I will present additional outcomes that may be affected by academic mismatch, and summarize why the effect is an important determinant in a student's life success.

Time to Completion

Studies have found that taking more than four years to complete a first bachelor's degree is associated with a decrease in future earning power. Controlling for wage differentials between fields and occupations, the difference in annual wages between full-time students who complete their bachelors in four years versus students who complete their bachelor's within six years is over $6,000. Students who take more than six years to complete their bachelor's degrees earn about the same amount as students who left college without a degree (Carruthers, Fox, Murray, and Thacker 2012).

---

[30] The ways in which mismatch is defined in previous studies and the improvements I am making on previously used techniques are described in Chapter 2.

[31] These changes include but are not limited to: (1) while over 80 percent of college students in the 1970s were 18-24 year old attending bachelor's degree programs full-time, that population makes up only 15 percent of the college going student body today, (2) the number of postsecondary institutions in the US has quadrupled since 1970, (3) federal funds supporting postsecondary institutions have been tied to college completion rates since the early 1990s changing the focus of institutions receiving federal aid, (4) online college education has become an increasingly important part of the higher education sector (Hartle 2013).

This is partially because those who graduate on time have an earlier start in the workforce, and partially because taking more than four years to complete a bachelor's degree has negative signaling effects to potential employers (Carruthers, Fox, Murray, and Thacker 2012). Taking additional semesters or quarters to graduate also disadvantages students in terms of hiring cycles, which are set to match school completion dates. If a student must take additional credits to graduate during the summer or following autumn semesters, they are not able to accommodate the needs of companies looking to hire new staff to begin work during the summer when most on-time graduates are able to do so (Carruthers, Fox, Murray, and Thacker 2012). Thus, graduating in more than four years potentially has long-term consequences for future employment.

The effects of taking more than four years to complete a bachelor's degree additionally exacerbate a student's financial health by adding to the total cost of education expenditures (Schneider and Lin 2011). Currently tuition and fees for a semester at a selective college or university amount to an average of $25,000. Even for students attending an in-state public institution the average cost of taking an additional semester to graduate is $7,000 (Cellini and Darolia, 2015). Many institutions do not charge students per quarter or semester but instead have pricing for credits or courses taken. Even at such institutions there are additional fees students must pay for being enrolled at any given time so the duration of time spent enrolled in college incurs additional financial costs (Schneider and Lin 2011).

For students that do not complete their bachelors in four years, the cost of taking longer to graduate is thus compounded. It does not only come in the form of additional tuition and fees, but this is combined with the financial cost of additional time spent in school, forgoing a salary and the negative consequences this has on future employment and income. Additionally, taking more than four years to complete a bachelor's degree can have adverse effects on student self-esteem. This is especially true in the case of students attending selective institutions, as peers at such institutions are most likely to graduate in four years. At selective institutions there has been a trend for students to speed up the education process by taking less than four years to complete their degree in which case the differences in time to graduation might be especially different for high versus low-ability students (Weingold 2012).

The plausible link between time to graduation and academic match is that students whose ability is lower than that of their peers may take a longer time to complete the required courses or may have to retake course credits because the coursework may be more difficult for them. In line with that logic, a student whose ability is higher than that of his peers may complete his education faster because the courses are not difficult for him.

College Major Field

The choice of college major field is one of the most important factors in what post-college employment opportunities a student will have. Students who major in Science, Technology, Engineering, or Mathematics (STEM) fields earn substantially more than other college degrees (Arcidacono 2004, Kinsler and Pavan 2012, Melguizo and Wolniak 2012).[32] Furthermore, they are almost three times less likely to work in jobs for which they are over qualified (such as an English major working as a barista) and five percent less likely to be unemployed. The "[d]ifferences in [financial] returns to majors are much larger than differences in returns to college quality" (James et al. 1989), making the choice of major more important

[32] The differences in returns to wage by major vary significantly with the time passed since graduating from college. STEM majors tend to earn significantly more in the early years of their careers and are more likely to enter careers that are closely linked to their education than humanities majors. Humanities majors on the other hand have a less linear career path and earn less in the early years post-college graduation, however, once these students enter more stable careers the difference between their earnings and the earnings of STEM majors decreases (Pascarella and Terrenzini 2005).

than the characteristics of the institution attended. While academic match has not been a focus of previous research on how undergraduates choose major fields, in studies on the effects of affirmative action on minority student's choice of major (Arcidiacono, Aucejo, and Hotz 2013) findings show that minority students, who on average are of lower measured ability than their peers, express just as much interest in a STEM major as white students but are almost 50 percent less likely to complete a STEM degree. Furthermore, as mentioned in the earlier research review in Table 1.2 Arcidiacono, Aucejo, and Hotz (2013) find that minority students who were admitted to institutions serving students that have on average higher ability because of affirmative action practices, "would be more likely to graduate with a science degree and graduate in less time had they attended the lower ranked university" (Arcidiacono, Aucejo, and Hotz 2013, page 1). These findings lead to the supposition that students whose ability is higher than that of their peers are more likely to complete a STEM major, while those whose ability is lower are less likely to do so.

College Grade Point Average

College grade point averages are a crucial factor in academic post-baccalaureate studies. Professional schools awarding degrees that result in the highest financial returns, such as law or medicine, are notorious for the high grade point averages of the students they admit. If low ability students attending institutions where their peers on average have higher ability have significantly lower grade point averages than the average student at their college this could be a significant detriment for post-college plans.

As outlined in Table 1.2, there is some evidence that peer ability in combination with student ability does have an effect on student grade point average. Students that come in with lower SAT scores than their peers are likely to also graduate with the lowest grade point averages (Loury and Garman 1995, Griffith 2009). Those in favor of expanding criteria used for admissions at selective institutions have argued that when lower ability students are admitted at institutions that on average serve high ability students they may potentially converge with their high ability peers in terms of grades once they do have access to the same high quality educational opportunities. Evidence suggests that this is not the case. In a study of one highly selective institution, Duke University, Arcidiciano and his colleagues (2012) find that minority students that are admitted despite significantly lower entrance exam scores do start having grade point averages that are similar to their peers after the first two years of college, but they note that this is because minority students are more likely to switch into humanities and social sciences majors, which at Duke have higher grade point average means.

Educational Aspirations

As mentioned in the mechanisms review, some researchers posit that attending a school where the majority of students have higher ability, as measured by standardized tests, than the student himself may have adverse effects on a student's confidence and academic performance. Several studies have proven that this effect likely does exist (see Marsh 2007 for review). In a study exploring the lack of minority faculty at universities in the United States, Stephen Cole and Elinor Barber suggest that one cause of the scarcity of minority faculty may be the poor academic performance minority undergraduate students experience once they enter college. Receiving lower grades than their peers encourages these students to believe that they are not cut out for academic studies, leading them to pursue career paths that do not involve post-graduate education (Cole and Barber 2003). The pursuit of degrees beyond the bachelor's is important in a student's post-secondary life opportunities as individuals with more advanced degrees earn more over a lifetime and have greater job security (Council of Graduate Schools and Educational

Testing Service 2010). Considering the relationship between peer ability and student ability on confidence it is likely that academic mismatch would exert some kind of effect on a student's educational aspirations.

IMPLICATIONS OF RESEARCH AND CONTRIBUTION TO KNOWLEDGE

The testing of the hypotheses outlined above contributes to and extends several strands of research and theoretical debates. Primarily, the testing of these hypotheses will extend understanding of peer and individual ability interaction effects on student academic as well as non-academic experiences in postsecondary education. The findings will extend the literature reviewed in Table 1.2 by both introducing a wider array of outcomes and reevaluating outcomes where findings have been contradictory. Furthermore, the testing of these hypotheses will provide a further point of evaluation for the mechanisms literature outlined in Table 1.3. Theories of mechanisms on how peer ability affects students have been advanced across social science fields from psychology to economics, and are generally tested using the context of elementary or secondary education. The results of this study will speak to all of the debates covered in the mechanisms section of this chapter. On a practical level, understanding the effects of the difference between student SAT score and peer SAT scores is important in informing college admissions practices.

CHAPTER 2

DATA AND RESEARCH DESIGN

Chapter 1 reviews the literature and states the key question addressed by this study: On average and other things equal, does the statistical effect of student SAT score on college outcomes vary (inversely or positively) with the mean SAT score of students at the same college? This chapter discusses the empirical strategies and data required to address this question, describes a particular dataset that satisfies those requirements, and reports descriptive statistics for students and schools in those data.

SORTING OF STUDENTS INTO POSTSECONDARY INSTITUTIONS AND IMPLICATION FOR ANALYSIS

As has been described in Chapter 1, the American postsecondary education system is highly stratified in terms of resources and the types of students that are served (Liu, 2011). For instance, four-year postsecondary institutions in the top quartile in terms of institutional financial resources on average graduate approximately 80 percent of the students that enroll. Four-year colleges that are in the bottom quartile in terms of financial resources on average graduate approximately 50 percent of the students that enroll (Pascarella and Terenzini, 2005). These differences in graduation rates are not driven by institutional resources, but by the fact that institutions with greater resources attract the students with the best academic records, which is highly correlated with student socioeconomic status (Hoxby, 2009).

Table 2.1 shows mean institutional SAT, per student expenditures, and mean student SAT and student SAT ranges by institutional quintile. The institutional numbers come from IPEDS 2005 while the student statistics are calculated from the BPS 04/09 data. Detailed description of both data sources and justification for their use in this study will be presented later in this Chapter.

The averages presented in Table 2.1 show that per student expenditures and mean institutional SAT are correlated. The ranges of student SAT scores attending each institutional quintile indicate that students with certain SAT scores are not represented in all institutional quintiles in the BPS 04/09 data. For instance, in Quintile 5, there are no data points for students whose score is below 790, while these types of students are represented in all the other institutional quintiles.

Table 2.1. Institutional mean SAT score, student SAT score and per student expenditures by institutional quintile, IPEDS 2005 (institution level data), BPS 04/09 (student level data)

	Institutional Quintile				
	1	2	3	4	5
Mean Institutional SAT score (IPEDS 2004)	963	1050	1113	1189	1327
SD	48	18	19	21	71
Expenditures per student (IPEDS 2004)	$5,268	$5,885	$7,712	$9,868	$20,091
SD	$1,749	$1,608	$2,348	$2,753	$13,441
Mean student SAT Score (BPS 04/09)	966	1043	1088	1146	1278
SD	159	148	146	150	149
Range of student SAT scores (BPS 04/09)	480-1530	560-1520	530-1580	530-1580	790-1600
N	1083	1086	1061	1138	1000

Source: Table by author

As discussed in Chapter 1, the American postsecondary institution sorting system is structured in such a way that students tend to select and be admitted to the most prestigious postsecondary institutions at which they will succeed academically (i.e. graduate) (Avery and Hoxby, 2004). Institutional prestige is positively correlated with institutional mean SAT, and institutional academic difficulty (i.e. competitiveness of other students) is positively correlated with institutional mean SAT (Winston and Zimmerman, 2004). This means that students are most likely to attend schools at which their own SAT scores are not much below or above the institutional average SAT score, the average SAT score of their peers. Students' own SAT scores and the mean institutional SAT scores of colleges they are applying to are the primary source of information students have for evaluating their chances of admission and academic success at any given college. On the flip side, postsecondary institutions seek to recruit students who enhance their prestige. Students with higher SAT scores bring more prestige to postsecondary institutions than those with lower SAT scores, other things equal (Arum and Roksa, 2011). Also, choosing to admit students with higher SAT scores ensures that those chosen will be able to complete their degree. Because of this postsecondary institutions seek to recruit students with higher SAT scores. Both of these processes operate in a system of simultaneous causation. Whatever the exact process that describes college-student matching at a particular institution, that process requires care to avoid confounding the effects of mean institutional SAT with those of student SAT score when trying to understand the effects of individual SAT score and peer SAT score on college outcomes.

A possible approach to avoid the confounding of the two variables in a regression model is to take into account the effect of institutional mean SAT by stratifying postsecondary institutions into quintiles by institutional mean SAT while including individual student SAT in the models as a control variable. Stratifying postsecondary institutions by mean institutional SAT is acceptable as a means for taking into account the effects of institutional mean SAT on the outcome because as Figure 2.1 shows, dividing four-year postsecondary institutions into quintiles by institutional mean SAT takes into account 90.1 percent of the variation in institutional mean SAT.

To arrive at the numbers graphed in Figure 2.1 I used the IPEDS 2005 data, which has the mean institutional SAT values for all the postsecondary institutions that are attended by students in the sample of BPS 04/09 students used for this study (i.e. recent graduates attending a four year postsecondary institution). I created dummy variables separating the institutions into groups with increasingly more tiers by institutional SAT mean, from three groupings to eight. I then used the following equations to record the percent of variation (adjusted R squared) in institutional mean SAT explained by the various institutional groupings:

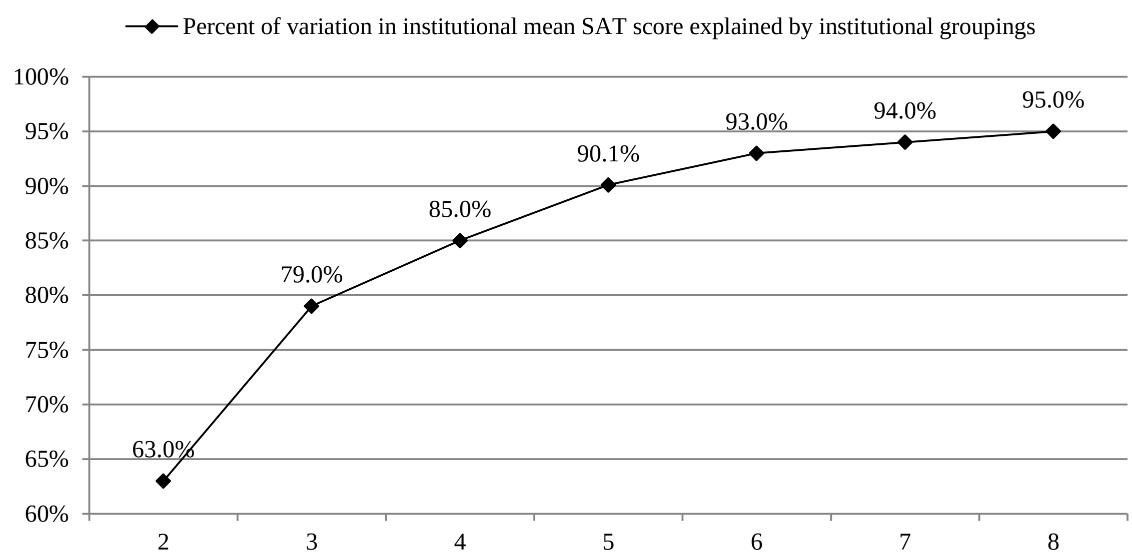
$(1)\ \text{Institutional mean SAT}_{\text{i}} = \text{Tertile 1}\ \beta_1 + \text{Tertile 2}\ \beta_2$ (omitted group= Tertile 3)

$(2)\ \text{Institutional mean SAT}_{\text{i}} = \text{Quartile 1}\ \beta_1 + \text{Quartile 2}\ \beta_2 + \text{Quartile 3}\ \beta_3$ (omitted group= Quartile 4)

(3) and so on for grouping of five through 8.

As can be seen in Figure 2.1, grouping institutions into more than quintiles does not greatly increase the percent of variation explained. Within quintiles, institutions have considerably similar mean institutional SAT scores, making this kind of categorization an acceptable way of indirectly controlling for institutional mean SAT. The detailed specifications for the regression models used will be outlined in the sections containing results in the next Chapter.

Figure 2.1. Percent of the variation in institutional mean SAT explained by institutional groupings, IPEDS 2005



Source: Graph by author

SELECTION BIAS IN COLLEGE ADMISSIONS

The analysis described above where postsecondary institutions are divided into quintiles to control for institutional mean SAT and student SAT is used as a control in each model will provide estimates that will answer the question if on average and other things equal, the statistical effect of student SAT score on college outcomes varies with the mean SAT score of students at the same college. However these estimates are not able to provide insight into how a student attending an institution in Quintile 1 would fare if she had instead attended an institution in Quintile 5. This “what if” scenario is an important consideration. As mentioned in the previous section, there are selection mechanisms that affect the ways in which students sort into postsecondary institutions and these mechanisms bias the estimates. The primary methodological challenge in estimating the statistical effect of how student SAT score on college outcomes varies with the mean SAT score of students at the same college is that postsecondary institutions that serve students with high SAT scores both attract and admit students with certain observed as well as unobserved characteristics that also exert an effect on the student's life outcomes.

Because of the selection bias inherent in the college application, admission, and selection processes, the ideal methodological design for understanding if on average and other things equal, the statistical effect of student SAT score on college outcomes varies with the mean SAT score of students at the same college is an analysis of a large number of students *randomly* assigned to a variety of postsecondary institutions. This is a balanced design in which the students attending colleges with different mean SAT scores do not differ in their characteristics and background in any way that is also related to the assignment to a postsecondary institution with a certain mean SAT score. A large sample of students is necessary so that various demographic background, academic ability and institutional characteristics can be taken into consideration in the analysis. Assigning students to institutions randomly is a crucial part of this design because, as discussed, postsecondary institutions that serve students with high SAT scores both attract and admit students with certain observed as well as unobserved characteristics that also exert an effect on the student's life outcomes. While the experimental design data described would be ideal, such data does not currently exist and the cost and implementation of a data collection such as this is not feasible for this study.

Strategies for Correcting Selection Bias

Fortunately, several methodological strategies have been developed to reduce selection bias when experimental data is not available. These methods all attempt to predict how student outcomes would change if students were exposed to differing educational environments. In the following section, I will discuss these methods as they have been used to evaluate the effects of student and peer ability differences on student outcomes in postsecondary education.

With the exception of Light & Strayer (2000), Griffith (2009), and Loury and Garman (1993, 1995), researchers have not specifically asked if on average and other things equal, the statistical effect of student SAT score on college outcomes varies with the mean SAT score of students at the same college. Instead, they are generally concerned with the effects of institutional quality on individual student achievement. Institutional quality can be defined in many ways, such as per pupil expenditures, faculty salaries, tuition cost, or student-to-teacher ratio (Long 2008). However, these institutional quality markers are so highly correlated with the mean SAT score of students attending the institution (Light & Strayer 2000, Long 2008) that many researchers have used the mean college entrance exam score as a proxy for institutional quality. The methodological strategies used to address the selection bias in these studies are: proxy variables, a variety of matching methods, and instrumental variables.

Proxy variables: Proxy variables are observed variables that serve as an indicator for certain unobservable characteristics that are related to students sorting into different types of colleges. Kane (1998) uses student participation in student government and honors societies in high school to control for academic ambition and motivation. Dale and Krueger (2002) and Melguizo (2008) use the mean SAT score of the postsecondary institutions to which a student applied. They argue that students are able to correctly estimate their own potential in college admissions, so that if there are any extraneous circumstances that may make a student attractive to an institution despite lower SAT scores the student would be aware of it and the mean SAT score of the institutions to which he had applied would be higher than if there was no extraneous factor that made the student more attractive to selective institutions.[1] The use of proxy variables is predicated on the strength of the chosen variable to decrease the selection bias.

Matching: Matching is a non-experimental method of evaluation used to estimate the effect of a certain treatment. A treatment could be attending an institution where one's SAT scores are above the institutional mean versus attending an institution where one's scores are below the institutional mean. Using available data, students who are similar based on the relevant characteristics but find themselves in different treatment groups are identified and a new sample is created (Todd 2006, Heckman et al. 1997, 1998). By creating samples where students only differ on the one dimension of interest the fact that students are not randomly assigned to a certain condition, such as attending an institution where their SAT score is above or below the mean, becomes less of a concern. However, matching does not entirely remove bias as only observable variables can be included in the matching model. Furthermore, the problematic aspect of using matching, especially in a study of education outcomes, is that there are many variables that students in both the treatment and control groups must be matched on. For instance, students should be matched on race, socioeconomic background, and all other variables that are known to affect the outcome but not the treatment assignment. Depending on the sample size of the data used it can be difficult to find similar students located in different groups. Matching works best when working with large datasets (Long 2008).

A unique case of matching in the literature on the effects of peer quality and student ability on educational outcomes was conducted by Dale and Krueger (2002). Using the College & Beyond dataset they had access to information on all of the institutions a student applied to and the subsequent admissions decisions. Dale and Krueger matched students based on the

[1] Dale and Kruger (2002) call this the self-revelation variable.

highest quality institution they were admitted to and then compared students who chose to attend that institution with students who elected to attend lower quality institutions. While this approach likely does control for some of the bias, students who choose the highest quality institutions and students who have the option but do not choose it are clearly different in some respects. Since that difference is not taken into account, Dale and Krueger acknowledge that there is likely to be remaining bias.

Matching using Propensity Scores: Propensity scores were suggested as a solution to difficulties finding adequate matches in small samples and even large samples when students must be matched on many variables (Rosenbaum & Rubin 1983). Propensity scores are calculated values that represent the probabilities that students with certain observed characteristics are assigned to a treatment of interest. The probabilities are calculated using measures that allow for the approximation of a balanced design, however, as students are matched on only one variable, the propensity score, this form of matching makes finding suitable matches more feasible (Rosenbaum & Rubin 1983). Black and Smith (2005) use propensity scores and define students as treated if they attend a top quartile institution and not treated if they attend a bottom quartile institution. The focus of their study is not on the location of students relative to the mean, but on their attendance at institutions of varying school quality—a measure highly correlated with peer ability. The counterfactual outcome for each treated student is calculated utilizing a weighted average of outcomes of untreated students with similar propensities to attend a top-quartile college.

Instrumental variables: Instrumental variables in the case of the questions posed in this study are those that have a significant direct effect on peer ability, while having no effect on the outcome of interest, such as college graduation, except through its effect on peer quality. These restrictions are designed to alleviate the effects of selection bias, but they make valid instruments difficult to find. The instrumental variable most commonly used in studies on college completion has been college proximity to a student's home (Card 1995, Kane & Rouse 1995, Lemke & Rischall 2003, Currie & Moretti 2003). This instrumental variable has however been challenged because of its weak relationship with years of education (Bound, Jaeger, and Baker 1995). Recently, another instrument has been developed for the study of postsecondary educational outcomes: the average quality, measured by median college entrance exam score of the institution, of universities located in a certain mile radius of student's home (Long 2008, Griffith 2013).

How these methods compare

Long (2008) used OLS, propensity score matching, instrumental variables, and the Dale & Kruger (2002) matching method to study the effects of college quality, as measured by mean institutional SAT score, on student graduation and wages. He finds that the effect sizes vary by method, however surprisingly "there is only modest evidence of positive selection bias in the OLS results" (Long 2008, page 12) likely because of the "richness of available control variables" (Long 2008, page 12) in his model. When comparing the estimates calculated from all of the methodological approaches mentioned above he finds that "only 14 of the 162 estimates are significantly different from the OLS results—about the rate one would expect by chance. The evidence for significant bias is lacking" (Long 2008, page 18).

In sum, while the methodological issues that accompany studying the effects of any institutional qualities on individual student achievement are clear, the best approach to solve these issues continues to be a subject of debate. In the absence of experimental data, there is no perfect way to approach the analysis on the effects of the interaction between peer ability and student ability on student outcomes in postsecondary, or any level, of education. Long recommends using several methods when attempting to understand the effect of the institution a student attends on his academic and career outcomes so that the most appropriate conclusions can be made. He notes that estimates are less significant when using instrumental variables or the Dale and Krueger (2002) matching approach because these analyses utilize smaller samples and have higher standard errors than OLS results, leading to lower rates of significance.

USING ADJUSTED PREDICTIONS TO CORRECT BIAS

The methods used in this study will be designed to answer two questions (1) if on average and other things equal, the statistical effect of student SAT score on college outcomes varies with the mean SAT score of students at the same college, and (2) how the effect of student SAT score on college outcome varies with the mean SAT score of students at the same college if students had attended an institution in a different quintile from the one they actually attend. The first question will be answered using OLS models for continuous outcomes (cumulative grade point average, months to bachelor's degree completion) and Logit models for binary outcomes (graduation, STEM major, decreasing aspirations). As outlined previously in these analyses postsecondary institutions will be divided into quintiles to avoid the confounding of individual student SAT and institution mean SAT. Covariance analyses will be conducted to test for the extent to which the coefficients, intercepts and interactions vary across quintiles. The second question will be answered using adjusted predictions.

Adjusted predictions are not widely used in Sociology and Education research and have not yet been utilized to understand the ways in which postsecondary institution environment influences the college outcomes of individual students (Williams, 2012). Adjusted predictions allow the computation of predicted values for hypothetical cases. For instance, one can calculate the predicted grade point average of an average Quintile 1 student if that student had attended a postsecondary institution that falls into Quintile 5. It is important to note that the predictions are made based on values for the predictors that the researcher chooses. The most common approach is to use the mean values of the independent variables to come up with an "average person" and use that person to understand how the outcome would change depending on the changing context (Williams, 2012), for instance, how the student's grades would change if she attended a Quintile 5 instead of a Quintile 1 institution. When calculating predictions it is also possible to see how the predictions vary with certain variables of interest. For instance, it is possible to see how a student's grades would vary by institutional quintile as her SAT scores are changing. This feature is particularly useful for the research questions addresses in this study because it allows researchers to understand if there is a tipping point with individual student SAT score where the outcome, such as grades, would be higher if the student attended a postsecondary institution in a different quintile. The detailed method for calculating the adjusted predictions will be presented with each analysis.

DATA REQUIREMENTS

To determine if the position of the student's SAT within the institutional SAT distribution has an effect on likelihood of graduation, time to graduation, choice of in major, grade point average, and educational aspirations, the following variables are required at minimum: student SAT score, mean or median institutional SAT, and a measure of whatever postsecondary learning outcome is of interest. Because there is a comprehensive literature on the student background and institutional characteristics that influence academic performance,[2] an assortment of these variables is also needed so that the effects of mean institutional SAT in combination with student SAT are not misattributed. These variables fall into the following categories: student demographic characteristics, family background, academic ability, educational motivation, high school preparation, and characteristics of four-year institution the student chooses to attend. The variables that can provide a measure for these confounding factors included in each category are outlined in Table 2.2.

Table 2.2. Summary of Confounding Variables Included in Study

Student Demographics	Family Background	Academic Ability	Educational Motivation	High School Preparation	Postsecondary Institution Characteristics
Race	Parental Education	SAT	SAT	SAT	Private
Gender	Household Income		High School Grades	High School Grades	Mean Institutional SAT
			Pre-Calculus in HS	Pre-Calculus in HS	

Source: Table by author

STUDENT CONTROLS

The factors affecting educational outcomes in postsecondary education are well established and need to be taken into consideration in any model on the effects of SAT score on college outcomes. A student's socioeconomic status is one of the strongest predictors of educational attainment (Pascarella & Terenzini, 2005). Students who have higher socioeconomic status do better on most academic outcomes throughout their education than students of lower socioeconomic status. Socioeconomic status has been measured in many ways, but primarily through parental education— a measure of cultural capital or the information required to succeed

[2] For the most comprehensive review on the variables affecting college outcomes see *How College Affects Students* by Pascarella and Terenzini (2005).

educationally— and family income—a measure of tangible resources, such as the ability to afford a home in a district with quality schools. Studies have found that income level is a better predictor of educational achievement than other socioeconomic indicators. In the particular arena of higher education research, however, it has been shown that having a parent with a college degree is one of the greatest predictors of a student's own postsecondary degree attainment (Duncan, Brooks-Gunn and Klebanov 1994, Stipek 1998). Furthermore, demographic factors such as race and family income have consistently been linked to likelihood of college completion. Minority students underperform academically relative to White and Asian students at every level of the education system (Fleming 1982, 1984, Pascarella and Terenzini 2005, Fisher 2007, Alon & Tienda 2005). Gender differences in education outcomes are less pronounced than racial differences; however gender may increasingly also become important in the study of postsecondary completion as females are making up larger portions of the college attending and graduating population (Goldin, Katz, and Kuziemko 2006). Immigration status has importance in any study of schooling as research shows that students who are foreign born are less likely to follow traditional educational trajectories (Baum and Flores 2011). Studies suggest that the greatest obstacle for foreign born students in college enrollment is completing secondary education. This is most likely because of familial and work obligations. Once immigrant students enroll in postsecondary education, their overall outcomes exceed those of non-immigrants (Vernez and Abrahamse 1996).

Student academic ability is a critical factor in determining academic achievement. Students that score in the top quartile on standardized tests designed to measure ability do better on average academically at all levels of education and in all environments than students that score in the bottom quartile. Furthermore, students with high measured ability are also more likely to pursue certain educational trajectories, such as majoring in STEM (Arcidiacono 2004). The most common measure of student ability in the context of college preparedness is the Scholastic Assessment Test (SAT) and the ACT.[3] Both of these ability assessments have controversial histories and previous research suggests that they are biased.[4] Students from low socioeconomic or minority backgrounds consistently score lower on average than privileged White and Asian students. Some education scholars have argued that less weight should be placed on such assessments and more on high school grade point average (Alon & Tienda 2007). The debate on which of these measures is a better predictor of academic ability is beyond the scope of this study. However, using high school grade point average as a proxy for student ability poses problems when working with a nationally representative dataset. High schools each have their own grading schemas and educational opportunities. What passes for a Physics class in one high school, can be very different from what passes as a Physics class in the high school across town. While high school grade point average may be used as a control to gage the extent to which a student is academically motivated and perhaps even interested in pursuing postsecondary education, it does not provide a measure of student ability that can be used when comparing students on a national level. Despite the controversy surrounding standardized testing, using the SAT and ACT as a measure of student ability is standard practice in studies on college effects.

High school preparation has proven to be important in determining the extent to which a student will attain a Bachelor's degree and is a good predictor of college performance in general (Adelman 1999). High school grade point average can be used as a measure of high school

[3] ACT is an acronym for American College Testing, the company that designed the assessment.
[4] One of the most cited examples of biased questions in the SAT is analogy question using oarsman:regatta as the comparison. These are concepts that are likely familiar to students who have had an upper-class upbringing but unfamiliar to others.

preparation or academic motivation. As high schools vary widely in terms of graduation requirements and grading rubrics, high school grade point average cannot be used as the only measure for high school preparation. In previous studies highest mathematics course completed in high school has proven to have significant effects on college outcomes, with students who take higher level mathematics in high school being more likely to successfully complete and do well in college (Adelman 2006). High school type, private versus public is potentially also an indicator of high school preparation and research suggests that attendance at elite private schools leads to better educational outcomes in postsecondary schools (Berkowitz and Hoekstra 2010). There is much heterogeneity within both the public and private high school sectors, which complicates the relationship of high school type and educational outcomes and when a large sample of nationally representative students is used, the effects of private versus public high school are negligible (Center for Education Policy 2007).

INSTITUTIONAL CONTROLS

Because the analyses are conducted separately for institutional mean SAT quintiles, institutional mean SAT is an indirect control variable. As described in Chapter 2 the separation of schools into quintiles explains over 90 percent of the variation in school mean SAT. Institutions that are more selective tend to have higher tuition costs and have more resources, such as per student expenditure or faculty-student ratio, which means that school mean SAT controls for a range of institutional factors (Light and Strayer 2000). Institutions with greater resources have greater capacity to support students to meet their educational goals in comparison to institutions with fewer resources (Alexander and Eckland 1977, Ethington and Smart 1986, Henson 1980, Tinto 1993).

In addition to institutional recourses, the distinction between private and public institution has proven important in determining outcomes. Public universities are generally larger, less selective, and have fewer financial resources than private institutions. There are notable exceptions to this such as selective flagstaff institutions (University of Michigan, University of Virginia, etc.). The differences in student experience between public and private institution tends to be significant which has made the use of institution type a consistent institutional control in higher education research. In recent decades, for-profit institutions have captured an increasing percentage of the college attending student body. For-profit institutions generally serve nontraditional students and have admissions criteria that are not based on ability.[5] As the sector of for-profit higher education institution is growing, the type of student these institutions are serving is also changing, as are the institutions themselves.

DATA USED IN THIS STUDY

There are several datasets that collect the information on student background and educational trajectories that can be used to answer the questions posed in this dissertation. Previous studies attempting to estimate institutional effects on student achievement in postsecondary education have used the National Longitudinal Survey of Youth, 1979 (NLSY) (Light & Strayer 2000, Black and Smith 2003), National Longitudinal Survey of Freshmen, 1999 (NLSF) (Griffith 2009, Espenshade and Radford 2009), National Education Longitudinal Study of 1972 (NELS:72) (Dale & Krueger 2002, Loury and Garman 1993, 1995), and 1988 (NELS:88) (Alon & Tienda 2005, Griffith 2009, Smith, Pender and Howell 2013), and College & Beyond (Bowen & Bok 1998, Alon & Tienda 2005).

---

[5] In the BPS 04:09 data 35 percent of students starting postsecondary study in 2003 are enrolled in a for-profit private institution, but when the sample is limited to recent high school graduates attending four year institutions, the representation of for-profit students falls to 7 percent.

The datasets cited all have their strengths and weaknesses. For example, College & Beyond has detailed information on all the institutions that students applied to and were either admitted to or rejected from, while the NELS:72 and NELS:88 datasets do not. Having the information on the institutions that students applied to and were accepted to and rejected from can be exploited to compare students that have had similar options but selected different trajectories. On the other hand, College & Beyond data only have information on students attending 34 highly selective or selective institutions in the United States, which means that any conclusions made are likely not generalizable.

For example, in their work on the effects of college quality on earnings using College & Beyond, Dale and Krueger (2002) find that college quality, if measured by mean institutional SAT score, is not significantly important. As the sample of institutions used is truncated and all the institutions are selective, the only conclusion that can be made is that once a student is attending a selective institution, the difference in selectivity within this selective group of institutions is not important. However the conclusion that college quality does not matter in general cannot be made, as the variation in college quality is quite limited in the sample used. Since the NELS datasets represent thousands of institutions and students nationwide, there is allowance for more generalizable conclusions though there is the limitation of not having detailed application data on each student. In sum, there is no perfect dataset that can be used to answer this research question and every choice comes with its own sacrifices and methodological challenges.

In this study I will use a dataset that has not previously been utilized to answer the questions posed in this study— the Beginning Postsecondary Students (BPS) Longitudinal Dataset (2004/09). This dataset had detailed education on student college and early career outcomes, as well as student background. The data contained is representative of both full time college students and four-year postsecondary institutions across the United States. Finally, the BPS 04/09 data represents the profile of the most recent college matriculating class available. These features of the BPS make it the most appealing for answering the particular questions of this study.

BPS-IPEDS DATA

The Beginning Postsecondary Students (BPS) Longitudinal Dataset (2004/09) consists of 18,610 students that began postsecondary education in the Fall of 2003. The initial cohort of students was drawn from the National Postsecondary Student Aid Study, which uses a nationally representative sample of postsecondary students and institutions to examine how students pay for college. BPS students were first surveyed at the end of their first year in postsecondary education (2003-2004), these interviews were followed up in the third year after initial enrollment (2005-2006), and finally in the sixth year after enrollment (2008-09). The focus of the study was first-time postsecondary beginners, thus all students included in the study were in their first spell of postsecondary education. 15,344 students completed three full or partial interviews. Transcripts were collected from institutions directly and were requested from every institution that the student attended. 25,410 transcripts were submitted for 16,960 students. I merged the transcript and survey data for this study, resulting in a total sample of 15,344 students in 2,046 institutions.

To acquire the necessary institutional characteristics, I merged the BPS data with the Integrated Postsecondary Education Data System (IPEDS) 2003-04 data. IPEDS includes data for all postsecondary education institutions that participate in any federal student financial assistance program authorized by Title IV of the Higher Education Act of 1965. Institutions are required to submit data on enrollments, college completions, faculty and staff numbers, and basic financial information. Institutions can choose to also provide information on admissions standards if applicable. Approximately sixty percent of postsecondary institutions in the United States do not require a college entrance exam. IPEDS includes the mean college entrance examination score for 1,296 institutions. A total of 7,372 students included in the BPS attend institutions that provide IPEDS a college entrance examination mean score for incoming students in the Fall of 2003.

Advantages of BPS Data

The advantage of BPS data is the ability to study effects of the interaction between student and peer ability on educational outcomes of the most recent cohort of students available. There are reasons to believe that the ways in which peer quality and student ability interact to affect student achievement may change over time. Gender differences in pursuing, completing, and selecting fields of study are an example where trends in higher education have experienced rapid shifts, with women both acquiring more education and moving into male dominated fields. Minority students have also made significant educational gains and are increasingly exposed to a social and cultural environment where minority individuals are occupying leadership positions in their field. Furthermore, debates on the uses of affirmative action, the policy of differentially evaluating applicants by race, has been reignited with two Supreme Court Cases in the past decade. It is conceivable that these changes may lead to students having different kinds of interactions and experiences with postsecondary education.

In addition to the advantage of representing the most recent data on college students available, the BPS is nationally representative of institutions and students and provides rich information on both the student's background and college experience. Transcripts are collected for each institution a student attended allowing for a detailed analysis of types of courses taken and grades received. Analysis of BPS data thus allows for more generalizable and nuanced conclusions than previously used datasets.

Problems with the BPS data and their consequences

The primary problem with the BPS data if used to study college and early career outcomes is that students are not randomly assigned to postsecondary institutions. This means that statistical methods have to be used to attempt to simulate a random assignment system with existing data so that effects of interest are not misappropriated. The problem of more able students sorting into higher quality institutions may be alleviated if the BPS data provided extensive college application information and information about admissions decisions. For instance, there is no information on why an admissions committee saw fit to admit a student with lower college entrance exam scores such as quality of teacher recommendations and personal statement. As there is no information on which institutions students applied, were accepted, and rejected from, it is also impossible to attempt to reconstruct the alternate options students had. However, while this kind of reconstruction can be useful, it is nonetheless problematic as students who choose different paths despite having similar options are clearly different on other dimensions, which may not be accounted for by the observable variables. In the absence of random assignment, there is potential for estimates to be biased regardless of the richness of the data.

Descriptive Statistics of BPS Data

The BPS surveys students that began any kind of postsecondary education or training in 2003-04. This includes students who are enrolled in a certificate program lasting only several months as well as students pursuing a Bachelor's degree. It can be problematic to include all students in the survey in a study on college outcomes, as there are students who have no interest in completing a four-year degree. Including these students who do not have an interest in obtaining a college degree with those who do in an analysis where any college outcomes are studied will provide distorted estimates for students who do want to complete college. The same is true if community college starters are included or students who are not beginning their college careers soon after graduating from high school. These student groups are affected by an extraneous circumstance that is shown to have a significant effect on educational outcomes (Black and Smith 2005, Long 2008). Because of this, the primary focus of this study, as of all previous studies on the effects of college quality and fit on student outcomes, will be students who began their postsecondary education at a four year institution within two years of graduating from high school. In the BPS the total sample size of students who are enrolled in a four-year institution is 6,418 students, representing approximately one third of the BPS sample.

Table 2.3. Descriptive Statistics for entire sample and recent high school graduates enrolled in four-year institutions (BPS04:09)

	All BPS04/09 Students					**BPS04/09 Students enrolled in 4-year Colleges**				
Variable	Number of non-missing observations	Mean	Std. Dev.	Min	Max	Number of non-missing observations	Mean	Std. Dev.	Min	Max
White	11165	0.69	0.46	0	1	6235	0.74	0.44	0	1
Black	11165	0.11	0.31	0	1	6235	0.08	0.28	0	1
Hispanic	11165	0.10	0.30	0	1	6235	0.08	0.27	0	1
Asian	11165	0.05	0.22	0	1	6235	0.05	0.22	0	1
Other	11165	0.05	0.22	0	1	6235	0.05	0.21	0	1
Male	11165	0.42	0.49	0	1	6235	0.43	0.50	0	1
Parent had BA	11165	0.51	0.50	0	1	6235	0.61	0.49	0	1
Household Income, 2003	11165	64029.90	52429.92	0	497686	6235	74324.81	54738.13	0	497686
Student foreign born	11165	0.09	0.29	0	1	6235	0.07	0.26	0	1
Parent foreign born	11165	0.20	0.40	0	1	6235	0.18	0.38	0	1
HS GPA 3.5-4.0	10547	0.43	0.49	0	1	6235	0.54	0.50	0	1
HS GPA 3.0-3.4	10547	0.34	0.47	0	1	6235	0.32	0.46	0	1
GPA less than 3.0	10547	0.24	0.42	0	1	6235	0.14	0.35	0	1
Pre-Calculus	11003	0.48	0.50	0	1	6235	0.61	0.49	0	1
SAT	10950	1013.40	206.04	400	1600	6219	1084.65	188.63	420	1600
Private	9738	0.34	0.47	0	1	5918	0.45	0.50	0	1

Source: Table by author

Table 2.3 shows the descriptive statistics of all students in the BPS data as well as students who have enrolled in four-year higher education institutions within two years of graduating from high school. The comparison between these two groups shows that students who are recent high school graduates attending four-year institutions are more privileged in comparison to students pursuing post-secondary education. 73 percent of the students are White and 61 percent have at least one parent who has attained at least a college degree. 55 percent of students have a high school grade point average that is above 3.5. The average SAT score is 1085, which is approximately 80 points above average for all SAT takers.

Table 2.4 provides institutional descriptive characteristics for institutions attended by recent high school graduates enrolled a four-year institution. There are 108 institutions represented in this sample.

Table 2.4. Descriptive Statistics for Institutions attended by recent high school graduates attending four-year institutions (BPS 04:09)

Private Institution	57
For-Profit Institution	5
Mostly Hispanic Serving Institution	5
Mostly Black Serving Institution	3
Percent Minority	24.27
Tuition Cost	$11,881
Percent Fulltime Faculty	34.17
Student Faculty Ration	1:17
Mean SAT	1112
N	108

Source: Table by author

Approximately half of the institutions are designated as Private not-for-profit and five are Private for-profit. The sample includes five institutions where the student body is primarily Hispanic and three where the student body is primarily black. On average across the institutions 24 percent of the student body is made up of minorities, which includes black, Hispanic, Asian, and any other racial group. The institutional mean SAT is 1112, which is considerably above average. This is not surprising as this sample is limited to institutions enrolling students who are starting on a four-year degree soon after completing high school.

Weights

The BPS 04:09 data are collected through a multi-stage sampling scheme involving stratification, disproportionate sampling of certain levels and clustered probability sampling. This is true for the majority of datasets collected by the Institute for Educational Sciences. These sampling procedures affect the calculation of standard errors by underestimating them (Curtin et al. 2004). In conducting the analyses for this study I made use of the included WTB000 weight, which is the participation weight for respondents who completed all three waves of the survey (or whose information could be constructed) with complete postsecondary transcripts. This is recommended for researchers using both the survey and transcript data. The STATA12 SVY command accounts for the multi-stage sampling scheme and was used to compute standard errors.

Missing Values

The BPS 04:09 data collection efforts included a variety of measures to decrease the attrition of students, especially certain student subgroups in order to avoid having data missing in a particular pattern that biases researchers' findings. Despite these efforts, there are students in the dataset who have certain key variables missing and will thus be excluded from any analysis. A missing case analysis was conducted for the outcomes studied. For instance, I tested for differences in bachelor's attainment for students who have complete information and for students who do not. As may be expected, students who did not complete their bachelor's degree are more likely to have missing information. This suggests that missing data are not missing at random, which means that there may be upward bias in the results. To understand the extent to which the non-random missing information presents a problem for the robustness of estimates presented in this study, I estimated the models for the sample of excluded cases, which allowed me to see how the estimates changed. These estimates indicate that the variables included in the analysis have the same direction and similar magnitudes. Thus, while there is a sample selection problem due to missing information not missing at random, the estimates that will be presented should nonetheless provide a good approximation of effects.

CHAPTER 3

EFFECTS OF STUDENT SAT SCORES AND INSTITUTION MEAN SAT SCORES ON COLLEGE GRADES AND MONTHS TO DEGREE COMPLETION

INTRODUCTION

In Chapter 2, I described the data used in this study, summarized and critiqued methodologies that have been utilized by researchers asking similar questions, and described student and institution sample characteristics. In this chapter, I present the hypotheses, analyses, and discussion of the effects of peer achieved ability on cumulative grade point average and time to degree completion.

HYPOTHESES

The literature review presented in Chapter 1 demonstrates that the ways in which student and peer academic achievement interact to affect student learning has been a concern for education scholars for decades (see Table 1.1 and 1.2 in Chapter 1 for summary of this research). Furthermore, as reviewed in Chapter 1, research on this topic has garnered mixed results with some finding that students whose peers have higher achieved ability (SAT scores) are more likely to have poorer academic outcomes (Marsh, 2007) while others find the opposite, i.e. that more able peers increase an individual student's academic outcomes (Pascarella, 1985). Lastly, studies have also found that the statistical interaction between student and peer academic preparation has no effect on student learning outcomes (Astin, 1977). As is mentioned in Chapter 1, these mixed results are likely partly due to the fact that the research was conducted over many years using dissimilar data sources and varying methods. In the context of the mixed results of past research, it seems appropriate to consider hypotheses of positive, negative and null effects on college outcomes of the difference between student SAT score and the mean SAT score of other students who attend the same school.

Hypotheses about Cumulative Grade Point Average

Previous research reports positive effects of student SAT score on student GPA, both within schools and when data from different schools are pooled (Kobrin, Patterson, Shaw, Mattern, and Barbuti, 2008).[1] Here, I consider the hypothesis that this positive effect for individuals is stronger at some schools than at others. That is, I consider the hypothesis that individual SAT scores interact with the average SAT of all students at the college that they attend. More formally,

Ha: On average and other things equal, the positive statistical effect of student SAT score on GPA varies with the mean SAT score of students at the same college.

Ho: On average and other things equal, the positive statistical effect of student SAT score on GPA does not vary with the mean SAT score of other students at the same college.

Table 3.1 below shows the plan of my analyses of GPA in this chapter. I begin with an Analysis of Covariance of the effects of student SAT on GPA, by school mean student SAT quintile. Because Johnson and Newman (1936) critique the usual Analysis of Covariance significance tests for these differences, I also follow their recommendations in an additional set of analyses. In those additional analyses, I constrain the effects of all independent variables other than student's SAT to be the same in all groups. Finally, in the third analysis, I use regression standardization to distinguish interquantile GPA differences (or similarities)

[1] Grading policies vary considerably by institutional type. The mean cumulative GPA at a private institution is 3.30 in comparison to 3.01 at a public institution.

due to quintile differences in independent variable means from interquintile GPA differences due to quintile differences in independent variable coefficients.

Table 3.1. Analysis Plan for GPA Analyses

Question Posed	Analysis	Tabulated Results	Unit of Analysis
1. Does the regression effect of SAT on GPA vary across quintiles of the school mean SAT distribution?	Regression of student GPA on student SAT score and control variables, for entire sample, and by quintiles of the school mean SAT distribution (Analysis of Covariance)	Table 3.4	Student and quintile of school mean SAT distribution
2. Same as 1, with slightly different model specification and tests.	Same as 1 with pair-wise tests of quintile differences in regression effect of student SAT on student GPA. Analyses follow Johnson and Newman's (1963) critique of Analysis of Covariance tests.	Table 3.5	Student and quintile of school mean SAT distribution
3. Are quintile differences (or similarities) in mean of student GPA attributable to quintile differences in independent variable means or coefficients?	Regression standardization using estimated regression coefficients and means of independent variables for quintiles of the school mean SAT distribution.	Table 3.6 Figure 3.1	Student and quintile of school mean SAT distribution

Source: Table by author

ANALYSIS

The Dependent Variable: Measurement Details

In the BPS 04/09 data analyzed here, each student's Grade Point Average (GPA) is calculated from data supplied to survey personnel on students' academic transcripts, and coded on the familiar four-point grade scale.[2] In these data, each student's GPA is the arithmetic mean of all of her or his college grades, weighted by the number of credit hours pertaining to each grade, at all baccalaureate institutions attended by the student. GPA's are not adjusted for differences in school academic difficulty, admissions selectivity, or for college courses that are included in the transcripts but not counted toward satisfying bachelor's degree credit hour requirements.

Because the GPA data is culled directly from academic transcripts, it does not suffer from problems of unreliable or biased reporting. However, grading standards, practices and

[2] The four-point scale corresponds to the letter-grade scale as follows: 4.0 = A; 3.0 = B; 2.0 = C, 1.0 = D; 0 = Failure.

policies vary somewhat across colleges and universities, (Arum and Roksa, 2011). Johnson (2003) reports that some schools impose a maximum mean grade average for each class or course (Johnson, 2003). Secular trends in GPA values (grade inflation) can add variance to grades earned over long periods of time by one student, and can complicate comparisons of GPA's earned at widely differing times. Because the BPS 04/09 data pertain to a single five-year period, they avoid problems of secular trend in grading standards. Overall grade point averages at public institutions are 2.88 and 3.13 at private institutions (calculated from BPS 04/09).[3]

In Table 3.2, the average cumulative student grade point averages for each institutional quintile are displayed in row 19. Avery and Hoxby (2004) argue that SAT scores reflect academic motivation as well as achieved academic ability, perhaps indicating that these characteristics explain why mean GPA is higher at higher quintile schools than at lower-valued quintiles. Further causes of the differences in grades between institutional quintiles will be addressed following the presentation of results.

Independent variables in GPA Analyses

For convenience, and to facilitate discussion of results, I recapitulate from Chapter 2 certain discussion and, in Table 3.2, tabulated information concerning independent variables. To summarize the profile of the average student in each quintile, Table 3.2 presents the descriptive statistics for all recent high school graduates attending four-year postsecondary institutions as well as for students by institutional quintile. Consistent with previous research, Table 3.2. shows a strictly monotonically increasing relationship of school mean SAT quintile with parental schooling and parental income (Hoxby, 2009). N for each quintile is the number of respondents who have non-missing values for SAT score and School Mean

[3] See Rojstaczer and Healy (2012) for a discussion of causes of these public-private differences.

SAT score. Non-missing N is the number of students that are used in the analysis. Over 95% of the observations that are dropped from the analyses are excluded due to a missing value in STEM major only. The STEM major variable was coded from transcripts. Missing values represent codes that could not be identified.

Table 3.2. N, Means of Analysis Variables, selected standard deviations, and analysis of variance, by Total and Quintiles of School Mean SAT Score Distribution

	Institutional Quintile						
	All	**1**	**2**	**3**	**4**	**5**	**F test of Ho: all group means equal**
Black	0.08	0.16	0.07	0.06	0.04	0.06	29.80, 0.000
Hispanic	0.09	0.11	0.06	0.05	0.08	0.06	8.35, 0.000
Asian	0.05	0.02	0.03	0.04	0.07	0.1	22.58, 0.000
Other	0.05	0.05	0.04	0.05	0.04	0.07	2.70, 0.029
White	0.74	0.67	0.8	0.8	0.77	0.71	19.85, 0.000
Male	0.43	0.38	0.46	0.42	0.42	0.45	4.21, 0.002
Parent has BA	0.61	0.45	0.57	0.66	0.68	0.82	90.20, 0.000
Parent Income	$74,324	$59,360	$70,249	$76,067	$81,476	$96,331	66.17, 0.000
SD	$54,738	$46,147	$49,922	$50,937	$55,444	$67,828	
Foreign born	0.07	0.07	0.07	0.05	0.08	0.08	3.39, 0.009
HS 3.5 plus	0.54	0.35	0.43	0.54	0.7	0.83	80.99, 0.000
HS 3.0-3.4	0.32	0.4	0.4	0.35	0.26	0.15	78.09, 0.000
Pre-Calculus	0.61	0.44	0.51	0.61	0.72	0.87	144.39, 0.000
SAT	1085	966	1042	1088	1146	1277	627.90, 0.000
SD	187	159	148	146	150	149	
Private	0.45	0.37	0.28	0.45	0.49	0.72	124.87, 0.000
STEM Major	0.28	0.21	0.25	0.25	0.35	0.36	18.26, 0.000
Cumulative GPA	2.99	2.78	2.92	3.03	3.13	3.29	93.32, 0.000
SD	0.7	0.77	0.69	0.66	0.57	0.48	
Months to BA	44	46	45	44	43	40	45.62, 0.000
SD	7	8	8	8	7	6	
N	5,368	1,083	1,086	1,061	1,138	1,000	
Non-missing N	3,728	718	718	721	816	755	

Source: Table by author

To understand the extent to which dropped cases due to missing information present a problem for the robustness of estimates presented in the analyses in this chapter, I estimated the models for the sample of excluded cases, which allowed me to see how the estimates changed. These estimates indicate that the variables included in the analysis have the same direction, similar magnitudes, and there are no changes in statistical significance. Compared to those in lower quintiles, students in higher quintiles are more likely to be White, have parents who completed college and have higher household incomes. Similarly, higher quintile students have higher mean high school GPAs, and are more likely to have completed a high school course in Pre-Calculus, both of which have been interpreted as indicators of academic motivation and the general quality of high school education (Pascarella and Terenzini, 2005). While high school grades and Pre-Calculus participation control for academic motivation and preparation these variables also to some extent capture achieved academic aptitude which is also measured by the SAT.[4] After all, students whose academic aptitude is high are likely to get good grades and thus place into advanced courses in high school. It can be argued that the inclusion of all three high school academic performance indicators in the model dilutes the effect of the SAT on college outcomes. Please see Appendix A for the discussion of how high school grades and Pre-Calculus participation change the effect of SAT on the outcome.

In terms of the college outcomes considered in this chapter, higher quintile students have higher college GPA's and take fewer months to complete their bachelor's degrees. In column 8 of Table 3.2, I present the F-test statistic and p-value of an analysis of covariance testing the null hypothesis that the means of the descriptive variables are the same across all quintiles (Ho: $\mu 1 = \mu 2 = ... = \mu r$; H1: two or more means are different from the others). As is evident by the p-values, the null hypothesis that the means for all independent variables individually are the same across quintiles can be rejected at the 0.05 level. The students that

[4] Please see Chapter 1 for a discussion on the history of the SAT and what it measures.

are served in each institutional quintile are significantly different on the demographic and academic preparation variables included in this analysis.

Nonlinear and Nonadditive Effects of Independent Variables

In preliminary analyses, I tested for non-linear and non-additive relationships between SAT and the outcome variables. Within Quintiles 1 through 4 I found no non-linear or non-additive relationships. In Quintile 5 estimates of the effect of individual SAT on GPA are more vulnerable to ceiling effects on than other quintiles. Wang, Zhang, McArdle and Salthouse (2008) discuss the possibility of utilizing a Tobit Model to reduce these effects. Therefore, I fitted both OLS and Tobit models to Quintile 5 data, but found virtually identical coefficients (to two decimal places) for OLS and Tobit models.

Analysis 1: Does the regression effect of SAT on GPA vary across quintiles of the school mean SAT distribution?

To answer the question if the regression effect of SAT on GPA varies across quintiles of the school mean SAT distribution I first specified a model of GPA presented in Equation 3.1. The model was run separately for each institutional quintile. See Chapter 2 for a detailed explanation of why analyses are conducted separately by quintile.

Equation 3.1. Regression of Cumulative College Grade Point Average on SAT and set of covariates, by institutional quintile

$$\begin{aligned} CollegeGPA_i = {} & Black\beta_1 + Hispanic\beta_2 + Asian\beta_3 + OtherRace\beta_4 + Male\beta_5 \\ & + ParenthasBA\beta_6 + ParentalIncome2003\beta_7 + ForeignBorn\beta_8 \\ & + HSGPA3.5 - 4.0\beta_9 + HSGPA3.0 - 3.4\beta_{10} + CalculusinHS\beta_{11} \\ & + STEMMajor\beta_{13} + PrivateCollege\beta_{13} \end{aligned}$$

Omitted categories in cases where a variable is not binary are white, and HS GPA less than 3.0.

Second, I used a multiple partial F-test for regression to test for and estimate institutional quintile differences in basic model coefficients and intercepts. The analytic strategy and results of these F-tests are summarized in Table 3.4.

Table 3.3. Regression Coefficients (and Standard Errors) for Regression Analysis of GPA, by Quintile of Mean Student SAT Score and Total, BPS 04/09

		Institutional Quintile				
Independent Variables	**All**	**1**	**2**	**3**	**4**	**5**
Black	-0.197***	-0.169***	-0.0910	-0.0993	-0.325***	-0.268***
	(0.0323)	(0.0649)	(0.0806)	(0.0858)	(0.0858)	(0.0666)
Hispanic	-0.135***	-0.0787	-0.165*	-0.0672	-0.205***	-0.108*
	(0.0346)	(0.0845)	(0.0919)	(0.0887)	(0.0651)	(0.0644)
Asian	-0.0851**	-0.0203	0.105	-0.122	-0.167**	-0.0699
	(0.0391)	(0.166)	(0.116)	(0.109)	(0.0741)	(0.0492)
Other	-0.116***	-0.272**	-0.197*	-0.0646	0.0390	-0.0770
	(0.0397)	(0.114)	(0.100)	(0.0904)	(0.0868)	(0.0599)
Male	-0.220***	-0.225***	-0.224***	-0.297***	-0.200***	-0.187***
	(0.0172)	(0.0471)	(0.0412)	(0.0409)	(0.0342)	(0.0296)
At least one parent has BA	0.0172	0.00267	0.0169	0.0337	0.0739*	-0.0415
	(0.0189)	(0.0477)	(0.0425)	(0.0427)	(0.0388)	(0.0410)
Parental Income, 2003	2.38e-07	1.56e-07	1.91e-07	1.58e-06***	-3.22e-07	1.61e-07
	(1.62e-07)	(5.31e-07)	(4.37e-07)	(4.15e-07)	(3.43e-07)	(2.18e-07)
Foreign born	0.0162	0.0346	0.00389	-0.0909	0.0336	0.0479
	(0.0348)	(0.101)	(0.0839)	(0.0976)	(0.0667)	(0.0540)
HS GPA 3.5-4.0	0.442***	0.560***	0.390***	0.439***	0.393***	0.245**
	(0.0309)	(0.0663)	(0.0630)	(0.0740)	(0.0881)	(0.100)
HS GPA 3.0-3.4	0.204***	0.244***	0.163***	0.226***	0.165*	0.0289
	(0.0301)	(0.0601)	(0.0588)	(0.0723)	(0.0904)	(0.104)
Pre-Calculus in HS	0.0574***	0.0482	0.136***	0.0964**	-0.0108	-0.0154
	(0.0194)	(0.0481)	(0.0422)	(0.0434)	(0.0402)	(0.0460)
Student SAT Score (*100)	0.0897***	0.104***	0.104***	0.103***	0.0968***	0.0901***
	(5.92e-05)	(0.000176)	(0.000158)	(0.000157)	(0.000125)	(0.000115)
STEM Major	-0.114***	-0.197***	-0.0477	-0.130***	-0.0970***	-0.107***
	(0.0192)	(0.0569)	(0.0476)	(0.0477)	(0.0366)	(0.0306)
Private Institution	0.110***	0.158***	0.159***	0.145***	0.0553	0.142***
	(0.0171)	(0.0476)	(0.0452)	(0.0394)	(0.0339)	(0.0325)
Constant	1.820***	1.636***	1.686***	1.555***	1.847***	2.040***
	(0.0601)	(0.172)	(0.158)	(0.169)	(0.154)	(0.155)
N	3,728	718	718	721	816	755
R-squared	0.305	0.321	0.288	0.319	0.252	0.252

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Table by author

Table 3.3 presents coefficient estimates for the regression of college GPA on student characteristics by institutional quintile presented in Equation 3.1. The unit of analysis in each regression is the individual student. As an informal check on the credibility of these results, note that results are consistent with commonplace previous findings on the impact of race, gender, high school grades, high school Pre-Calculus enrollment, college major, and private/public institutional status. As hypothesized, the impact of specific independent variables on GPA varies across quintiles. For instance, taking into account all of the other control variables, compared to White students Black and Hispanic students have lower grades at Quintile 4 and 5 institutions than at institutions in the bottom three quintiles. On the other hand, male students have significantly lower grades than females at institutions in all quintiles. The estimate of the effect of SAT score on cumulative grade point average is highlighted in Table 3.4. Across institutional factors, student SAT score exerts a statistically significant effect on grades. For instance, in Quintile 1, a 100 difference in SAT score between students who are alike in terms of all other factors included in the model results in a grade point average difference of 0.104 points. In grade point calculation, 0.33 points makes a difference in letter grade. For instance, a 4.00 is an "A" letter grade, while a 3.67 is an "A-" letter grade. Thus, a student in Quintile 1 would have to have approximately a 340 points difference in SAT in order to receive a lower grade, such as go from a B+ to a B.

Table 3.4 summarizes the analyses and tests conducted to understand the extent to which intercepts, all model coefficients, and the coefficient of SAT in particular vary across quintiles.

Row 1 of Table 3.4 tests the null hypothesis that the model does not fit the data. This hypothesis can be rejected at alpha 0.000. Rows 2 and 3 of Table 3.4 show that there are statistically significant differences in intercepts and coefficients across quintiles respectively.

Table 3.4. Covariance Analysis Tests for Cumulative Grade Point Average

Interpretation	Analysis Plan	d.f.	F-statistic	p-value
Ho: Model does not fit data. The explanatory variables collectively do not have an effect on the response variable.	Regress GPA on independent variables for all quintiles pooled.	14, 5291	163.7200	0.0000
Ho: Intercepts do not vary across quintiles.	Regress GPA on independent variables and dummy variables for quintile on all quintiles pooled.	4, 3709	4.4867	0.0013
Ho: Coefficients of independent variables do not differ across quintiles, after allowing intercepts to vary across quintiles.	Interact quintile dummies with all independent variables.	42, 3667	1.9099	0.0004
Ho: Coefficients of independent variables AND intercept do not differ across quintiles.	Interact quintile dummies with all independent variables.	46, 3667	2.138	0.0000
Ho: Coefficient of SAT does not vary across quintiles when allowing all other coefficients and intercepts to vary across quintiles.	Interact quintile dummies with all independent variables except for SAT.	4, 3676	0.1377	0.9684

Source: Table by author

The F-test summarized in row 5 of Table 3.4 indicates that the coefficient of SAT in particular does not vary across quintiles after allowing for all other coefficients and intercepts to vary across quintiles. This means that, for instance, a student who gains an additional 50 points on his SAT will not increase his grade point average by more points in one quintile versus another. The effect of SAT on GPA does not vary across quintiles of the school mean distribution.

Analysis 2: Does the regression effect of SAT on GPA vary across quintiles of the school mean SAT distribution using Johnson-Neyman regions of significance approach?

Critics have argued that the tests of covariance used in Table 3.4 can be misleading in cases where regression slopes are not homogenous and have recommended the Johnson-Neyman regions of significance approach (Johnson and Neyman, 1936; Pedhazur, 1997). This approach involves running an analysis on two institutional quintiles at a time with an addition of an interaction term between SAT and institutional quintile (Pedhazur, 1997).[5] The significance value of the interaction term (t-test, p-value) was used to determine if the SAT has a greater effect on cumulative grade point average in one institutional quintile versus another. Table 3.5 presents the results of significance tests comparing the extent to which the estimates for the effect of SAT are statistically different across institutional quintiles. If statistical significance is determined by alpha<0.05, as is the convention in social science research, then none of the effects of SAT on student cumulative grade point average are statistically different between quintiles.

Table 3.5. Results of significance tests on SAT coefficient between institutional quintiles

	Institutional Quintile				
Institutional Quintile	**1**	**2**	**3**	**4**	**5**
1		t=-0.26; p=0.799	t=-0.08; p=0.94	t=-0.42; p=0.67	t=-1.5; p=0.13
2			t=-0.26; p=0.79	t=-0.7; p=0.49	t=p=-1.8; 0.08
3				t=-0.68; p=0.49	t=-1.7; p=0.09
4					t=-1.07; p=0.28
5					

Note: p<0.1 **p<0.05***p<0.01 (two-tailed tests)
Source: Table by author

This finding corroborates the result in Table 3.4, Row 4, which also shows that the coefficient of SAT does not vary across quintiles. The results of these significance tests lead to the conclusion that that the effect of student SAT score on cumulative college GPA does not vary with the mean SAT score of other students at the same college. It is not possible to

[5] See Pedhazur (1997) Chapter 14 for detailed description of this method. Also, see Aiken and West (1991) for discussion on best practices in testing and interpreting interactions.

reject the null hypothesis that on average and other things equal, the statistical effect of student SAT score on GPA does not vary with the mean SAT score of other students at the same college.

Analysis 3: Are quintile differences (or similarities) in mean of student GPA attributable to quintile differences in independent variable means or coefficients?

The results and significance tests presented in Table 3.4 and Table 3.5 above lead to the conclusion that on average and other things equal, the positive statistical effect of student SAT score on GPA does not vary with the mean SAT score of other students at the same college. In practical terms, the research on the effects of peer-achieved ability on student educational outcomes is conducted to understand if the current sorting mechanisms of students into postsecondary institutions are the most efficient for student learning. Previous research has especially been concerned about the use of the SAT to sort students into postsecondary institutions. For example, in studies on the effects of affirmative action, researchers have wondered if students with lower SAT scores are harmed if attending an institution where students on average have higher SAT scores (Alon and Tienda, 2005). Similar questions have also been asked in educational psychology where researchers have looked at the ways in which the student's own ability interacts with the ability of her peers to affect her learning outcomes (Marsh, 2007).

To understand the relevance of this analysis in practical terms, I will use the method of standardized regression to calculate how the grade point average of a student from one institutional quintile would be changed if she attended an institution in another quintile. In standardized regression standard values for basic model variables are selected and substituted into Equation 3.1. This method allows us to know if quintile differences (or similarities) in mean of student GPA are attributable to quintile differences in independent variable means or coefficients. Standardizations in this analysis are based on five different hypothetical individuals each based on the average characteristics of the students in each institutional quintiles. For example, the average Quintile 1 student as depicted in the descriptive statistics in Table 3.2 is a white female with a high school grade point average between 3.0 and 3.4 who has not participated in high school Pre-Calculus. Neither of her parents has completed a college degree and their average household income was $59,360 in 2003.

Table 3.6. Raw and Adjusted Mean GPA Values by Quintile

	Institutional Quintile				
	1	**2**	**3**	**4**	**5**
Unadjusted Mean GPA	2.776	2.921	3.029	3.125	3.285
Adjusted Mean GPA					
Hypothetical Q1 Student	2.893	2.893	2.864	2.919	2.954
Hypothetical Q2 Student	3.339	3.328	3.307	3.298	3.184
Hypothetical Q3 Student	3.388	3.377	3.363	3.340	3.225
Hypothetical Q4 Student	3.449	3.438	3.431	3.394	3.277
Hypothetical Q5 Student	3.744	3.578	3.589	3.514	3.395

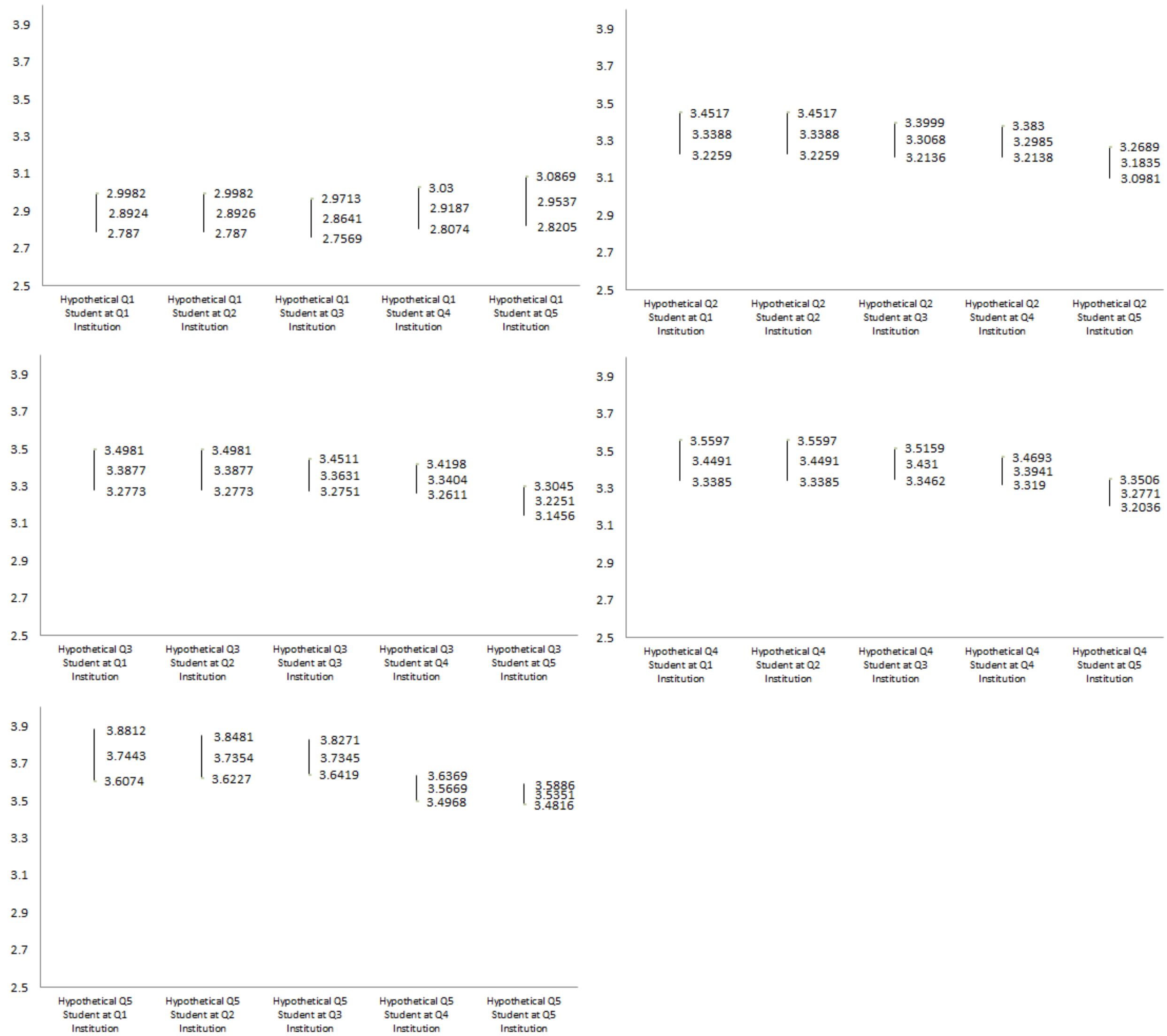
Source: Table by author

Row 1 of Table 3.6 shows the unadjusted mean GPAs by institutional quintile, which is the true average GPA for students attending institutions in that quintile. Row 2 of Table 3.6 shows the predicted GPA the average hypothetical Quintile 1 student would obtain if she attended a Quintile 1 institution as well as her predicted GPA if she attended an institution in any other quintile. The adjusted GPA for the hypothetical Quintile 1 student is highest if the student attended an institution in Quintile 5 (2.954) and lowest if the student attended an institution in Quintile 3 (2.864). Hypothetical Quintile 2, 3, and 5 students achieve the highest predicted grades are if they attend a Quintile 1 institution and the lowest if attending a Quintile 5 institution. Hypothetical Quintile 5 students, on the other hand, have the highest predicted GPA in Quintile 3 institutions, and the lowest in Quintile 5.

Figure 3.1 shows the predicted GPAs for the hypothetical Quintile 1 through 5 student in each of the institutional quintiles with ninety five percent prediction bands. Each graph within Figure 3.1 depicts a row presented in Table 3.6 above with the corresponding significance interval. For instance, the first graph corresponds to Table 3.6, Row 2 (Hypothetical Quintile 1 Student). I calculated prediction bands[6] using the method described in Kleinbaum, Kupper, Nizam, and Muller (2008, page 61-2) for each estimation depicted in the graph. Prediction bands determine whether there is a significant difference between the predicted grade point averages for a given student SAT score depending on the institutional quintile. The significance threshold used is $p<0.05$. While there are differences in predicted GPA between quintiles, none of these are statistically significant. A hypothetical Quintile 1 student would not have a statistically significantly different GPA if she attended a Quintile 5 institutions, and vice versa. Furthermore, in practical terms the differences in GPA a hypothetical student would earn depending on which quintile institution she attends do not result in a practically large difference in student grades. For instance, the letter grade that would be assigned to the average GPA a hypothetical Quintile 1 student would receive at any of the institutions is a B, as a B corresponds to any GPA that falls in the 2.9 to 3.1 range. The most extreme difference in predicted GPA for a student if she attended one institution versus another would result in a letter grade being increased by half, meaning going from a B to a B+ or an A- to an A.

[6] Prediction interval calculations are necessary in this case because “predicting an actual observed Y for a given individual, there are two sources of error operating: individual error measured by the standard deviation and the error in estimating the predicted value using the point estimate.” (Kleinbaum, Kupper, Nizam, and Muller, 2008, page, 62).

Figure 3.1. Adjusted GPA (Y) of Hypothetical Student with 95% Prediction Bands, by Quintile



Source: Figure by author

The findings summarized in Table 3.6 and Figure 3.1 allow a greater understanding of why previous research concerned with the effects of academic environment on student achievement has garnered such mixed results. Depending on what institutional quintile one focuses on the conclusion as to whether or not students have higher grades when surrounded by peers who have lower or higher SAT scores changes. In Quintile 1 the conclusion is that the average student has slightly higher grades when surrounded by peers with significantly higher SAT scores. For Quintiles 2, 3, and 4, and 5 students have highest predicted grades when surrounded by peers with lower SAT scores.

CUMULATIVE GRADE POINT AVERAGE ALTERNATIVE EXPLANATIONS

There are several factors that may influence the direction of results presented in the previous section that are unrelated to student ability or other factors that have been taken into consideration in this study. For instance, the importance of postsecondary institution rankings at top institutions may have an effect on how students are graded (Monks and Ehrenberg, 1999).[7] Student grades and overall degree completion rates make up a portion of many popular rankings systems. Rankings are increasingly gaining prominence and importance in student decisions on where to go to college (Meredith, 2004), and there are institutional pressures to improve those statistics that are important in ranking systems (Saunder and Espeland, 2009). This may increase pressure to give higher grades to all students at top institutions concerned about their rankings and thus affects the coefficients in these models. Institutions that fall in Quintiles 1, 2, and 3, are likely less concerned with their rankings than institutions in Quintiles 4 and 5 because they are too low on the totem pole to be included in such systems.

[7] See Sauder and Espeland (2009) for an overview of how rankings affect institutions internal workings. While they focus on legal education and law schools, many connections can be made to the ways rankings exert pressure on undergraduate institutions.

MONTHS TO DEGREE COMPLETION

Hypotheses for Months to Degree Completion

After extensively researching the literature on the effects of student SAT scores, institutional mean SAT scores, and college outcomes I am unaware of any research that has explored the effects of student SAT and peer SAT scores, both individually and jointly, on student time to degree completion.[8] As discussed in Chapter 1, time to degree completion is increasingly an important college outcome as research shows that even an additional semester spent in college has an effect on student employment status and earnings (Carruthers, Fox, Murray, and Thacker 2012). Please see Chapter 1 for a more thorough discussion of the importance of time to graduation.

The dearth of research on time to completion as a college outcome means that there is not much information to guide the development of the direction of the hypotheses on this outcome. However, as research shows that on average and other things equal, student SAT score has been found to have a positive statistical effect on student college grades (Kobrin, Patterson, Shaw, Mattern, and Barbuti, 2008), I hypothesize that a similar relationship exists between time to degree and SAT score. This connection between grades and time to degree can be made as presumably students who are getting good grades are not repeating courses or taking remedial courses, which would add time to degree completion. Furthermore, I consider the hypothesis that this positive effect for individuals is stronger at some schools than at others. That is, I consider the hypothesis that individual SAT scores interact with the average SAT of all students at the college that they attend. More formally,

[8] Many universities do collect the information on time to graduation by student SAT score and make it available on their websites.

Ha: On average and other things equal, the positive statistical effect of student SAT score on months to bachelor's degree completion varies with the mean SAT score of students at the same college.

Ho: On average and other things equal, the positive statistical effect of student SAT score on months to bachelor's degree completion does not vary with the mean SAT score of other students at the same college.

Table 3.7 below shows the plan of my analyses of months to graduation in this chapter. I begin with an Analysis of Covariance of the effects of student SAT on months to graduation, by school mean student SAT quintile, followed by the Johnson-Neymann regions of significance test, followed by the standardized regression. This analysis plan is identical to the one utilized for college GPA in the preceding section.

Table 3.7. Analysis Plan for Months to Degree Completion

Question Posed	Analysis	Tabulated Results	Unit of Analysis
1. Does the regression effect of SAT on months to graduation vary across quintiles of the school mean SAT distribution?	Regression of student months to graduation on student SAT score and control variables, for entire sample, and by quintiles of the school mean SAT distribution (Analysis of Covariance)	Table 3.8	Student and quintile of school mean SAT distribution
2. Same as 1, with slightly different model specification and tests.	Same as 1 with pair-wise tests of quintile differences in regression effect of student SAT on student months to graduation. Analyses follow Johnson and Newman's (1936) critique of Analysis of Covariance tests.	Table 3.9	Student and quintile of school mean SAT distribution
3. Are quintile differences (or similarities) in mean of student months to graduation attributable to quintile differences in independent variable means or coefficients?	Regression standardization using estimated regression coefficients and means of independent variables for quintiles of the school mean SAT distribution.	Table 3.10 Figure 3.2	Student and quintile of school mean SAT distribution

Source: Table by author

ANALYSIS

The Dependent Variable: Measurement Details

There are several ways in which one could measure time to graduation. Previous studies have often measured this variable roughly, marking students that graduate prior to

September in the fourth year of college as graduating on time, and marking students that graduated after that month as graduating in five years, and so on. While a valuable indicator of the rates at which students are graduating on time, this measure does not capture if students are taking an extra quarter or an extra year to complete their degrees and thus misses some of the more nuanced differences between students. Furthermore, few studies focus on differentiating between students that graduate on time and students that graduate early. As tuitions are rising completing a bachelor's degree in less than four years increasingly represents a significant financial advantage, both from the perspective that these students incur fewer student costs and that they are able to enter the job market sooner, and thus are potentially able to position themselves to earn more over a lifetime.

Independent variables in Months to Degree Analysis

In addition to the control variables that were used for the model estimating the determinants of grade point average, I am also adding whether or not the student used Advanced Placement (AP) credits to add credits to his or her college transcript and how many hours the student worked per week. AP credits are important to take into account because these are credits that students earn in high school and are able to receive college credit for. Using these credits earned in high school can decrease time spent in college. There are some problematic aspects of controlling for AP credits that stem from the variation in use of such credits by postsecondary institutions. Over 90 percent of four-year postsecondary institutions accept AP credits for college credit (College Board, 2014); however, the requirements for acceptance vary significantly by institution. For instance, "58 percent of public colleges give credit for a [AP] score of 3 [while] only 33 percent of private colleges accept this score" (Henshaw 2012). Furthermore, the acceptance of AP credits continues to shift at post-secondary institutions. There has been a recent push at elite institutions to stop the acceptance of AP scores for college credit (Ben-Achour 2013). Hours spent on paid work per week is also an important factor in any time to graduation analysis as studies repeatedly show that students who work more hours while simultaneously enrolled in college have lower grades and are less likely to complete college (Galbraith and Merrill 2015).

In this analysis I am only concerned with students that did complete a bachelor's degree and the time that they required to do so. As such this analysis is limited in sample and makes no statements about students who are non-completers. It is simply an analysis of duration for students who completed their degrees without taking any time off from attending college. By restricting the sample in such a way, there are self-selection issues as only the completing students in each quintile are considered.

Analysis 1: Does the regression effect of SAT on months to graduation vary across quintiles of the school mean SAT distribution?

To answer the question if the regression effect of SAT on months to graduation varies across quintiles of the school mean SAT distribution I first specified a model of months to degree completion presented in Equation 3.2. The model was run separately for each institutional quintile as well as for the pooled sample. See Chapter 2 for a detailed explanation of why analyses are conducted separately by quintile.

Equation 3.2. Regression of Cumulative College Grade Point Average on SAT and set of covariates, by institutional quintile

$$\begin{aligned} MonthstoBA_i = \; & Black\beta_1 + Hispanic\beta_2 + Asian\beta_3 + OtherRace\beta_4 + Male\beta_5 \\ & + ParenthasBA\beta_6 + ParentalIncome2003\beta_7 + ForeignBorn\beta_8 \\ & + HSGPA3.5 - 4.0\beta_9 + HSGPA3.0 - 3.4\beta_{10} + CalculusinHS\beta_{11} \\ & + STEMMajor\beta_{13} + PrivateCollege\beta_{13} + APCredits\beta_{13} \\ & + HoursWork\beta_{14} \end{aligned}$$

Omitted categories in cases where a variable is not binary are white, and HS GPA less than 3.0. In preliminary analyses, I tested for non-linear and non-additive relationships between SAT and the outcome variables. Within Quintiles 1 through 5 I found no non-linear or non-additive relationships. Second, I used a multiple partial F-test for regression to test for and estimate institutional quintile differences in basic model coefficients and intercepts. The analytic strategy and results of these F-tests are summarized in Table 3.9.

Table 3.8 presents the estimates of the determinants of months to bachelor's degree completion by institutional quintile for bachelor's degree completers. Demographic factors such as race and gender do not have a statistically significant effect on months to completion. The difference between Hispanic and White students time to degree completion is significant only at institutions in Quintile 2.   High school preparation, as measured by high school grades, has a significant effect on time to completion in Quintile 5 institutions, but not in the remaining institutions. Similarly, the use of AP credits has a significant effect only for Quintile 5 students and reduces time to completion by 1.62 months. Attending a Private as opposed to public postsecondary institution significantly reduces a students' time spent in college by as much as three to four months across all institutional quintiles. This result has been previously document and is likely due to course availability and resources at Private institutions (Choy, 1997).

Table 3.8. Determinants of Months to Bachelor's Degree Completion, BPS 04/09

			Institutional Quintile			
Independent Variables	**All**	**1**	**2**	**3**	**4**	**5**
Black	0.952	-0.726	3.167	0.937	0.496	1.230
	(0.932)	(2.063)	(2.469)	(2.328)	(2.633)	(1.560)
Hispanic	0.650	2.885	5.604*	0.967	-0.756	-1.862
	(1.003)	(2.650)	(3.024)	(2.486)	(2.161)	(1.545)
Asian	-0.122	-0.323	1.339	-0.758	0.772	-0.788
	(1.035)	(5.138)	(3.287)	(3.163)	(2.235)	(1.180)
Other	0.466	2.805	2.703	-1.566	-2.150	2.042
	(1.061)	(3.424)	(3.049)	(2.390)	(2.444)	(1.437)
Male	0.511	-0.0792	0.0529	1.688	1.265	0.385
	(0.464)	(1.407)	(1.214)	(1.088)	(1.006)	(0.708)
At least one parent has BA	-0.405	-1.610	1.096	0.110	-0.292	-1.267
	(0.521)	(1.439)	(1.256)	(1.133)	(1.148)	(1.017)
Parental Income, 2003	-1.52e-05***	-2.31e-05	-2.23e-05*	-1.24e-05	-4.72e-06	-1.56e-05***
	(4.26e-06)	(1.69e-05)	(1.27e-05)	(1.07e-05)	(9.91e-06)	(5.17e-06)
Foreign born	-1.272	-6.073*	-0.636	-0.407	-5.041**	2.256*
	(0.966)	(3.452)	(2.554)	(2.749)	(2.048)	(1.293)
HS GPA 3.5-4.0	-0.157	1.698	-1.321	-0.479	-0.0179	-4.411*
	(0.926)	(2.124)	(1.974)	(2.063)	(2.728)	(2.571)
HS GPA 3.0-3.4	0.154	2.555	1.145	-1.557	-0.627	-5.160*
	(0.923)	(2.002)	(1.859)	(2.048)	(2.805)	(2.675)
Pre-Calculus in HS	-0.461	-1.378	0.462	0.147	-1.322	0.444
	(0.536)	(1.443)	(1.246)	(1.164)	(1.188)	(1.122)
Student SAT Score (*100)	-0.0808	0.27	-0.356	0.12	-0.211	-0.278
	(0.00171)	(0.00545)	(0.00485)	(0.00438)	(0.00396)	(0.00294)
STEM Major	1.564***	0.168	-0.796	1.212	2.025*	3.131***
	(0.521)	(1.789)	(1.425)	(1.281)	(1.081)	(0.736)
Used AP Credits	-1.515***	-0.820	-1.667	-1.457	-1.233	-1.618**
	(0.520)	(1.732)	(1.447)	(1.192)	(1.072)	(0.800)
Number hours student worked per week, 2006	0.00139	-0.0238	0.00397	0.0385	0.0241	-0.0374
	(0.0210)	(0.0550)	(0.0499)	(0.0456)	(0.0475)	(0.0418)
Private Institution	-2.627***	-1.949	-4.017***	-4.111***	-2.440**	-0.916
	(0.459)	(1.411)	(1.310)	(1.029)	(0.998)	(0.815)
Constant	44.55***	41.91***	47.00***	42.49***	45.00***	49.74***
	(1.798)	(5.426)	(4.885)	(4.751)	(4.969)	(3.945)
N	3,011	448	569	558	702	734
R-squared	0.032	0.028	0.057	0.045	0.033	0.078

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Table by author

The estimate of the effect of SAT score on months to bachelor's degree completion is highlighted in Table 3.8. Student SAT score does not exert a statistically significant effect on time to graduation. However, students with higher SAT scores graduate sooner in Quintiles 2, 4, and 5. The differences depending on SAT score are slight. An academic quarter is approximately 10 weeks, which translates to 2.5 months. Looking at students in Quintile 3 institutions for example, a 2 month difference in time to graduation holding all other terms constant would require an SAT increase of around 600 points. The trend in Quintiles 1 and 3 is reverse where students with higher scores are more likely to take more months to complete their degrees. However, the estimate remains slight and statistically insignificant.

Table 3.9 summarizes the analyses and tests conducted to understand the extent to which intercepts, all model coefficients, and the coefficient of SAT in particular vary across quintiles.

Table 3.9. Covariance Analysis Tests for Months to Degree Completion

Interpretation	**Analysis Plan**	**d.f.**	**F-statistic**	**p-value**
Ho: Model does not fit data. The explanatory variables collectively do not have an effect on the response variable.	Regress months to degree completion on independent variables for all quintiles pooled.	16, 2994	6.10	0.0000
Ho: Intercepts do not vary across quintiles.	Regress months to degree completion on independent variables and dummy variables for quintile on all quintiles pooled.	4, 2986	0.6180	0.6497
Ho: Coefficients of independent variables do not differ across quintiles, after allowing intercepts to vary across quintiles.	Interact quintile dummies with all independent variables.	48, 2646	1.3862	0.0409
Ho: Coefficients of independent variables AND intercept do not differ across quintiles.	Interact quintile dummies with all independent variables.	50, 2944	1.3815	0.0398
Ho: Coefficient of SAT does not vary across quintiles when allowing all other coefficients and intercepts to vary across quintiles.	Interact quintile dummies with all independent variables except for SAT.	4, 2942	0.3887	0.8169

Source: Table by author

Row 1 of Table 3.9 tests the null hypothesis that the model does not fit the data. This hypothesis can be rejected at alpha 0.000. Rows 2 and 3 of Table 3.9 test for differences in intercepts and coefficients across quintiles respectively. I fail to reject the null hypothesis that the intercepts do not vary across quintiles. However, I can reject the null hypothesis that the coefficients of the independent variables do not differ across quintiles, after allowing intercepts to differ across quintiles. The F-test summarized in row 5 of Table 3.9 indicates that I fail to reject the hypothesis the coefficient of SAT in particular does not vary across quintiles after allowing for all other coefficients and intercepts to vary across quintiles. This means that a student who gains an additional 50 points on his SAT will not reduce or increase his months to graduation by more time in one quintile versus another. In sum, the effect of SAT on GPA does not vary across quintiles of the school mean distribution.

Analysis 2: Does the regression effect of SAT on GPA vary across quintiles of the school mean SAT distribution using Johnson-Neyman regions of significance approach?

Table 3.10 presents the significance tests using the Johnson-Neyman regions of significance approach which compares the extent to which the estimates for the effect of SAT are statistically different across sets of institutional quintiles. Unlike the results presented in Table 3.9 which only compare the five quintiles overall, this tests allows for more specific conclusions about which SAT coefficients are statistically significantly different. See the analysis for grade point average above for more detail about the Johnson-Neyman approach. Two of the SAT estimates across institutional quintiles are statistically significantly different from each other at alpha 0.05: Quintile 1 versus Quintile 2 and Quintile 2 versus Quintile 3.

Table 3.10. Results of significance tests on SAT coefficient between institutional quintiles (Unpaired t-test)

	Institutional Quintile				
Institutional Quintile	**1**	**2**	**3**	**4**	**5**
1		t=-1.96; p=0.050	t=-0.00; p=0.997	t=-0.38; p=0.708	t=-1.22; p=0.22
2			t=1.95; p=0.051	t=1.22; p=0.221	t=1.20; p=0.230
3				t=-0.67; p=0.510	t=-1.01; p=0.311
4					t=-0.37; p=0.709
5					

Note: p<.1. *p<.05.***p<.01** (two-tailed tests)
Source: Table by author

Because the SAT estimates are statistically different form each other in some quintiles but not others I can reject the null hypothesis tested in this section, which posits that on average and other things equal, the positive statistical effect of student SAT score on months to bachelor's degree completion does not vary with the mean SAT score of other students at the same college. The results indicate that in some cases, such as the case of Quintile 1 and Quintile 2 institutions, a student's 200 point gain on the SAT would produce a differing effect on the student's time to completion.

Analysis 3: Are quintile differences (or similarities) in mean of student months to graduation attributable to quintile differences in independent variable means or coefficients?

As in the analysis of cumulative grade point average above, I will present several scenarios of students adjusted months to bachelor's degree completion at institutions within different quintiles to understand what the results of this analysis mean practically. In other words, how would an average student in a given quintile perform if placed in another quintile? This analysis is contained to students who completed their bachelor's degree which means that the average student descriptive statistics presented in Table 3.2 cannot be used as that sample includes both college completers and non-completers. Table 3.11 presents the descriptive statistics of college completers by institutional quintile. These values will be used to calculate the predicted time to graduation for the average student at each institutional quintile.

Table 3.11. N, Means of Analysis Variables, selected standard deviations, by Quintiles of School Mean SAT Score Distribution

	Institutional Quintile				
	1	**2**	**3**	**4**	**5**
Black	0.14	0.07	0.05	0.04	0.06
Hispanic	0.10	0.04	0.05	0.06	0.06
Asian	0.02	0.03	0.03	0.06	0.10
Other	0.04	0.03	0.05	0.04	0.07
White	0.70	0.82	0.81	0.80	0.72
Male	0.36	0.44	0.38	0.40	0.44
Parent had BA	0.48	0.60	0.67	0.69	0.82
Household Income, 2003	$62,079	$72,188	$78,843	$83,528	$97,113
SD	$44,721	$48,417	$52,338	$55,938	$67,052
Foreign born	0.06	0.07	0.04	0.07	0.08
HS GPA 3.5-4.0	0.44	0.48	0.59	0.73	0.84
HS GPA 3.0-3.5	0.39	0.39	0.33	0.24	0.14
Pre-Calculus in HS	0.49	0.56	0.64	0.73	0.88
SAT	993	1057	1100	1152	1283
SD	155	145	143	145	145
STEM Major	0.18	0.23	0.24	0.34	0.36
Private Institution	0.28	0.28	0.46	0.51	0.73
AP Credits used (Yes/No)	0.21	0.23	0.33	0.39	0.62
Hours worked while in school, 2006	11.45	9.74	8.93	8.78	5.81
SD	12.31	11.84	10.99	10.62	8.78
N	605	757	789	904	908

Source: Table by author

Row 1 of Table 3.12 shows the unadjusted mean months to degree completions by institutional quintile, which is the true average months to degree completion for students attending institutions in that quintile. The average time to completion varies between 41.9 months to 39 months which is a difference of 2.9 months, corresponding roughly to a semester. The higher the institutional quintile the lower the time to completion. This is not a surprising finding considering the research on greater resources and focus on college persistence and retention at higher ranked institutions (Choy, 1997). Row 2 of Table 3.12 shows the predicted moths to degree completion for the average hypothetical Quintile 1 student if she attended a Quintile 1 institution as well as her predicted months to degree completion if she attended an institution in any other quintile. Row 3 of Table 3.12 is the hypothetical Quintile 3 student and months to degree completion in the various quintiles and so on.

Table 3.12. Raw and Adjusted Mean Months to Graduation Values by Quintile

	Institutional Quintile				
	1	2	3	4	5
Unadjusted Mean Months to Graduation	41.902	41.340	41.043	40.019	39.033
Adjusted Mean Months to Graduation					
Hypothetical Q1 Student	44.465	40.734	43.009	42.905	40.899
Hypothetical Q2 Student	40.734	41.969	41.653	37.193	34.768
Hypothetical Q3 Student	41.542	41.635	42.864	40.824	39.940
Hypothetical Q4 Student	39.610	37.193	38.822	38.244	38.728
Hypothetical Q5 Student	38.753	34.768	37.278	36.643	36.678

Source: Table by author

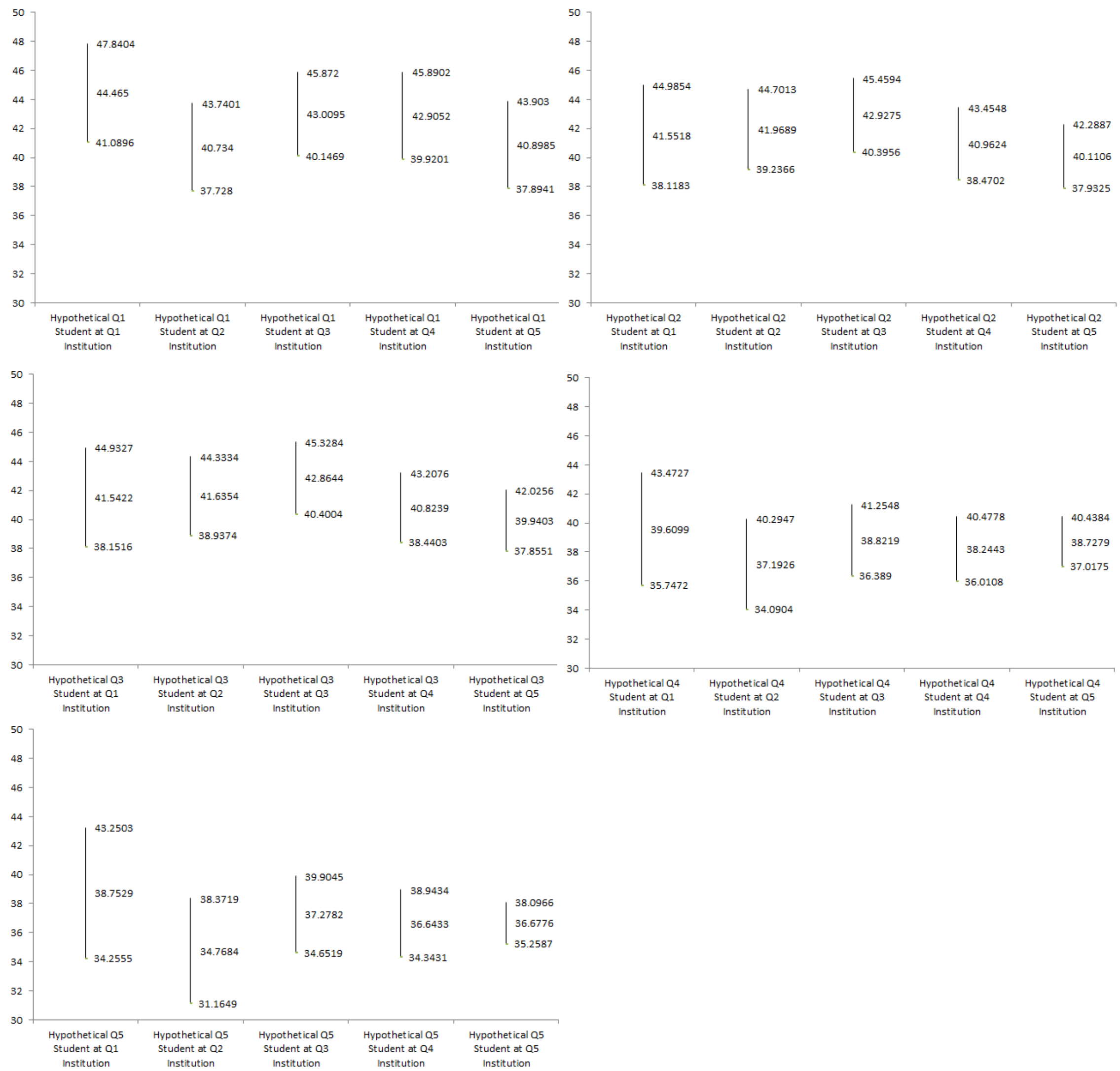
The hypothetical Quintile 1 student would complete her degree fastest if she attended a Quintile 2 institution. Hypothetical Quintile 2 and 3 students have the shortest time to degree completion if attending Quintile 5 institutions. Finally, hypothetical Quintile 5 and 4 students have the shortest time to degree if attending Quintile 2 institutions. Regarding the question whether or not students would complete their degrees sooner if attending an institution where the achieved peer ability is different than their own, as with the analysis on grades, the conclusion varies depending on institutional quintile considered. Hypothetical Quintile 5 and Quintile 4 students would complete their degree soonest at institutions where the average student has on average lower ability, while hypothetical Quintile 2, 3, and 1 students would complete their degree faster if attending an institution where their peers have higher ability on average.

Figure 3.2 shows the predicted months to degree completion for the hypothetical Quintile 1 through 5 student in each of the institutional quintiles with ninety five percent prediction bands. Each graph within Figure 3.2 depicts a row presented in Table 3.12 above with the corresponding significance interval. For instance, the first graph corresponds to Table 3.12, Row 2 (Hypothetical Quintile 1 Student). See the discussion in the GPA analysis above for more details on the method of calculating prediction bands.

As in the case of cumulative grade point average analysis presented above, while there are differences in predicted months to degree completion for the average hypothetical student in any given quintile, none of these are statistically significantly different. The overall trend indicates that attending an institution in a higher quintile reduces time to degree completion in most, though not all, scenarios. The lack of substantial differences in time to degree completion between quintiles is evident in both the coefficient and intercept tests presented in Table 3.9 (since I fail to reject the null hypothesis that the coefficients and intercepts do not vary across quintiles) and the adjusted months to graduation averages in Table 3.12.

These result indicate that holding constant other control variables, students in the US pursuing a four-year degree at a four-year institution without taking time off from the time of initial enrollment to graduation are completing their bachelor's degree in approximately the same amount of time regardless of what type of institution they attend. The greatest difference between Quintile 1 and Quintile 5 institutions in unadjusted mean months to graduation completion is two months, which is roughly one semester.

Figure 3.2. Adjusted Months to Bachelor's Degree Completion (Y) of Hypothetical Student with 95% Prediction Bands, by Quintile



Source: Figure by author

The finding that the differences between quintiles are not substantial is likely influenced by the fact that non-completers and students who take breaks from their education are excluded in the analysis. Recent research indicates that the time to degree completion is increasing for many postsecondary students due to the fact that students are taking time off from their education (Complete College, 2014). Students who are likely to take time off while pursuing the bachelor's degree are overrepresented in the bottom institution quintiles (Arum and Roksa, 2011), which means that excluding these students results in an incomplete picture of the enrollment parents of students in those quintiles.

MONTHS TO DEGREE COMPLETION ALTERNATIVE EXPLANATIONS

As is shown in Table 2.1, Quintile 5 institutions have the greatest per student expenditures, a variable highly correlated with institutional mean SAT score. Because of the financial resources they invest in students, these top institutions offer the most in terms of student support for successful completion (Hoxby and Avery, 2012). The services offered include things such as writing and tutoring centers, faculty mentoring and advising, and policies that in general make it easier for students to persist in college (Tinto, 2005). Furthermore, as in the case of grade point average, because of their elite status, Quintile 5 institutions are more likely to be concerned about rankings, which rely, among other things, on four-year graduation rates. The fact that postsecondary institution rankings are most important for elite institutions increases the focus of such institutions on the factors that make up their ranking calculations. The disparity in resources and support provided across institutional quintiles, as well the pressure for top institutions to maintain high graduation rates may influence the estimates and results in the above analyses.

SUMMARY: GRADES AND TIME TO DEGREE COMPLETION

The primary question of this chapter asks if the effect of student SAT score on GPA and months to degree completion varies with the mean SAT score of other students at the same postsecondary institution. The estimates and tests of significance presented in Tables 3.4, 3.5 for grade point average and 3.9 and 3.10 for months to graduation, suggest that there is not a statistically significant interaction between student SAT and mean institutional SAT when it comes to GPA, but there is a statistically significant interaction between student SAT and mean institutional SAT in the case of months to graduation when comparing Quintile 1 versus 2 and Quintile 2 versus 3 interaction estimates.

The question of whether or not the average (hypothetical) student in a given quintile would have a different GPA or time to completion if she attended an institution in another quintile is answered by results shown in Table 3.8 and Figure 3.1 and Table 3.12 and Figure 3.2. To sum up: for grade point average, students attending Quintile 5 institutions would have higher grades at lower quintile institutions, while Quintile 2, 3, and 4 students would have the lowest predicted grades at Quintile 5 institutions, and Quintile 1 students have the highest grades at Quintile 5 institutions. For months to completion, on the other hand, students in Quintile 1, Quintile 4, and Quintile 5 complete their degrees in fewer months at Quintile 2 institutions, students in Quintiles 2 and 3 complete their degrees in the shortest number of months at Quintile 5 institutions. These predictions lend support to previous research that finds mixed effects depending on ability grouping. For instance, as is summarized in Table 1.1 in Chapter 1, O'Mara and Marsh (2007) and Marsh and Hau (2003) find that high-achieving high school students attending high-achieving high schools develop a lower academic self-concept than if they attended schools with mixed achieving peers. On the other hand, the lowest achieving students have been found to benefit when in classrooms with high achieving peers (Justice, Petscher, Schatschneider, and Mashburn, 2011). However, it is important to note that none of the differences are statistically significant.

CHAPTER 4

EFFECTS OF PEER ACHIEVED ABILITY ON BACHELOR'S DEGREE COMPLETION, STEM MAJOR, AND EDUCATIONAL ASPIRATIONS

INTRODUCTION

In Chapter 3, I presented the hypotheses, analyses, and discussion of the effects of peer achieved ability on cumulative grade point average and time to degree completion. In this Chapter 4, I will present the hypotheses, analyses, and discussion of the effects of peer achieved ability on completing a bachelor's degree, selecting a STEM major, and experiencing a decrease in educational aspirations.

HYPOTHESES FOR BACHELOR'S DEGREE COMPLETION

College completion has been the primary outcome studied in literature on how the effects of student SAT score on college outcomes varies with the mean SAT score of students at the same college (Light & Strayer 2000, Alon & Tienda 2005, Long 2008). As outlined in Chapter 1, much of this research has focused on evaluating the mismatch hypothesis which posits that minority students admitted to higher education institutions where their own SAT scores are lower than that of the institutional mean SAT score would have higher chances of academic success (as measured by college completion, grades, etc.) if attending an institution where their peers have similar SAT scores. Prior research indicates that regardless of their own SAT scores, students are more likely to complete college at institutions that have higher average institutional SAT scores. On average and other things equal, a student's own SAT score has been found to have a positive statistical effect on a student's likelihood of completing college (Kobrin, Patterson, Shaw, Mattern, and Barbuti, 2008). After all, students who arrive at college with greater academic achievement are more likely to find the coursework manageable and complete their degree. In light of these previous findings, I consider the hypothesis that this positive effect for individuals is stronger at some schools than at others. That is, I consider the hypothesis that individual SAT scores interact with the average SAT of all students at the college that they attend. More formally,

> Ha: On average and other things equal, the positive statistical effect of student SAT score on the probability of college completion varies positively with the mean SAT score of students at the same college.
>
> Ho: On average and other things equal, the positive statistical effect of student SAT score on the probability of college completion does not vary with the mean SAT score of other students at the same college.

Table 4.1 below shows the plan of my analyses of likelihood of bachelor's degree completion in this chapter. I begin with an Analysis of Covariance of the effects of student SAT on the likelihood of college completion, by school mean student SAT quintile. This analysis will allow me to understand if the effect of SAT on the likelihood of bachelor's degree completion varies across the five quintiles of the school mean SAT distribution. Second, I use logistic regression standardization to distinguish interquantile likelihood of bachelor's degree completion (or similarities) due to quintile differences in independent variable means from interquintile likelihood of bachelor's degree completion due to quintile differences in independent variable coefficients.

Table 4.1. Analysis Plan for Bachelor's Degree Completion Analyses

Question Posed	Analysis	Tabulated Results	Unit of Analysis
1. Does the effect of SAT on likelihood of BA completion vary across quintiles of the school mean SAT distribution?	Logistic regression of BA completion on student SAT score and control variables, for entire sample, and by quintiles of the school mean SAT distribution	Table 4.3	Student and quintile of school mean SAT distribution
2. Are quintile differences (or similarities) in mean of likelihood of bachelor's degree completion attributable to quintile differences in independent variable means or coefficients?	Logistic regression standardization using estimated regression coefficients and means of independent variables for quintiles of the school mean SAT distribution.	Table 4.4 Figure 4.1	Student and quintile of school mean SAT distribution

Source: Table by author

ANALYSIS

The Dependent Variable: Measurement Details

Bachelor's degree completion is a binary outcome. Students who completed their bachelor's degree prior to the end of the BPS04/09 study in 2009 are marked as 1, competed degree, while students who did not complete a bachelor's degree by the end of the study are marked as 0. The data collection for BPS 04/09 followed students who started their postsecondary education in the Fall of 2003. The last time that data was collected for all students recruited to participate in the study is Fall 2009. Students had six years from the time of their initial enrollment in postsecondary education to complete a bachelor's degree. The fact that data collection did not continue after 2009 means that it is possible that some students who are marked as not having received a bachelor's degree did in fact complete their degree after the conclusion of the study. The variable as marking bachelor's degree was collected directly from student transcripts and coded by BPS04/09 personnel.

Analysis 1: Does the regression effect of SAT on the likelihood of bachelor's degree completion vary across quintiles of the school mean SAT distribution?

To answer the question if the logistic regression effect of SAT on the likelihood of bachelor's degree completion varies across quintiles of the school mean SAT distribution I first specified a model of the likelihood of bachelor's degree completion presented in Equation 4.1. The model was run separately for each institutional quintile as well as all quintiles pooled. See Chapter 2 for a detailed explanation of why analyses are conducted separately by quintile.

Equation 4.1. Logistic Regression of Bachelor's Degree Completion on SAT and set of covariates, by institutional quintile

$$P(O_i | q_i, S_i, F_i, I_i) = \frac{e^{(\beta qi + \beta Si + \beta Fi + \beta I + \varepsilon i)}}{1 + e^{(\beta qi + \beta Si + \beta Fi + \beta I + \varepsilon i)}}$$

In the equations above, O_i is the completion of a bachelor's degree during the study period, the outcome of interest. q is Student combined math and verbal SAT score (1600 scale), S is a set of student attributes (race, gender, SAT, participation in high school Pre-Calc/Pre-Calculus, high school grade point average, foreign born), F is a set of family attributes (at least one parent has college degree, household income in 2003), and I is a set of institution quality variables (private vs. public institution). Omitted categories in cases where a variable is not binary are white, and HS GPA less than 3.0. Please see Chapter 2 for a review of the importance of these variables in educational outcomes and the justification for the inclusion in these analyses. I used a chi square test to estimate institutional quintile differences in basic model coefficients and intercepts. The analytic strategy and results of these chi square tests are summarized in Table 4.3.

Table 4.2 presents the estimates of the logistic regression of college completion on individual student characteristics by institutional quintile. Note that for this study the sample is based on students who are beginning college within two years of completing high school and who are enrolling full-time at a four year institution. Students who begin postsecondary studies immediately after completing high school have greater likelihood of attaining a bachelor's degree than students who are adult learners (Pascarella & Terenzini 2005).

Table 4.2. Logistic Regression Coefficients (and Standard Errors) for Logistic Regression Analysis of Bachelor's Degree Completion, by Quintile of Mean Student SAT Score and Total, BPS 04/09

		Institutional Quintiles				
Independent Variables	**Pooled**	**1**	**2**	**3**	**4**	**5**
Black	-0.225	-0.275	-0.285	0.0335	-0.685	0.0169
	(0.146)	(0.229)	(0.361)	(0.383)	(0.465)	(0.587)
Hispanic	-0.607***	-0.0545	-0.979**	-0.557	-1.517***	-0.282
	(0.157)	(0.303)	(0.393)	(0.383)	(0.320)	(0.538)
Asian	-0.0453	-0.395	0.588	-0.849*	-0.384	-0.0984
	(0.210)	(0.589)	(0.674)	(0.468)	(0.426)	(0.461)
Other	-0.0196	-0.0864	-0.274	-0.190	0.672	0.112
	(0.210)	(0.409)	(0.454)	(0.420)	(0.754)	(0.640)
Male	-0.369***	-0.203	-0.291	-0.589***	-0.423*	-0.868***
	(0.0894)	(0.171)	(0.205)	(0.195)	(0.216)	(0.303)
At least one parent had BA	0.251***	0.278	-0.0878	0.207	0.322	0.499
	(0.0949)	(0.174)	(0.212)	(0.201)	(0.238)	(0.353)
Parental Income, 2003	3.53e-06***	2.78e-07	4.97e-06**	5.27e-06**	2.08e-06	2.53e-06
	(9.95e-07)	(1.92e-06)	(2.40e-06)	(2.27e-06)	(2.34e-06)	(2.59e-06)
Foreign born	-0.0886	-0.325	0.0299	-0.105	-0.370	0.0934
	(0.171)	(0.355)	(0.384)	(0.432)	(0.368)	(0.523)
HS GPA 3.5-40	1.080***	1.171***	1.198***	0.806**	1.030**	0.708
	(0.140)	(0.240)	(0.295)	(0.320)	(0.473)	(0.738)
HS GPA 3.5-4.0	0.463***	0.431**	0.572**	0.457	0.478	0.358
	(0.129)	(0.207)	(0.253)	(0.305)	(0.479)	(0.766)
Pre-Calculus in HS	0.219**	0.0804	0.547***	0.457**	-0.543**	-0.205
	(0.0962)	(0.177)	(0.208)	(0.205)	(0.268)	(0.451)
SAT	0.00146***	0.00128**	-0.000275	0.00109	-0.000354	0.00110
	(0.000308)	(0.000648)	(0.000781)	(0.000749)	(0.000766)	(0.00109)
STEM	-0.346***	-0.484**	-0.280	-0.537**	-0.0315	-0.420
	(0.100)	(0.207)	(0.234)	(0.223)	(0.230)	(0.293)
Private	0.369***	0.216	0.167	0.497**	-0.189	0.992***
	(0.0903)	(0.175)	(0.234)	(0.194)	(0.218)	(0.290)
Constant	-1.248***	-1.261**	0.636	-0.990	2.017**	0.112
	(0.304)	(0.627)	(0.770)	(0.793)	(0.923)	(1.292)
N	3,768	719	718	721	817	793

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Table by author

Excluding non-traditional and part-time students from the analysis thus restricts the sample to the students whose likelihood of completing a postsecondary degree is highest in the overall postsecondary student population. The results indicate that in line with previous research[1] on the relationship between race and college completion, minority students overall are less likely to complete a degree than white students. The results in Table 4.2 indicate that this is especially true for Hispanic students. Male students are significantly less likely to complete their degrees regardless of institutional quintile. High school preparation as measured by high school grade point average and participation in Pre-Calculus has a significant effect on the likelihood of completion. The estimate of the effect of SAT score on college completion is highlighted in Table 4.2. Holding constant other variables, student SAT score exerts a statistically significant effect on college completion for students in Quintile 1. For students in Quintiles 2 and 4, higher SAT scores decrease the likelihood of college completion, however, the results are not statistically significant and the effect is reverse for institutions in Quintiles 3 and 5.

Table 4.3. Covariance Analysis Tests for Bachelor's Degree Completion (ML Difference in Chi Square Test)

Interpretation	**Analysis Plan**	**d.f. difference**	**Chi2**	**p-value**
Ho: Model does not fit data. The explanatory variables collectively do not have an effect on the response variable.	Logistic Regression of BA completion on independent variables for all quintiles pooled.	14	395.00	0.000
Ho: Intercepts do not vary across quintiles.	Logistic Regression of BA completion on independent variables and dummy variables for quintile on all quintiles pooled.	4	64.64	0.000
Ho: Coefficients of independent variables do not differ across quintiles, after allowing intercepts to vary across quintiles.	Interact quintile dummies with all independent variables.	42	67.26	0.008
Ho: Coefficients of independent variables AND intercept do not differ across quintiles.	Interact quintile dummies with all independent variables.	46	131.9	0.000
Ho: Coefficient of SAT does not vary across quintiles when allowing all other coefficients and intercepts to vary across quintiles.	Interact quintile dummies with all independent variables except for SAT.	3	4.54	0.2088

Source: Table by author

[1] See Pascarella and Terenzini (2005) for a comprehensive overview of factors impacting the likelihood of college completion.

Row 1 of Table 4.3 tests the null hypothesis that the model presented in Equation 4.1 does not fit the data. This hypothesis can be rejected at alpha 0.000. Rows 2 and 3 of Table 4.3 show that there are statistically significant differences in intercepts and coefficients across quintiles respectively. The chi square test summarized in row 5 of Table 4.3 indicates that the coefficient of SAT in particular does not vary across quintiles after allowing for all other coefficients and intercepts to vary across quintiles. This means that, for instance, a student who gains an additional 50 points on his SAT will not increase his grade point average by more points in one quintile versus another.

Analysis 2: Are quintile differences (or similarities) in mean of student likelihood of bachelor's degree completion attributable to quintile differences in independent variable means or coefficients?

Table 4.4 presents the adjusted likelihood of completing a bachelor's degree for the average hypothetical student in each quintile, as well as the likelihood of that student completing a bachelor's degree if she attended an institution that falls in one of the other quintiles. Please see the review of adjusted means in Chapter 2 for a review of this method. Row 1 of Table 4.4 summarizes the average rate of bachelor's degree completion within each institutional quintile. As is expected in light of prior research on graduation rates, institutions with higher mean SAT scores, graduate more students (Pascarella & Terenzini 2005). Row 2 of Table 4.4 provides the adjusted mean likelihood of college completion for the average hypothetical student in Quintile 1 for each of the five institutional quintiles. See Table 3.2 for a summary of the average student in each quintile. For example, the average Quintile 1 student as depicted in the descriptive statistics in Table 3.2 is a white female with a high school grade point average between 3.0 and 3.4 who has not participated in high school Pre-Calculus and has a SAT score of 966.

Table 4.4. Raw and Adjusted Likelihood of Completing BA

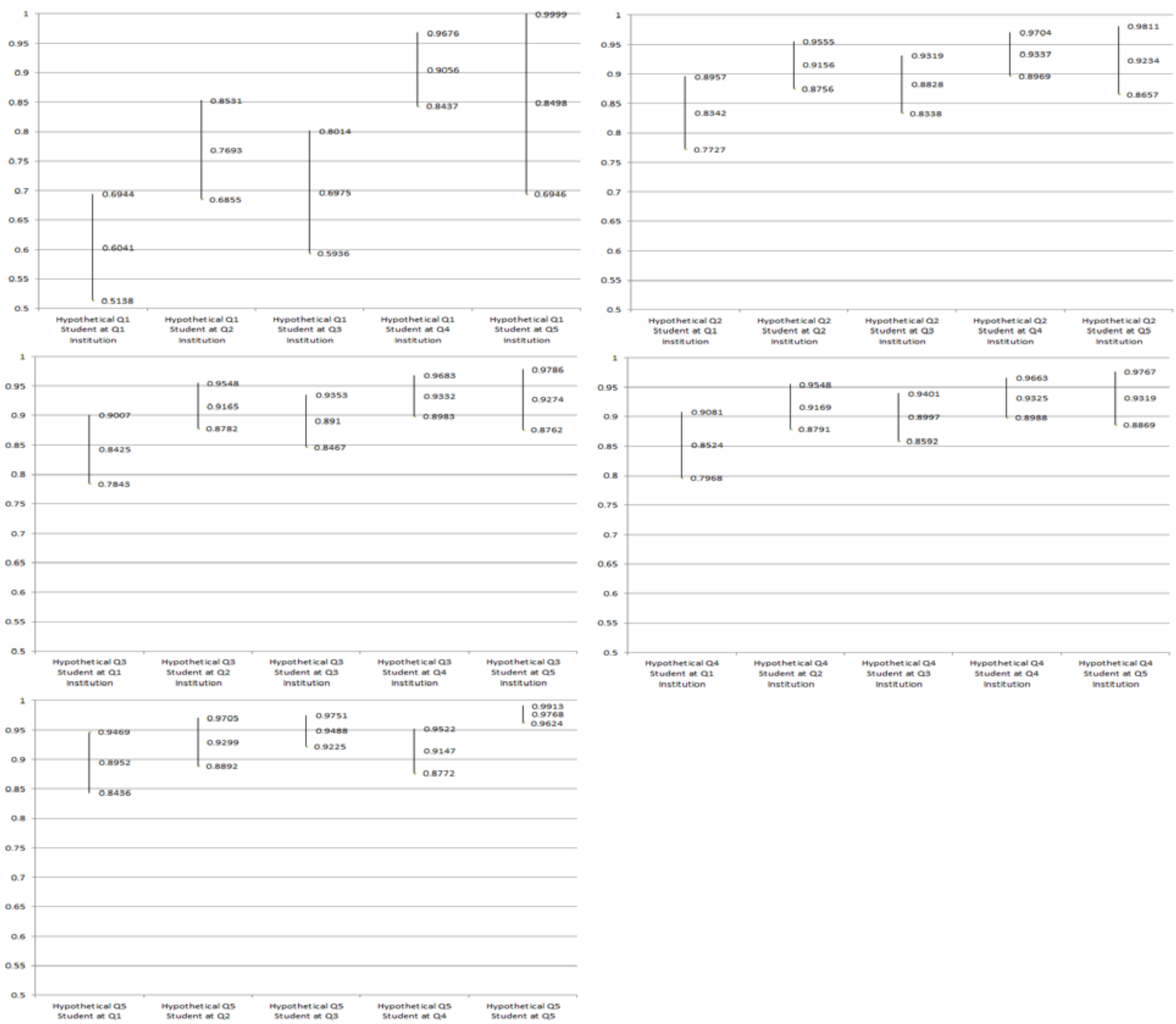
	Institutional Quintile				
	1	2	3	4	5
Unadjusted % students complete BA	53.65%	69.15%	71.63%	79.80%	90.00%
Adjusted mean likelihood of BA completion					
Hypothetical Q1 Student	60.41%	76.93%	69.75%	90.56%	84.98%
Hypothetical Q2 Student	83.42%	91.56%	88.28%	93.37%	92.34%
Hypothetical Q3 Student	84.25%	91.65%	89.10%	93.32%	92.74%
Hypothetical Q4 Student	85.24%	91.69%	89.97%	93.25%	93.19%
Hypothetical Q5 Student	89.52%	92.99%	94.88%	91.47%	97.68%

Source: Table by author

Neither of her parents has completed a college degree and their average household income was $59,360 in 2003. The hypothetical Quintile 1 student would have the best chance of completing her degree if she attended an institution in Quintile 4 (90.56%) and the lowest if she attended a Quintile 1 institution (60.41%), indicating that having on average higher able peers would not decrease the likelihood of graduation for the lowest ability students, but would in fact increase it. The same is true for the hypothetical Quintile 2 and Quintile 3 students whose likelihood of graduating is highest at Quintile 4 institutions. For all of the hypothetical students, the likelihood of completing a bachelor's is lowest at Quintile 1 institutions. Both Quintile 4 and Quintile 5 students have the highest predicted likelihood of completing their degrees if attending an institution that falls into their own quintile. Though for the hypothetical Quintile 4 students the difference in likelihood of college completion at Quintile 4 or Quintile 5 institutions is only slight at 0.06 percent. While Quintile 1, 2, and 3 students have a higher likelihood of graduating in institutions where peers have on average higher ability, Quintile 4 and Quintile 5 students have the best chances of completing their education if attending an institution where peers have similar ability.

Figure 4.1 shows the predicted likelihood of Bachelor's degree completion for the hypothetical Quintile 1 through 5 students in each of the institutional quintiles with ninety five percent prediction bands. Each graph within Figure 4.1 depicts a row presented in Table 4.3 above with the corresponding significance interval. See Chapter 3 for an explanation of how prediction bands are calculated.

Figure 4.1. Adjusted Likelihood of Bachelor's Degree Completion (Y) of Hypothetical Student with 95% Prediction Bands, by Quintile



Source: Figure by author

For the hypothetical Quintile 1 students, the predicted likelihood of graduating is significantly higher in Quintile 2, Quintile 4, and Quintile 5 compared to Quintile 1. For hypothetical Quintile 2 and Quintile 3 students the predicted likelihood of college graduation is significantly higher in Quintile 4 in comparison to Quintile 1. In the case of hypothetical Quintile 5 students, the likelihood of completion is significantly higher in Quintile 5 in comparison to Quintile 1 and Quintile 4.

BACHELOR’S DEGREE COMPLETION ALTERNATIVE EXPLANATIONS

As has been discussed in the analysis of grade point average in Chapter 3, student grades and overall degree completion rates make up a portion of many popular rankings systems. Rankings are increasingly gaining prominence and importance in student college decision making (Meredith, 2004), and there are institutional pressures to improve those statistics that are important in ranking systems (Saunder and Espeland, 2009). Private institutions, especially those that participate in ranking systems, have considerably greater resources and programing aimed at student retention and persistence. The focus on rankings may additionally increase pressure to graduate all students at top institutions concerned about their rankings and thus affects the coefficients the models used to predict graduation rates.

HYPOTHESES FOR STEM MAJOR COMPLETION

The effect of peer ability on the likelihood of selecting a STEM major has not been a focus of previous research on how undergraduates choose major fields. However, as discussed in Chapter 1, in studies on the effects of affirmative action on minority student’s choice of major (Arcidiacono, Aucejo, and Hotz, 2013) findings show that minority students, who on average are of lower measured ability than their peers, express just as much interest in a STEM major as white students but are almost 50 percent less likely to complete a STEM degree. Furthermore, as

Arcidiacono, Aucejo, and Hotz (2013) find that minority students who were admitted to institutions serving students that have on average higher ability because of affirmative action practices, "would be more likely to graduate with a science degree and graduate in less time had they attended the lower ranked university" (Arcidiacono, Aucejo, and Hotz 2013, page 1). These findings lead to the hypothesis that students whose ability is higher than that of their peers are more likely to complete a STEM major, while those whose ability is lower are less likely to do so. More formally, this research leads to the hypothesis that:

> Ha: On average and other things equal, the positive statistical effect of student SAT score on the probability of majoring in a STEM field varies with the mean SAT score of students at the same college.
>
> Ho: On average and other things equal, the positive statistical effect of student SAT score on the probability of majoring in a STEM field does not vary with the mean SAT score of other students at the same college.

Table 4.5 below shows the plan of my analyses of STEM major selection in this chapter. I begin with an Analysis of Covariance of the effects of student SAT on the likelihood of STEM major selction, by school mean student SAT quintile, followed by the standardized regression which will indicate how the predicted likelihood of STEM major selection changes as average students from each quintile are placed in the environment of an institution in a different quintile. This analysis plan is identical to the one utilized for completion of bachelor's degree in the preceding section.

Table 4.5. Analysis Plan for STEM Major Analyses

Question Posed	Analysis	Tabulated Results	Unit of Analysis
1. Does the effect of SAT on likelihood of STEM major selection vary across quintiles of the school mean SAT distribution?	Logistic regression of STEM major selection on student SAT score and control variables, for entire sample, and by quintiles of the school mean SAT distribution	Table 4.6	Student and quintile of school mean SAT distribution
2. Are quintile differences (or similarities) in mean of likelihood of STEM major selection attributable to quintile differences in independent variable means or coefficients?	Logistic regression standardization using estimated regression coefficients and means of independent variables for quintiles of the school mean SAT distribution.	Table 4.7 Figure 4.2	Student and quintile of school mean SAT distribution

Source: Table by author

ANALYSIS

The Dependent Variable: Measurement Details

STEM Major is a binary variable where students who majored in a STEM field are marked as having a 1, while students who did not are marked as STEM major are marked as 0. A major is classified as belonging in the Science, Technology, Engineering, and Math fields if it falls in the National Science Foundation classification of STEM programs (NSF 11-316, 2011). BPS 03/09 personnel coded the student major from transcripts collected between 2003 and 2009.

Analysis 1: Does the logistic regression effect of SAT on STEM Major vary across quintiles of the school mean SAT distribution?

To answer the question if the logistic regression effect of SAT on the likelihood of STEM Major selection varies across quintiles of the school mean SAT distribution I first specified a model of STEM major selection presented in Equation 4.2. The model was run both pooled and separately for each institutional quintile. See Chapter 2 for a detailed explanation of why analyses are conducted separately by quintile.

Equation 4.2. Logistic Regression of STEM Major on SAT and set of covariates, by institutional quintile

$$P(O_i|\, q_i, S_i, F_i, I_i) = \frac{e^{(\beta qi+\beta Si+\beta Fi+\beta I+\varepsilon i)}}{1+\ e^{(\beta qi+\beta Si+\beta Fi+\beta I+\varepsilon i)}}$$

In the equation above, O_i is the selection of a STEM major, the outcome of interest. q is Student combined math and verbal SAT score (1600 scale), S is a set of student attributes (race, gender, SAT, participation in high school Pre-Calc/Pre-Calculus, high school grade point average, foreign born), F is a set of family attributes (at least one parent has college degree, household income in 2003), and I is a set of institution quality variables (private vs. public institution). Table 4.5 presents the estimates of the logistic regression of college completion on individual student characteristics by institutional quintile. As has been shown in prior research, male students are significantly more likely to complete a STEM major in all institutional quintiles. Parental education is a statistically significant predictor of the likelihood of STEM major in Quartile 4 and 5, however the results ae opposite. In Quintile 4 students who have at least one parent who has completed a BA are more likely to complete a STEM major, whereas in Quintile 5 students who have at least one parent with a bachelor’s are less likely to complete a STEM major than students who do not have a parent with a bachelor’s degree. Incoming achievement is more important in STEM major completion than in the other outcomes analyzed in this study. Students who have participated in high school Pre-Calculus are significantly more likely to complete the STEM major.

Table 4.6. Logistic Regression Coefficients (and Standard Errors) for Logistic Regression Analysis of Likelihood of STEM Major, by Quintile of Mean Student SAT Score and Total, BPS 04/09

		Institutional Quintiles				
Independent Variables	**Pooled**	**1**	**2**	**3**	**4**	**5**
Black	0.391**	0.498*	0.561	0.567	0.632	-0.244
	(0.152)	(0.278)	(0.382)	(0.412)	(0.401)	(0.370)
Hispanic	0.346**	0.601*	0.913**	-0.316	0.572*	-0.0710
	(0.155)	(0.340)	(0.401)	(0.456)	(0.301)	(0.343)
Asian	0.615***	-1.282	0.693	0.251	1.419***	0.368
	(0.162)	(1.071)	(0.498)	(0.472)	(0.344)	(0.251)
Other	0.153	0.295	0.162	0.792**	-0.279	0.0308
	(0.179)	(0.473)	(0.479)	(0.392)	(0.421)	(0.324)
Male	0.717***	0.731***	0.947***	0.892***	0.647***	0.528***
	(0.0773)	(0.196)	(0.196)	(0.191)	(0.157)	(0.156)
At least one parent had BA	0.0934	0.0580	-0.00487	0.272	0.415**	-0.369*
	(0.0883)	(0.206)	(0.205)	(0.207)	(0.187)	(0.217)
Parental Income, 2003	-9.63e-07	-1.65e-06	2.32e-06	-8.32e-07	-1.63e-06	-9.28e-07
	(7.40e-07)	(2.43e-06)	(2.03e-06)	(1.96e-06)	(1.65e-06)	(1.20e-06)
Foreign born	0.367**	-0.186	0.309	1.014**	-0.0650	0.512*
	(0.149)	(0.441)	(0.368)	(0.408)	(0.313)	(0.279)
HS GPA 3.5-4.0	0.361**	0.0224	0.251	0.836**	0.475	0.735
	(0.155)	(0.288)	(0.311)	(0.415)	(0.466)	(0.662)
HS GPA 3.0-3.4	0.0770	-0.0157	0.0392	0.641	-0.0669	0.288
	(0.155)	(0.266)	(0.296)	(0.412)	(0.483)	(0.688)
Pre-Calculus	0.806***	1.013***	0.823***	0.926***	0.634***	0.546*
	(0.0963)	(0.206)	(0.209)	(0.225)	(0.201)	(0.280)
SAT*100	0.140***	0.0890	0.219***	0.194***	0.184***	0.120**
	(0.000265)	(0.000749)	(0.000730)	(0.000739)	(0.000588)	(0.000609)
Private	-0.0759	0.226	-0.195	0.0880	-0.223	-0.0773
	(0.0784)	(0.200)	(0.218)	(0.186)	(0.160)	(0.176)
Constant	-3.745***	-3.231***	-4.887***	-5.347***	-4.099***	-3.150***
	(0.286)	(0.749)	(0.775)	(0.868)	(0.786)	(0.920)
N	3,768	719	718	721	817	793

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Table by author

The effect of student SAT scores is highlighted in Table 4.6. For students attending institutions falling in Quintiles 2, 3, 4, and 5 SAT scores have a significant effect on the likelihood of STEM major completion. In Quintile 3 for instance, one additional point of the SAT increases the likelihood of a student completing a STEM major by 0.194 percent.

Table 4.7. Covariance Analysis Tests for STEM Major Selection (ML Difference in Chi Square Test)

Interpretation	Analysis Plan	d.f.	Chi square	p-value
Ho: Model does not fit data. The explanatory variables collectively do not have an effect on the response variable.	Logistic Regression of STEM major on independent variables for all quintiles pooled.	13	367.25	0.000
Ho: Intercepts do not vary across quintiles.	Logistic Regression of STEM major on independent variables and dummy variables for quintile on all quintiles pooled.	4	8.84	0.0652
Ho: Coefficients of independent variables do not differ across quintiles, after allowing intercepts to vary across quintiles.	Interact quintile dummies with all independent variables.	39	62.6	0.0096
Ho: Coefficients of independent variables AND intercept do not differ across quintiles.	Interact quintile dummies with all independent variables.	43	71.44	0.0040
Ho: Coefficient of SAT does not vary across quintiles when allowing all other coefficients and intercepts to vary across quintiles.	Interact quintile dummies with all independent variables except for SAT.	3	2.33	0.50768

Source: Table by author

The hypotheses in this section posits that student SAT score varies with the mean institutional SAT score. Analysis of covariance results presented in Table 4.7 suggests that this is not the case. Row 1 of Table 4.7 tests the null hypothesis that the model does not fit the data. This hypothesis can be rejected at alpha 0.000. Rows 2 and 3 of Table 4.7 show that there are not statistically significant differences in intercepts at alpha 0.05 but there are statistically significant differences in coefficients across quintiles respectively. The chi squared test summarized in row 5 of Table 4.6 indicates that the coefficient of SAT in particular does not vary across quintiles after allowing for all other coefficients and intercepts to vary across quintiles.

Analysis 2: Are quintile differences (or similarities) in likelihood of STEM Major attributable to quintile differences in independent variable means or coefficients?

Standardized logistic regression allows for an understanding of how the probability of selecting a STEM major would change if the average student in any given quintile were to attend an institution in a different quintile. Row 1 of Table 4.8 shows the unadjusted percent of students selecting a STEM major by institutional quintile. Row 2 of Table 4.8 shows the predicted likelihood of the average hypothetical Quintile 1 student selecting a STEM major if she attended a Quintile 1 institution as well as her predicted likelihood of selecting a STEM major if she attended an institution in any other quintile. The predicted likelihood of selecting a STEM major is lowest for the hypothetical Quintile 1 student at a Quintile 3 institution (5.21%) and highest at a Quintile 5 institution (14.22%). For hypothetical students in Quintiles 2, 3, 4, and 5 the highest predicted likelihood of completing a STEM major is if attending a Quintile 4 institution. As in preceding analyses this result indicates that for the lowest ability students, being around peers who have on average higher ability results in greater likelihood of STEM completion. In this analysis, the same principle is true for hypothetical Quintile 2 and 3 students since these two groups are also more likely to major in STEM if surrounded by more able peers. In the case of top ability students, represented by the hypothetical Quintile 5 students, the likelihood of selecting a STEM major is highest if attending an institution where students are slightly less able as in Quintile 4.

Table 4.8. Raw and Adjusted Likelihood of STEM Major

	Institutional Quintile				
	1	2	3	4	5
Unadjusted % students STEM Major	20.80%	24.70%	25.10%	35.00%	36.40%
Adjusted Mean likelihood of STEM Major					
Hypothetical Q1 Student	7.43%	6.89%	5.21%	7.89%	14.22%
Hypothetical Q2 Student	20.97%	20.06%	20.31%	31.07%	25.71%
Hypothetical Q3 Student	21.40%	21.95%	21.74%	32.72%	26.68%
Hypothetical Q4 Student	22.02%	24.43%	23.67%	34.94%	27.99%
Hypothetical Q5 Student	27.41%	26.72%	30.09%	35.03%	29.69%

Source: Table by author

Figure 4.2 shows the predicted likelihood of selecting a STEM major for the hypothetical Quintile 1 through Quintile 5 students in each of the institutional quintiles with ninety five percent prediction bands. Each graph within Figure 4.2 depicts a row presented in Table 4.8 above with the corresponding significance interval. As is evident when comparing the predicted likelihood of STEM major for a hypothetical student across the quintiles, while the likelihood of selecting STEM major does differ depending on which Quintile institution a student is placed in, none of the differences are statistically significant.

ALTERNATIVE EXPLANATIONS FOR STEM MAJOR SELECTION

A possibility of why some students may be more likely to pursue STEM majors in some institutional quintiles versus others could be due to differences of STEM major availability by institutional quintile. For instance, it is possible that institutions falling into Quintile 4 are more likely to offer a wider range of STEM majors than institutions that fall into the other quintiles. A comprehensive analysis of differences in majors offered across institutional quintiles is beyond the scope of this study, but in the event that there are differences, these differences may affect the results presented here.

Figure 4.2. Adjusted Likelihood of STEM Major (Y) of Hypothetical Student with 95% Prediction Bands, by Quintile

Source: Figure by author

HYPOTHESES FOR DECREASE IN EDUCATIONAL ASPIRATIONS

Educational aspirations have an effect on academic outcomes (Sewell et. al., 1969; Campbell, 1983). This finding makes intuitive sense, as a student who aspires to attend college is more likely to do so than a student who does not aspire to attend college. The factors most frequently discussed in the development of student aspirations are socioeconomic background, race, and gender (Gurin and Epps, 1975; Gottfredson, 1981; Kao, 1995; Duran and Weffer 1992). While these factors play primary roles in the development of aspirations and attainment of educational goals, another factor that has been found to exert influence on student aspirations is the match between the student's academic ability and the academic ability of the student's peers (see review by Marsh, 2007). Research on this has garnered mixed results with some finding that students whose peers have higher ability are more likely to develop a poor self-concept and lower their academic aspirations (Marsh and Hau, 2003) and others finding the opposite, that more able peer increase motivation and aspirations overall (Pascarella, 1985). While the effects of peer and student ability match on the educational aspirations of elementary and secondary students have received attention in recent years, these effects have largely been neglected in postsecondary education. To understand the ways in which student and peer ability interact to affect educational aspirations in college, I will test the hypothesis that:

Ha: On average and other things equal, the positive statistical effect of student SAT score on the probability of experiencing a decrease in educational aspirations during college varies with the mean SAT score of students at the same college.

Ho: On average and other things equal, the positive statistical effect of student SAT score on the probability of experiencing a decrease in educational aspirations during college does not vary with the mean SAT score of other students at the same college.

Table 4.9. Analysis Plan for Decrease in Educational Aspirations Analyses

Question Posed	Analysis	Tabulated Results	Unit of Analysis
1. Does the effect of SAT on likelihood of decrease in educational aspirations completion vary across quintiles of the school mean SAT distribution?	Logistic regression of decrease in educational aspirations on student SAT score and control variables, for entire sample, and by quintiles of the school mean SAT distribution	Table 4.9	Student and quintile of school mean SAT distribution
2. Are quintile differences (or similarities) in likelihood of decrease in educational aspirations attributable to quintile differences in independent variable means or coefficients?	Regression standardization using estimated regression coefficients and means of independent variables for quintiles of the school mean SAT distribution.	Table 4.10 Figure 4.3	Student and quintile of school mean SAT distribution

Source: Table by author

ANALYSIS

The Dependent Variable: Measurement Details

Decrease in educational aspirations is a binary variable where students that experienced a decrease in educational aspirations are marked as 1, and students whose educational aspirations increased or remained static are marked as 0. The decrease in educational aspirations is measured between the initial year of college attendance, 2003-04 and three years after college attendance, 2006. In 2003 and 2006 students participating in the BPS 04/09 were asked, "What is the highest degree you expect to attain?" The answer options were: Certificate, Bachelor's degree, Post-BA or post-master certificate, Master's degree, Doctoral degree, First-professional degree. A student is coded as having experienced a decrease in future educational aspirations if his answer three years post college entry is a lower educational level than the answer he gave in his first year. If his answer three years post college is higher than or same as the answer in his first year he is coded as not having experienced decrease in future educational aspirations. For this purpose, a doctoral degree and first-professional degree are coded as the same level of education so that if a student decides to pursue a first-professional degree in 2003 and a doctorate in 2006, that change is not considered a decrease in educational aspirations.

Analysis 1: Does the logistic regression effect of SAT on the likelihood of decrease in educational aspirations vary across quintiles of the school mean SAT distribution?

To answer the question if the logistic regression effect of SAT on the likelihood of experiencing a decrease in educational aspiration varies across quintiles of the school mean SAT distribution I first specified a model of decrease in educational aspiration presented in Equation 4.3. The model was run both pooled and separately for each institutional quintile. See Chapter 2 for a detailed explanation of why analyses are conducted separately by quintile.

Equation 4.3. Logistic Regression of Decline in Educational Aspirations on SAT and set of covariates, by institutional quintile

$$P(O_i |\, q_i, S_i, F_i, I_i) = \frac{e^{(\beta qi+\beta Si+\beta Fi+\beta I+\varepsilon i)}}{1+\ e^{(\beta qi+\beta Si+\beta Fi+\beta I+\varepsilon i)}}$$

In the equations above, O_i is the decrease in educational aspirations, the outcome of interest. q is Student combined math and verbal SAT score (1600 scale), S is a set of student attributes (race, gender, SAT, participation in high school Pre-Calc/Pre-Calculus, high school grade point average, foreign born), F is a set of family attributes (at least one parent has college degree, household income in 2003), and I is a set of institution quality variables (private vs. public institution).

Table 4.10 presents coefficient estimates for the logistic regression of decline in educational aspirations on student characteristics by institutional quintile presented in Equation 4.3. The unit of analysis in each regression is the individual student. The factors that have a significant effect on decrease in educational aspirations vary by institutional quintile.

Table 4.10. Logistic Regression Coefficients (and Standard Errors) for Logistic Regression Analysis of the Likelihood of Decrease in Educational Aspirations, by Quintile of Mean Student SAT Score and Total, BPS 04/09

		Institutional Quintiles				
Independent Variables	**Pooled**	**1**	**2**	**3**	**4**	**5**
Black	-0.106	-0.178	0.263	-0.621**	0.240	-0.386
	(0.117)	(0.201)	(0.272)	(0.311)	(0.313)	(0.341)
Hispanic	0.0982	-0.0772	0.796***	-0.171	-0.197	0.0782
	(0.121)	(0.240)	(0.285)	(0.312)	(0.265)	(0.305)
Asian	-0.225	-0.00207	-0.355	-0.967**	-0.504*	0.101
	(0.151)	(0.454)	(0.466)	(0.455)	(0.298)	(0.251)
Other	0.0284	-0.190	0.645*	-0.266	0.0702	-0.0403
	(0.141)	(0.324)	(0.331)	(0.316)	(0.332)	(0.297)
Male	0.106*	-0.0277	0.145	0.305**	0.105	-0.0129
	(0.0620)	(0.138)	(0.142)	(0.141)	(0.135)	(0.147)
At least one parent has BA	-0.0914	0.113	-0.253*	-0.0242	-0.210	-0.113
	(0.0678)	(0.141)	(0.150)	(0.148)	(0.148)	(0.204)
Parental Income, 2003	-8.04e-07	-6.94e-07	-7.69e-07	-3.00e-06**	-1.27e-06	1.09e-06
	(6.06e-07)	(1.54e-06)	(1.54e-06)	(1.51e-06)	(1.33e-06)	(1.11e-06)
Foreign born	0.0972	-0.294	-0.150	0.289	0.520**	0.0104
	(0.129)	(0.305)	(0.303)	(0.343)	(0.255)	(0.284)
HS GPA 3.5-4.0	-0.269***	-0.384**	-0.401*	-0.367	-0.0958	0.132
	(0.104)	(0.190)	(0.212)	(0.235)	(0.310)	(0.508)
HS GPA 3.0-3.4	-0.225**	-0.197	-0.330*	-0.258	-0.114	0.0373
	(0.100)	(0.168)	(0.195)	(0.230)	(0.319)	(0.529)
Pre-Calculus	-0.0589	-0.134	-0.0788	0.0727	-0.268*	0.187
	(0.0683)	(0.140)	(0.147)	(0.147)	(0.151)	(0.234)
SAT*100	-0.0383*	-0.0619	-0.0730	-0.0696	-0.0195	-0.0994*
	(0.000213)	(0.000501)	(0.000557)	(0.000537)	(0.000489)	(0.000569)
Private	-0.0581	-0.0804	0.0774	-0.163	-0.163	-0.0344
	(0.0618)	(0.139)	(0.154)	(0.137)	(0.134)	(0.165)
Constant	-0.0839	0.236	-0.499	0.435	-0.0764	-0.00977
	(0.211)	(0.487)	(0.551)	(0.570)	(0.574)	(0.751)
N	5,352	1,067	1,086	1,061	1,138	1,000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Table by author

Race is a significant predictor in Quintiles 2, 3, and 4. However, in Quintile 2 Hispanic students are more likely to decrease their aspiration that White students, while in Quintiles 3 and 4 Black and Asian students are less likely to decrease their aspiration than White students. Males are more likely to experience a decrease in aspirations in Quintile 3 in comparison to females.

Across the quintiles student SAT score has an inverse relationship with the likelihood of a decline in aspirations so that the higher the SAT score, the less likely it is that the student will experience a decline in aspirations. The effect is statistically significant for students attending Quintile 5 institutions.

Table 4.11. Covariance Analysis Tests for Decrease in Educational Aspirations

Interpretation	**Analysis Plan**	**d.f. difference**	**Chi Square**	**p-value**
Ho: Model does not fit data. The explanatory variables collectively do not have an effect on the response variable.	Regress GPA on independent variables for all quintiles pooled.	13	43.72	0.0067
Ho: Intercepts do not vary across quintiles.	Regress GPA on independent variables and dummy variables for quintile on all quintiles pooled.	4	7.46	0.113
Ho: Coefficients of independent variables do not differ across quintiles, after allowing intercepts to vary across quintiles.	Interact quintile dummies with all independent variables.	39	50.81	0.0975
Ho: Coefficients of independent variables AND intercept do not differ across quintiles.	Interact quintile dummies with all independent variables.	43	58.27	0.0601
Ho: Coefficient of SAT does not vary across quintiles when allowing all other coefficients and intercepts to vary across quintiles.	Interact quintile dummies with all independent variables except for SAT.	3	1.92	0.5892

Source: Table by author

Table 4.11 summarizes the analyses and tests conducted to understand the extent to which intercepts, all model coefficients, and the coefficient of SAT in particular vary across quintiles. Row 1 of Table 4.11 tests the null hypothesis that the model does not fit the data. This hypothesis can be rejected at alpha 0.05. Rows 2, 3, and 4 of Table 4.11 show that there are no statistically significant differences in intercepts and coefficients across quintiles respectively. The chi square summarized in row 5 of Table 4.11 indicates that the coefficient of SAT also does not vary across quintiles after allowing for all other coefficients and intercepts to vary across quintiles.

Analysis 2: Are quintile differences (or similarities) in likelihood of decline in aspirations attributable to quintile differences in independent variable means or coefficients?

As the tests in Table 4.11 show, neither the coefficients nor the intercepts are statistically significantly different across the five institutional quintiles at alpha 0.05. Because of this lack of difference it is not necessary to estimate separate models for the different quintiles if the outcome is decline in educational aspirations. Nonetheless, to see how the average predictions of likelihood vary across the quintiles for the hypothetical average student in each quintile, it is useful to calculate the predicted value of the likelihood of experiencing a decline in educational aspirations for the average hypothetical students in each quintile. Row 1 of Table 4.12 shows the unadjusted percent of students experiencing a decrease in educational aspirations by institutional quintile. Students in Quintile 5 institutions are least likely to experience a decline in educational aspirations, while students in Quintile 1 are most likely to experience it. This follows the similar pattern of previous outcomes in this study as the higher quintile has the more desirable outcome while the lowest quintile has the least desirable outcome. Row 2 of Table 4.12 shows the predicted likelihood of the average hypothetical Quintile 1 student experiencing a decline in educational aspirations if she attended a Quintile 1 institution as well as her predicted likelihood of experiencing a decline in educational aspirations if she attended an institution in any other quintile. The hypothetical Quintile 2, 3, 4, and 5 students are all most likely to experience a decline in educational aspirations if attending a Quintile 5 institution. All hypothetical students are least likely to experience a decline in educational aspirations at a Quintile 2 institution.

The hypothetical Quintile 1 student is most likely to experience a decline in educational aspirations if attending a Quintile 4 institution, closely followed by a Quintile 1 institution. The overall trend does not, however, show that students are progressively more likely to experience a decline in educational aspirations if attending institutions with higher mean ability students.

Table 4.12. Raw and Adjusted Likelihood of Decrease in Educational Aspirations

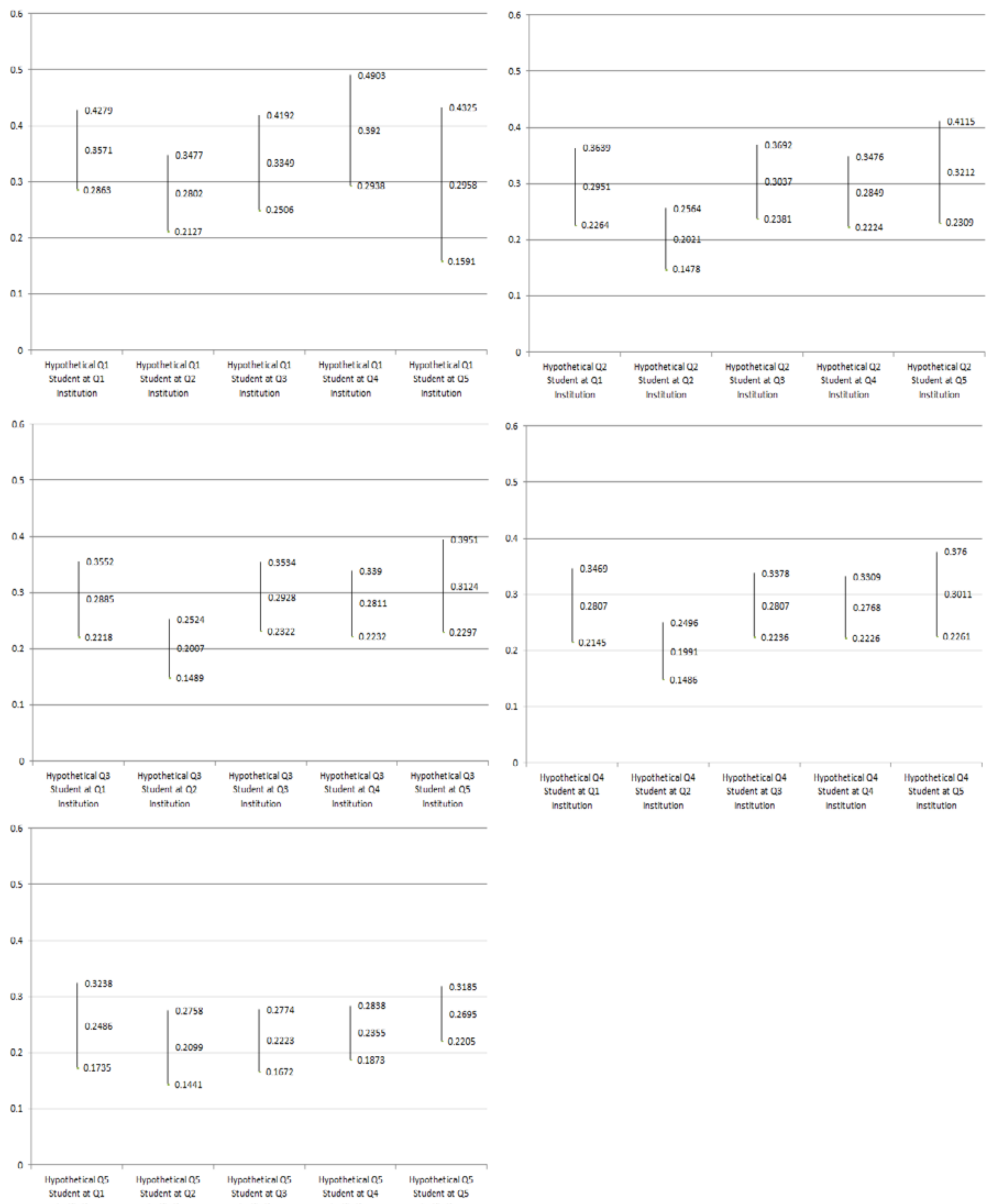
	Institutional Quintile				
	1	2	3	4	5
Unadjusted % students decreased aspirations	32.70%	28.10%	30.60%	29.90%	26.50%
Adjusted Likelihood of experiencing decrease in educational aspirations					
Hypothetical Q1 Student	35.71%	28.02%	33.49%	39.20%	29.58%
Hypothetical Q2 Student	29.51%	20.21%	30.37%	28.49%	32.12%
Hypothetical Q3 Student	28.85%	20.07%	29.28%	28.11%	31.24%
Hypothetical Q4 Student	28.07%	19.91%	28.07%	27.68%	30.11%
Hypothetical Q5 Student	24.86%	20.99%	22.23%	23.55%	26.95%

Source: Table by author

The predictions for the likelihood of experiencing a decline in educational aspirations if attending a Quintile 1 institution indicate that for hypothetical Quintile 2, 3, 4, and 5 students the likelihood of decreasing aspirations is lower at Quintile 3 and 4 institutions than it is in Quintile 1. That means that no generalization can be made that higher ability peers or lower ability peers are more likely to influence the likelihood of decreasing aspirations. It is clear that other factors are at stake.

Figure 4.3 shows the predicted likelihood of experiencing a decrease in educational aspirations for the hypothetical Quintile 1 through Quintile 5 student in each of the institutional quintiles with ninety five percent prediction bands. Each graph within Figure 4.3 depicts a row presented in Table 4.12 above with the corresponding significance interval. As is evident when comparing the predicted likelihood of experiencing a decrease in educational aspirations for a hypothetical student across the quintiles, while the likelihood of experiencing a decrease in educational aspirations major does differ depending on which Quintile institution a student is placed in, none of the differences are statistically significant.

Figure 4.3. Adjusted Likelihood of Decrease in Education Aspirations (Y) of Hypothetical Student with 95% Prediction Bands, by Quintile



Source: Figure by author

SUMMARY: DEGREE COMPLETION, STEM MAJOR, AND EDUCATIONAL ASPIRATIONS

For all three outcomes analyzed in this chapter, bachelor's degree completion, STEM major selection, and decline in educational aspirations, the effect of SAT on the outcome does not vary across the five institutional quintiles. In other words, A SAT point increase or decrease does not have greater effect on the outcome in one institutional quintile versus another.
The question of how the performance of the average hypothetical student in a quintile would change if the student were to be placed in an institution that falls into another quintile, indicates that attending an institution in the bottom quintile would significantly decrease the desirability of student outcomes in the case of bachelor's degree completion and STEM major selection. As can be seen in the analyses, the lowest predicted likelihood of completing a bachelor's all of the hypothetical Quintile 1 through Quintile 5 students is if attending a Quintile 1 institution. While the lowest quintile institutions generate the lowest predicted likelihood of college completion, it is not true that the top quintile generates the highest predicted likelihood of college completion for all hypothetical students. For hypothetical Quintile 2, 3, and 4 students the highest predicted likelihood of college completion is in Quintile 4 institutions while for hypothetical Quintile 5 students it is in Quintile 5 institutions.

A similar overall pattern is evident in the analysis of STEM major selection. The predicted likelihood of selecting a STEM major is lowest for the hypothetical Quintile 1 student at a Quintile 3 institution and highest at a Quintile 5 institution. For hypothetical students in Quintiles 2, 3, 4, and 5 the highest predicted likelihood of completing a STEM major is if attending a Quintile 4 institution and the lowest is if attending a Quintile 1 institution. Again, it is not the case that the top quintile generates the greatest likelihood of selecting a STEM major, but the lowest quintile generates the smallest for almost all of the hypothetical groups of students. Overall the analysis of these two outcomes points to the conclusion that if lower and average ability students (such as those enrolled in Quintile 1, 2, and 3 institutions) are enrolled in institutions where their peers on average have higher ability (such as Quintile 4 and 5 institutions) they are more likely have the desirable outcomes of college completion and selecting a STEM major. On the other hand, high ability students (such as those enrolled in Quintile 4 and 5 institutions) do best if attending institutions that have similar levels of ability.

For the analysis of decline in educational aspirations neither the model coefficients nor intercepts are statistically significantly different across the five quintiles. This indicates that this outcome is not sensitive to the type of institution a student attends. Additionally, the analysis does not follow the same pattern of least desirable predictions occurring in Quintile 1 institutions. The hypothetical Quintile 1 student is most likely to experience a decline in educational aspirations if attending a Quintile 4 institution. The predictions for the likelihood of experiencing a decline in educational aspirations for hypothetical Quintile 2, 3, 4, and 5 students is highest at top quintile institutions. Thus, in the case of educational aspirations the least desirable outcome for low and average ability students occurs if they attend a top quintile institution where their pees will have higher ability. However, the likelihood of experiencing a decline in educational aspiration is second highest at Quintile 1 for the same group of students which indicates that it is not possible to draw the conclusion that being around more able peers increases the likelihood of decreasing educational aspirations.

CHAPTER 5

SUMMARY AND CONCLUSION

In high schools across the United States, students interested in pursuing postsecondary education are told to apply to colleges that accept applicants with better academic records and entrance exam scores than their own. Because these institutions serve students that are on average more academically able than the applicant and thus may be more difficult to gain admission to, the colleges that make up this category for a student are frequently called reach schools. Students are advised to apply to reach, match, and safety schools, with an understanding that all things being equal, the student will elect to attend the most selective institution to which he has applied. There is a pervading belief that attending the most selective college a student can gain acceptance to will lead to the greatest returns on a student's investment in his education.

Prior research in this area presented in Chapter 1 has shown that this belief may be unsubstantiated. Light and Strayer (2000) find that students whose standardized exam scores place them in the bottom of the academic ability distribution at their college are more likely to complete college if attending an institution whose mean SAT score places the institution in the bottom, versus the top, quartile of postsecondary institutions. Similarly, Arcidiacono, Aucejo, Coate and Hotz (2012) find that better matching of minority students after the ban on racial preference in college admission, increased minority graduation rates. Furthermore, students "with SAT scores that are high relative to the campus average are more likely to persist in a science major and graduate with a science degree" (Arcidiacono, Aucejo, and Hotz 2013, page 2). This research would suggest that students have the best chances of college completion when surrounded by similarly able peers, and benefit from less able peers in terms of completing a

STEM major. Other studies, using different methods and data, have come to contradicting conclusions supporting the idea that more selective schools have better outcomes for all students regardless of their ability. Alon and Tieda (2005) and Melguizo (2008) find that students are more likely to graduate from institutions that are more selective regardless of their own SAT score. Additionally, institutional selectivity may pay dividends in terms of future salary (Black and Smith 2005).

Considering this contradictory evidence, the questions remain: What are the effects of academic match between student and institution on college outcomes? Is a more selective institution a better choice for all students? Can going to a college where you are less qualified than your peers increase the likelihood of experiencing negative college outcomes? What about a college where you are more qualified than your peers?

How the findings in this study fit in with prior research

In this study I have attempted to contribute to the clarification of the contradicting findings on the effects of academic match on college outcomes by analyzing how student SAT exerts an impact on important college outcomes depending on the average SAT score of the institution the student attends. The findings presented in Chapter 3 and 4 show that the results of the investigation depend on both the outcomes observed as well as student ability. The findings are simplified in Table 5.1 to assist in demonstrating the institutional environment that would be best for the average student in each quintile. The full results in Chapter 3 and 4 indicate that the differences in outcomes are frequently not significant between institutional quintiles. However, the simplification in Table 5.1 is helpful in the interest of discussing overall trends.

As the summary in Table 5.1 indicates, the average Quintile 1 student would have more desirable college outcomes if placed in the educational context of an institution that falls into a higher mean SAT quintile. These average Quintile 1 students would have higher grades, take less time to complete their education, be more likely to graduate and complete a STEM major if attending an institution in a higher quintile. In the case of most outcomes, these students would experience the most desirable outcome at institutions in the top two quintiles, where peers who have significantly greater SAT scores would surround them. If one were to focus on students whose SAT scores place them in the bottom quintile, the conclusion would be that more selective institutions lead to better college outcomes and would support those arguing that more able peers are beneficial for student's own academic performance. The findings provide support for the epidemic/contagion, cognitive, institutional-expectations, and disruption theories which suggest that a high achieving environment increases the performance of on average lower achieving students (Hoxby and Weingarth 2005, Jenks and Mayer 1990). This finding is corroborated by some peer-effect research on younger K-12 students, where researchers have found that performance for the students receiving low scores is most improved when they are in classrooms with high scoring students (Burke and Sass 2006, Mashburn et al. 2011).

Table 5.1. Summary of Findings

		Average student at:				
Outcome		**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Cumulative GPA	Highest Predicted Outcome	5	1	1	1	1
	Lowest Predicted Outcome	3	5	5	5	5
Time to Graduation	Highest Predicted Outcome	1	2	3	1	1
	Lowest Predicted Outcome	2	5	5	2	2
Bachelor's Degree Completion	Highest Predicted Outcome	4	4	4	4	5
	Lowest Predicted Outcome	1	1	1	1	1
STEM Major	Highest Predicted Outcome	5	4	4	4	4
	Lowest Predicted Outcome	1	2	1	1	2
Decrease in Educational Aspirations	Highest Predicted Outcome	4	5	5	5	5
	Lowest Predicted Outcome	2	2	2	2	2

Source: Table by author

This trend of more selective institutions leading to better college outcomes is, however, not as straightforward for students whose SAT scores do not place them into the bottom quintile. For the average Quintile 2 and 3 students, the trend of more selective institutions leading to better outcomes is accurate if higher degree completion and STEM major selection are the outcomes considered. However, in terms of cumulative grades, all average students in Quintiles 2 through 5 would have the highest predicted average grades if attending institutions in the bottom quintile. For all but the lowest achieving students, attending an institution with on average lower achieving peers is more likely to result in a higher grade point average. This lends support to the theories of relative deprivation or individuous comparison which posit that higher and similarly able peers inhibit a student's success while less able peers encourage it (Marsh 1991, Jenks and Mayer 1990, Hoxby and Weingarth 2005).[1] The results indicate that, with the exception of the least able students, in an environment surrounded by lower performing peers, average students receive the highest grades.

While it logically makes sense that students with higher measured ability have better grades when surrounded by lower able peers, it is not clear why the average Quintile 1 student would have the highest average grades when enrolled at an institution that falls into the top quintile. The students who score lower on the SAT should in theory experience more academic difficulties at top quintile institutions where the average student is more academically able, but the results of the adjusted predictions in Chapter 3 show that this is not the case. The causes behind the more desirable predicted performance of the bottom quintile students at the top two quintile institutions may be related to vast differences in institutional resources and support across the American higher education system (Liu 2011). As has been mentioned in the analysis

[1] For a more detailed review on the mechanisms behind peer effects on student academic performance see discussion in Chapter 1.

of results in Chapter 3 and 4, institutions that fall in Quintiles 4 and 5 have greater resources to assist students. The results in this study show that these resources may even be able to help support the performance of students who are at the lowest rungs of academic achievement as measured by the SAT.

While the additional support at the top two quintile institutions— in terms of both financial aid as well as academic resources—likely has an effect on student college outcomes, it is also the case that the institutions falling in the top two quintiles experience greater pressure than bottom quintile institutions in terms of producing a desirable outcome such as high grades and grater rates of college completion. As mentioned in Chapter 3, institutions in top quintiles are subject to a postsecondary ranking system that is increasingly becoming an important tool for student recruitment. Rankings take college outcomes such as on-time graduation rates and student grades into account. Because of the importance of these rankings at top quintile institutions it is plausible that institutions feel pressure to graduate more students within four years or to give higher grades. Grade inflation in particular has been well-documented at top institutions (Johnson 2003).

Despite the possibility that the pressure of rankings contributes to a push for institutions to promote all students regardless of ability, it is also true that in the case of STEM major, average students attending lower ranked institutions are more likely to select a STEM major if attending an institution in one of the top two quintiles. As the number of students completing a STEM major is not a factor in rankings and college major is a student choice, this outcome is not impacted by the pressures top quintile institutions feel in pandering to ranking systems. The analysis conducted here does not allow for drawing conclusion as to whether STEM major rates are higher for students attending higher quintiles because of additional academic supports, or simply because there are more opportunities to major in STEM fields at more selective institutions.

Time to graduation does not seem to follow a pattern of more selective institutions always providing the best outcomes as for the average Quintile 1, 4, and 5 student the fewest months to graduation are predicted at Quintile 2 institutions. This is counterintuitive as overall Quintile 5 institutions have on average the fastest college completion rates. When time to degree completion is considered the lowest performing students have better outcomes at institutions where students on average have slightly higher ability, while the most able students have the best outcomes when attending an institution where students on average have lower achieved ability. Finally, it is interesting to note that for the average student in each quintile the greatest likelihood of experiencing a decline in educational aspirations occurs at institutions in the top quintile. This lends some support to Marsh's Big Fish, Little Pond (1991) hypothesis presented in Chapter 1, which argues that more able peers may decrease student's self-confidence and academic aspirations. However, the results presented in Chapter 4 do show that the trend here is not linear. It is not true that the more selective the institution the greater the likelihood of experiencing a decrease in educational aspirations for all students. After Quintile 5, the institution where students are most likely to experience a decrease in educational aspirations is Quintile 1, where the average student is likely less academically able. It may be that being both at the bottom as well as at the top has similar effects on student aspirations.

The analyses presented in this dissertation provide an insight into why there have been so many contradictory conclusions in the research on the effect of academic match on educational outcomes. The conclusions drawn are highly dependent on the student groups considered. The lowest ability students and highest ability students have starkly different experiences. This is an especially salient point to consider in academic mismatch research when evaluating the dataset researchers are using to draw their conclusions. Influential papers in academic mismatch research such as Dale and Krueger (2002) and Alon and Tienda (2005) have relied on the College and Beyond dataset,[2] which only contains data on students attending institutions that would fall into the top quintile.

Beyond the differences in effects by student ability, there are also considerable differences depending on the outcome considered. In the case of college completion, which has been the primary outcome considered to date, the top two institutional quintiles produce the greatest likelihoods of college completion for all average students. However, in the case of grades, for most average students being at the least selective institution results in the best college grade point average. It is clear that depending on the outcome that is considered the evaluation of the effects of academic mismatch on student performance would lead to different conclusions as to what the effects of academic mismatch are as well as who benefits from academic mismatch.

The practical advice that a student can take from this study is that attending an institution in the top two quintiles will likely increase their likelihood of successful college completion and provide greater support for those interested in STEM majors. College completion is the outcome that will most determine future opportunities and thus the most important outcome to consider. High grades are useless if a student does not complete a degree. However, this study also indicates that it is not necessary to attend the top postsecondary institutions for the best outcomes. Institutions in Quintile 4 where the average student SAT score in math and verbal hovers around 1100 (2003 Combined Math and Verbal Scores) are in most cases likely to provide the best outcomes.

[2] See Chapter 2 for a more detailed discussion on datasets used in previous studies.

APPENDIX A:

EFFECT OF THE SAT AFTER CONTROLLING FOR HIGH SCHOOL GRADES AND PARTICIPATION IN PRE-CALCULUS

In Chapter 2 I outline the reasons why I am using high school grade point average, SAT scores, and participation in Pre-Calculus in high school as control variables in all models. As I explain, there are two factors beyond SAT score, student family background and demographic characteristics that prior research suggests are important factors in determining a student's college performance: academic motivation and high school preparation. The variables that previous scholars have used to control for these two factors are varied and are described in Table A1.

Academic motivation can be measured in a variety of ways. Most prior scholars have relied on high school performance metrics such as class rank or grade point average (Bowen & Bok, 1998, Dale & Krueger, 2002, Alon & Tienda 2005, Long 2008, Griffith 2009). It is logical to assume that students who want to do well academically will put in the effort to get good grades. High school grades are also in turn a measure of high school preparation, as students who put more work into their studies have on average acquired more skill and are better prepared for college. As high schools vary widely in terms of graduation requirements and grading rubrics, high school grade point average cannot be used as the only measure for high school preparation. In one high school a 4.0 grade point average describes a student who is college–ready while in another it may describe a student who is reading at the ninth grade level. Because of this scholars have also generally included variables that provide a measure of high school quality. These have varied with simply distinguishing between private and public high schools (Alon & Tienda 2005, Griffith 2009), to high school teacher salary (Black & Smith 2005), to measures that capture the quality of the neighborhood the student's school is located in such as percent of the population with a postsecondary degree (Light & Strayer 2000, Long 2008).

Table A1. Variables used to control for academic motivation and preparation in prior studies on standardized test effects on college outcomes

Prior research	**Academic Ability/Preparation Measures Included**
Loury & Garman (1995)	SAT score
Bowen & Bok (1998)	SAT High school class rank Public vs. Private high school
Light & Strayer (2000)	AFQT test scores High school student-teacher ratio Percent of population in neighborhood completed postsecondary Percent of population in neighborhood unemployed
Dale & Krueger (2002)	SAT High school class rank
Alon & Tienda (2005)	SAT High school class rank Public vs. Private high school
Black & Smith (2005)	ASVAB scores High school size High School teacher salary Percent of students in High School disadvantaged
Long (2008)	SAT High School GPA Percent of population in neighborhood completed postsecondary Percent of population in neighborhood unemployed High School Quality Index Urban/Rural high school
Griffith (2009)	SAT High school GPA Public vs. Private high school

Source: Table by author

Because of the limited high school information provided in BPS 04/09, the dataset used for this study, I am unable to make use of many of the previously utilized measures of high school preparation and thus rely on participation in Pre-Calculus courses in high school as a measure of high school quality. The availability of Pre-Calculus courses in high school is not ubiquitous and thus a marker of high school quality (Trusty and Niles, 2003). Furthermore, in previous studies highest mathematics course completed in high school has proven to have significant effects on college outcomes, with students who take higher level mathematics in high school being more likely to successfully complete and do well in college (Adelman, 2006).

Researchers have been careful to utilize markers of academic motivation and preparation when studying the effects of the SAT on college outcomes because it is important to distinguish the effects of SAT on something such as college grades, from the effects of being academically motivated on college grades. However, this effort to isolate the effect of SAT score on an outcome from the effect of motivation and preparation may potentially obscure some of the SAT effect. This is because while academic motivation (high school grades), preparation (participation in Pre-Calculus), and academic ability (SAT score) in tandem with student demographics and family background are important determinants of college performance, they are also highly correlated. Logically it is not difficult to understand why this correlation exists. Students who are academically motivated are more likely to want to participate in more rigorous coursework, to want to be more prepared on the SAT, and to have higher grades. For the sample of students from the BPS 04/09 used in this study the correlation between SAT and high school grades is 0.438, while the correlation between SAT and Pre-Calculus participation is 0.396. Since SAT, high school grades, and Pre-Calculus participation are interrelated, it is important to ask: after controlling for achieved academic ability as measured by high school grades and participation in Pre-Calculus, what effect on outcomes is left for SAT score to measure?

I address the concerns expressed above by doing two analyses that show the extent to which other variables influence the effect of SAT on college outcomes. First, I will regress SAT on all other pre-college independent variables, for the total sample and for each of the five quintiles. This analysis demonstrates if the effect of achieved academic ability (SAT) is being hidden by the fact that it is competing with indicators, Pre-Calculus participation and high school grades, of similar metrics. Furthermore, the results will allow me to see how much SAT scores vary for college students who do not differ in race, gender, parental schooling, family income, foreign birth, high school, GPA, and high school Pre-Calculus. It may be that once these other variables are held constant, SAT does not vary enough to show big effects on GPA. Second, I will regress each college outcome considered in this study on SAT without any of the covariates, both for the total sample and for each of the five quintiles. This analysis demonstrates if there are effects of SAT on the college outcomes of interest that the other covariates used in the model obscure. I will also regress each outcome on SAT and high school grades, SAT, high school grades, and Pre-Calculus preparation to show how the effect of SAT changes as the various measures of academic motivation and preparation are included in the model. Additionally, this second analysis will indicate if stratifying the analysis by postsecondary institution mean SAT is masking the effects of SAT on the college outcomes.

Analysis 1: Regression of Covariates on SAT

Table A2 presents the results of a regression of race, gender, parental education and income, foreign born status, high school grades, Pre-Calculus participation, STEM major indicator, and private postsecondary institution indicator on SAT score. These variables, with the exception of STEM major, are used in all the models presented in this study in Chapter 3 and 4. The results below indicate that the effect of SAT is not hidden by the fact that it is competing with Pre-Calculus participation and high school grades. However, students with higher grades are more likely to have a higher SAT scores, as are students who participate in Pre-Calculus in high school. All of the variables included in the model explain 31.1% of variation in SAT scores in the pooled model, meaning that 70% of the variation in SAT score remains unexplained.

Table A2. Regression of Covariates on SAT, BPS 04/09

	Pooled Sample	Institutional Quintile 1	2	3	4	5
Black	-111.2***	-119.3***	-132.0***	-104.8***	-131.5***	-78.94***
	(8.746)	(13.12)	(18.62)	(20.23)	(23.82)	(20.14)
Hispanic	-49.32***	-81.73***	-58.41***	-16.28	-53.98***	-49.87**
	(9.569)	(17.79)	(21.87)	(21.32)	(18.31)	(19.94)
Asian	19.99*	-63.20*	-9.856	-32.88	-46.78**	11.62
	(10.83)	(35.50)	(27.83)	(26.13)	(20.90)	(15.49)
Other	-8.714	-0.125	1.463	-22.14	-63.36***	-19.73
	(11.06)	(24.26)	(23.99)	(21.70)	(24.45)	(19.08)
Male	31.43***	0.0828	48.45***	25.32***	18.49*	37.57***
	(4.753)	(10.06)	(9.693)	(9.794)	(9.640)	(9.193)
At least one parent has BA	60.36***	29.50***	48.22***	16.98*	44.86***	64.88***
	(5.176)	(10.11)	(10.01)	(10.24)	(10.86)	(12.86)
Household income, 2003	0.000305***	0.000349***	-5.93e-05	0.000198**	3.61e-05	0.000113
	(4.47e-05)	(0.000112)	(0.000105)	(9.93e-05)	(9.69e-05)	(6.88e-05)
Foreign born	-31.12***	-81.73***	-28.02	-29.05	-11.80	-29.03*
	(9.680)	(21.30)	(20.03)	(23.44)	(18.87)	(17.07)
HS GPA 3.5-4.0	162.9***	118.8***	127.1***	127.6***	107.2***	129.7***
	(8.196)	(13.43)	(14.29)	(17.12)	(24.61)	(31.90)
HS GPA 3.0-3.4	70.49***	41.51***	64.64***	48.18***	70.01***	64.32*
	(8.327)	(12.72)	(13.85)	(17.27)	(25.44)	(33.47)
Pre-Calculus in High School	84.06***	50.10***	58.25***	61.75***	66.86***	81.63***
	(5.250)	(10.11)	(9.849)	(10.16)	(11.12)	(14.48)
STEM Major	29.05***	13.66	34.85***	31.51***	32.28***	19.17**
	(5.315)	(12.15)	(11.30)	(11.40)	(10.30)	(9.595)
Private	45.01***	-8.301	-2.489	3.267	15.55	56.74***
	(4.695)	(10.15)	(10.80)	(9.456)	(9.577)	(10.20)
Constant	853.7***	888.4***	898.7***	939.0***	969.5***	976.9***
	(8.932)	(14.98)	(16.54)	(19.93)	(26.90)	(33.91)
N	3,768	719	718	721	817	793
R-squared	0.311	0.359	0.320	0.267	0.213	0.263

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Table by author

Analysis 2: The Effect of SAT on College Outcome

Table A3 presents the effect of SAT on each college outcome by itself and with additional control variables added. The first row shows the effect of SAT on the outcome when

SAT is the only control. The second row shows the effect of SAT on the outcome when SAT and high school grades are taken into account. Finally, the third row shows the effect of SAT on the outcome when SAT, high school grades, and Pre-Calculus participation are taken into account. As there is some concern that the effect of SAT is being obscured by high school grades and Pre-Calculus, looking at the ways in which the effect of SAT on the outcome changes as various control variables are added will allow an estimate of how much of the SAT effect is diminished by the fact that academic ability, motivation, and preparation are all to some extent captured by SAT, high school grades, and Pre-Calculus participation.

The results in Table A3 above indicate that the effect of SAT on each of the outcomes considered does in fact diminish when high school grades and Pre-Calculus participation are taken into account. This is to be expected since, as was mentioned above, there is a positive correlation between SAT scores, high school grades, and Pre-Calculus participation. However, despite the fact that the effect of SAT does diminish when additional academic performance indicators are included, there does remain an SAT effect and in the majority of instances presented in the SAT effects above, the addition of high school grades and Pre-Calculus as controls does not change the statistical significance and direction of the effect of SAT on the college outcomes. This indicates that even when accounting for academic motivation via high school grades, and preparation via Pre-Calculus participation, there is still a component of academic ability that is only measured by the SAT.

Table A3. Effect of SAT on College Outcomes, with high school grades and Pre-Calculus participation added controls

		Institutional Quintile				
	Pooled	**1**	**2**	**3**	**4**	**5**
			Outcome: Cumulative College GPA			
SAT	0.155***	0.167***	0.171***	0.157***	0.129***	0.119***
	(0.00459)	(0.0139)	(0.0132)	(0.0131)	(0.0107)	(0.00990)
	0.177	0.120	0.134	0.119	0.114	0.131
SAT (HS GPA control)	0.105***	0.106***	0.119***	0.111***	0.100***	0.103***
	(0.00485)	(0.0138)	(0.0134)	(0.0133)	(0.0106)	(0.0102)
	0.257	0.237	0.215	0.194	0.187	0.159
SAT (HS GPA, Pre-Calculus control)	0.0995***	0.0992***	0.110***	0.106***	0.100***	0.104***
	(0.00509)	(0.0140)	(0.0138)	(0.0139)	(0.0109)	(0.0105)
	0.258	0.242	0.220	0.196	0.187	0.159
			Outcome: Time to Graduation			
SAT	1.886***	2.356***	1.389***	1.470***	0.392	0.170
	(0.150)	(0.454)	(0.446)	(0.426)	(0.370)	(0.281)
	0.029	0.025	0.009	0.011	0.001	0.000
SAT (HS GPA control)	1.053***	1.195**	0.667	0.925**	-0.0613	0.153
	(0.165)	(0.473)	(0.474)	(0.451)	(0.381)	(0.293)
	0.052	0.069	0.025	0.023	0.018	0.000
SAT (HS GPA, Pre-Calculus control)	0.873***	1.100**	0.403	0.673	-0.0681	0.0920
	(0.173)	(0.482)	(0.488)	(0.468)	(0.391)	(0.302)
	0.054	0.070	0.029	0.026	0.018	0.001
			Outcome: BA			
SAT	0.333***	0.239***	0.202***	0.225***	0.0917*	0.307***
	(0.0187)	(0.0408)	(0.0462)	(0.0481)	(0.0493)	(0.0684)
SAT (HS GPA control)	0.232***	0.136***	0.111**	0.147***	0.0343	0.281***
	(0.0203)	(0.0434)	(0.0493)	(0.0511)	(0.0515)	(0.0724)
SAT (HS GPA, Pre-Calculus control)	0.216***	0.130***	0.0815	0.124**	0.0532	0.290***
	(0.0212)	(0.0442)	(0.0508)	(0.0530)	(0.0530)	(0.0745)
			Outcome: STEM			
SAT	0.236***	0.105*	0.306***	0.302***	0.235***	0.168***
	(0.0207)	(0.0586)	(0.0607)	(0.0625)	(0.0514)	(0.0521)
SAT (HS GPA control)	0.210***	0.110*	0.299***	0.269***	0.209***	0.138**
	(0.0228)	(0.0635)	(0.0642)	(0.0666)	(0.0527)	(0.0540)
SAT (HS GPA, Pre-Calculus control)	0.145***	0.0411	0.232***	0.192***	0.170***	0.110**
	(0.0238)	(0.0659)	(0.0658)	(0.0687)	(0.0541)	(0.0552)
			Outcome: Decrease in Aspirations			
SAT	-0.0755***	-0.0807*	-0.0860*	-0.0702	-0.0672	-0.0716
	(0.0165)	(0.0414)	(0.0461)	(0.0459)	(0.0433)	(0.0478)
SAT (HS GPA control)	-0.0506***	-0.0384	-0.0497	-0.0433	-0.0637	-0.0844*
	(0.0184)	(0.0443)	(0.0494)	(0.0488)	(0.0449)	(0.0500)

Table A3., continued

SAT (HS GPA, Pre-Calculus control)	-0.0458**	-0.0289	-0.0481	-0.0483	-0.0452	- 0.0954*
	(0.0193)	(0.0451)	(0.0508)	(0.0507)	(0.0462)	(0.0516)

Source: Table by author

Nonetheless, because there is some overlap in what SAT scores, high school grades, and Pre-Calculus participation measure, the SAT effect may be muted by the inclusion of these two high school academic performance controls and this is important to keep in mind when evaluating the results presented in this dissertation.

BIBLIOGRAPHY

ACT. 2013. “Overview.” Accessed July 25, 2013. < http://www.act.org/products/k-12-act-test/>

Adelman, C. 1999. *Answers in the tool box : Academic intensity, attendance patterns, and bachelor's degree attainment.* Washington, DC: U.S. Dept. of Education Office of Educational Research and Improvement.

Adelman, C. 2006. *The Toolbox Revisited: Paths to Degree Completion From High School Through College.* Washington, D.C.: U.S. Department of Education

Aiken, L. S., and West, S. G. 1991. *Multiple regression: Testing and interpreting interactions.* Newbury Park: Sage.

Alexander, K. and B. Eckland. 1977. High School Context and College Selectivity: Institutional Constraints in Educational Stratification. *Social Forces* 56:166-188.

Alon, S. and Tienda, M. 2007. Diversity, Opportunity, and the Shifting Meritocracy in Higher Education. *American Sociological Review* 72: 487–511.

Alon, S. and Tienda, M. 2005. Assessing the Mismatch Hypothesis: Differences in College Graduation Rates by Institutional Selectivity. *Sociology of Education* 78: 294–315.

Angrist, J.D. and K. Lang. 2004. Does School Integration Generate Peer Effects? Evidence from Boston’s Metco Program. *American Economic Review* 94: 1613-1634.

Arcidiacono, P. 2004. Ability Sorting and the Returns to College Major. *Journal of Econometrics* 121 (2): 343-375.

Arcidiacono, P., Aucejo, E. and Hotz, V.J .2013. University Differences in the Graduation of Minorities in STEM Fields: Evidence from California. *IZA Discussion Papers*: 7227.

Arum, R. and Roksa, J. 2011. *Academically Adrift: Limited Learning on College Campuses*. Chicago: University of Chicago Press.

Astin, A. W. 1977. *Four Critical Years.* San Francisco: Jossey-Bass.

Astin, A.W. and Oseguera, L. 2004. The declining equity of American higher education. *The Review of Higher Education* 27 (3): 321-341.

Atkinson, R. C. (2001). *Standardized Tests And Access To American Universities*. (Robert H. Atwell Distinguished Lecture). <http://www.ucop.edu/ucophome/pres/comments/satspch.html>

Avery, C., and C. Hoxby. 2012. The Missing One-Offs: The Hidden Supply of High-Achieving, Low-Income Students. *NBER Working Paper*: 18586.

Avery, C. and C. Hoxby. 2004. Do and Should Financial Aid Packages Affect Students' College Choices? in C. Hoxby (Ed.) *College Choices: The Economics of Where to Go, When to Go, and How to Pay For It,* (pp. 239-302). Cambridge, MA: National Bureau of Economic Research, Inc.

Baum, S., and Flores, S. M. 2011. Higher education and children in immigrant families. *Future of Children* 21(1), 171-193.

Becker, S.O., and Ichino, A. 2002. Estimation of average treatment effects based on propensity scores. *Stata Journal* 2(4): 358-377.

Behrman, J. 1996. The Impact of Nutrition and Health on Education. *World Bank Research Observer* 11(1): 23-37.

Ben-Achour, S. 2013. "More colleges stop giving credit for AP Exams." Marketplace. February 20, 2013. <http://www.marketplace.org/topics/life/education/more-colleges-stop-giving-credit-ap-exams>

Berkowitz, D. and Hoekstra, M. 2011. Does High School Quality Matter? Evidence from Admissions Data. *Economics of Education Review* 30(2): 280-288.

Black, D. A. and Smith, J.A. 2005. How robust is the evidence on the effects of college quality? Evidence from matching? *Journal of Econometrics* 121(1-2): 99-124.

Borg, W. 1965. Ability grouping in the public schools. *The Journal of Experimental Education* 34: 1-97.

Bowen, W. and Bok, D. 1998. *The Shape of the River: Long-term consequences of considering race in college and university admissions.* Princeton, NJ: Princeton University Press.

Bowen, W.G., Kurzweil, M.A., and Tobin, E.M. 2006. *Equity and excellence in American higher education*. Charlottesville: University of Virginia Press.

Bound, J., Jaeger, D.A. and R. M. Baker. 1995. Problems with Instrumental Variables Estimation When the Correlation between the Instruments and the Endogenous Explanatory Variables is Weak. *Journal of the American Statistical Association* 90(430): 443-50.

Buchman, C., Condron, D., and Roscigno, V. 2010. Shadow Education, American Style: Test Preparation, the SAT and College Enrollment. *Social Forces* 89(2): 435-462.

Burke, M.A. and Sass, T. 2006. Classroom peer effects and student achievement. *Federal Reserve Bank of Boston Working Papers*: 08-5.

Campbell, R.T. 1983. Status Attainment Research: End of the Beginning or Beginning of the End? *Sociology of Education* 56:47-62.

Card, D.E. 1995. Using Geographic Variation in College Proximity to Estimate the Returns to

Schooling. In *Aspects of Labour Market Behaviour: Essays in Honor of John Vanderkamp*. eds. L. N. Christofides et al. Toronto: University of Toronto Press, 201-221.

Carruthers, C., Fox, W., Murray, M., and Thacker, A. 2012. *A Profile of Non-Completers in Tennessee Higher Education.* Knoxville, TN: Tennessee Higher Education Commission & Center for Business and Economic Research.

Cellini, S.R., and Rajeev D. 2015. College Costs and Financial Constraints: Student Borrowing at For-Profit Institutions. In *Student Loans and the Dynamics of Debt*. Brad Hershbein and Kevin M. Hollenbeck, eds. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research, 137-174.

Center for Education Policy. 2007. *Are Private High Schools Better Academically than Public High Schools?* Washington D.C.: Center for Education Policy.

Choy, S. 1997. *Public and Private Schools: How they Differ?* Washington DC: US Department of Education, Office of Educational Research and Improvement.

Chudgar, A., Luschei, T. F., and Yisu Zhou. 2013. Science and Mathematics Achievement and the Importance of Classroom Composition: Multicountry Analysis Using TIMSS 2007. *American Journal of Education* 119(2): 295–316.

Cohen, J., & Cohen, P. 1983. *Applied multiple regression/correlation analysis for the behavioral sciences (2nd Ed.).* Hillsdale, NJ: Erlbaum.

College Board. 2014. "Explore AP" <https://apstudent.collegeboard.org/exploreap>

Cohen, E.G. 1994. Restructuring the Classroom: Conditions for productive small groups. *Review of Educational Research* 64: 1-36.

College Board. 1995. *Feasibility of Using the SAT in Academic Guidance.* Washington, DC: College Board.

College Entrance Examination Board. 1972. *The Effects of Special Instruction for Three Kinds of Mathematics Aptitude Items.* Washington, DC: ETS.

College Board. 2009. *Socioeconomic Status and the Relationship Between the SAT and Freshman GPA: An Analysis of Data from 41 Colleges and Universities.* Washington, DC: College Board.

College Board. 2011. Low-SES Students and College Outcomes: The Role of AP Fee Reducations. Washington, DC: College Board.

College Board. 2013. "Applying 101." Accessed on March 25, 2013. Available at: < https://bigfuture.collegeboard.org/get-in/applying>

College Board. 2013. "Compare Scores." Accessed on January 15, 2013. Available at:

< http://professionals.collegeboard.com/testing/sat-reasoning/scores/compare>

Cole, S. and Barber, E. 2003. *Increasing Faculty Diversity: The Occupational Choices of High Achieving Minority Students.* Cambridge, MA: Harvard University Press.

Complete College America. 2014. *The Four Year Myth*. Indianapolis, IN: Complete College America. <http://completecollege.org/wp-content/uploads/2014/11/4-Year-Myth.pdf>

Council of Graduate Schools and Educational Testing Service. 2010. *The Path Forward: The Future of Graduate Education in the United States.* Report from the Commission on the Future of Graduate Education in the United States. Princeton, NJ: Educational Testing Service.

Cope, R., and Hannah, W. 1975. *Revolving college doors: The causes and consequences of dropping out, stopping out, and transferring.* New York: Wiley

CUNY Office of Policy Research. 2010. "Improving Student Transfer at CUNY." Available at: < http://www.cuny.edu/about/administration/offices/aa/acr/TransferReport.pdf>

Currie, J. and Enrico M. 2003. Mother's education and the intergenerational transmission of human capital: Evidence from college openings. *Quarterly Journal of Economics* 118 (4): 1495–1532.

Dale, S.B. and Krueger, A.B. 2002. Estimating the Payoff to Attending a More Selective College: an Application of Selection on Observables and Unobservables. *Quarterly Journal of Economics* 117(4): 1491–1528

Dar, Y., & Resh, N. 1986. Classroom intellectual composition and academic achievement. *American Educational Research Journal* 23: 357-374

Deary, I.J. 2000. *Looking down on human intelligence: from psychometrics to the brain.* Oxford: Oxford University Press.

Dixon-Roman, E. Everson, H. & McArdle, J. 2013. Race, Poverty and SAT Scores: Modeling the Influences of Family Income on Black and White High School Students' SAT Performance. *Teachers College Record, 115* (4): 1-33

Dowling, J. E. 2007. *The Great Brain Debate: Nature or Nurture?* Princeton, NJ: Princeton University Press.

Duncan, G. J., Brooks-Gunn, J., & Klebanov, P. K. 1994. Economic deprivation and early childhood development. *Child Development* 65: 296–318.

Duncan, G. J., Yeung, W., Brooks-Gunn, J., & Smith, J. R. 1998. How much does childhood poverty affect the life chances of children? *American Sociological Review* 63: 406–423.

Duran, B. and Weffer, R.E. 1992. Immigrants' Aspirations, High School Process, and Academic Outcomes. *American Educational Research Journal* 29: 163-181.

Else-Quest, N.M., Mineo, C.C., and Higgins, A. 2013. Math and Science Attitudes and Achievement at the Intersection of Gender and Ethnicity. *Psychology of Women Quarterly* 23:45-65.

Espenshade, T. and Chung, C. Y. 2005. The Opportunity Cost of Admission Preferences at Elite Universities. *Social Science Quarterly* 86 (2): 293-305.

Espenshade, T. and Radford, A.W. 2009. *No Longer Separate, Not Yet Equal: Race and Class in Elite College Admission and Campus Life.* Princeton, New Jersey: Princeton University Press.

Ethington, C. A., and J. C. Smart .1986. Persistence to graduate education. *Research in Higher Education* 24(3): 287-303.

Fleming, J. 1982. Sex Differences in the Impact of College Environments on Black Students. In Pamela Perun (ed.) *The Undergraduate Woman: Issues in Educational Equity*. Massachusetts: DC Heath and Company, 229-250.

Fleming, J. 1984. *Blacks in College*. San Francisco: Jossey-Bass, Inc.

Fleming, J. 1985. *Black Colleges—The Right Stuff. Paper presented at the Black Student Retention in Historically/Traditionally Black Colleges and Universities National Conference.* ERIC Document Reproduction Service No. ED 316 608.

Fordham, S. 1996. *Blacked out: dilemmas of race, identity and success at Capitol high*. Chicago: University of Chicago Press.

Galbraith, C. and Merrill, G. 2015. Academic performance and burnout: an efficient frontier analysis of resource use efficiency among employed university students. *Journal of Further and Higher Education* 39 (2): 255-277.

Gardner, H. 2011. *Frames of Mind: The Theory of Multiple Intelligences* (3rd edition). New York, New York: Basic Books.

Goldin, C., Katz, L.F., and Kuziemko, I. 2006. The Homecoming of American College Women: The Reversal of the College Gender Gap. *Journal of Economic Perspectives, American Economic Association* 20(4): 133-156.

Gottfredson, L. S. 1981. Circumscription and compromise: A developmental theory of occupational aspirations. *Journal of Counseling Psychology* 28 (6): 545-579.

Griffith, Amanda. 2009. *Essays in Higher Education Economics*. Cornell University Economics Department Dissertation.

Gurin, P. and Epps, E.G. 1975. *Black Consciousness, Identity and Achievement: A Study of Students in Historically Black Colleges*. New York: Wiley Press.

Gurin, P., Dey E.L., Hurtado, S., and Gurin, G. 2002. Diversity and higher education: Theory and impact on educational outcomes. *Harvard Educational Review* 72 (3): 330-66.

Hanushek, E. A., Kain, J.F., Markman, J. M. and Rivkin, S.G. 2003. Does Peer Ability Affect Student Achievement? *Journal of Applied Econometrics* 18:527-544.

Harris, D. N. 2010. How do school peers influence student educational outcomes? Theory and evidence from economics and other social sciences. *Teachers College Record*112(4): 1163-1197.

Hartle, Terry. 2013. *Keeping College within Reach: The Role of Federal Student Aid Programs*. Statement presented at the House Education and the Workforce Committee on April 16, 2013. < http://www.acenet.edu/news-room/Documents/Testimony-Hartle-House_StudentAidHearing.pdf>

Heckman, J., Hidehiko I. and P.Todd. 1997. Matching As An Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Program. *Review of Economic Studies* 64(4): 605-654.

Henry, G. T., and D. K. Rickman. 2007. "Do peers influence children's skill development in preschool?" Economics of Education Review 26:100-112.

Henshaw, Ashley. 2012. *AP Classes That Count as College Credit*. Santa Monica, CA: Campus Explorer.

Henson, J. W. 1980. *Institutional excellence and student achievement: A study of college quality and its impact on educational and career achievement.* Unpublished doctoral dissertation, School of Education, UCLA

Howe, Michael J. A., & Davidson J. W., & Sloboda, J. A. 1998. Innate Talents: Reality or Myth. *Behavioral and Brain Sciences* 21: 399-442.

Hoxby, C. 1997. How the Changing Market Structure of American College Education Explains Tuition. *National Bureau of Economic Research Working Paper*: 6323.

Hoxby, C. M. 2000. Peer Effects in the Classroom: Learning from Gender and Race Variation. *NBER Working Paper*: 7867.

Hoxby, C. M. 2009. The Changing Selectivity of American Colleges. *The Journal of Economic Perspectives* 23 (4): 95-118.

Hoxby, C. M. and Avery, C. 2012. The Missing ‘One Offs’: The Hidden Supply of High-Achieving, Low-income Students. *NBER Working Paper:* 18586.

Hubin, D. R. 1988. *The Scholastic Aptitude Test: Its Development and Introduction.* Ph.D. Dissertation, University of Oregon.

Hurtado, S., and Guillermo-Wann, C. 2013. *Diverse Learning Environments: Assessing and Creating Conditions for Student Success*. Final Report to the Ford Foundation. University of California, Los Angeles: Higher Education Research Institute. Available at: < http://heri.ucla.edu/dle/DiverseLearningEnvironments.pdf>

James, E., N. A., Conaty, J., and To, D. 1989. College Quality and Future Earnings: Where Should You Send Your Child to College? *American Economic Review* 79: 247-52.

Jencks C. and Mayer S. 1990. The social consequences of growing up in a poor neighborhood. In *Inner-City Poverty in the United States*, ed. L Lynn, Jr., MGH McGeary. Washington, DC: Natl. Acad. Press, 111-85.

Jencks, C. and M. Phillips. 1998. *The Black-White Test Score Gap*. Washington D.C.: Brookings Institution Press.

Jencks, C. 1999. Interview: Secrets of the SAT. FRONTLINE. Transcript available at: <http://www.pbs.org/wgbh/pages/frontline/shows/sats/interviews/jencks.html>

Johnson P.O. and Neyman J. 1936. Tests of certain linear hypotheses and their applications to some educational problems. *Statistical Research Memoirs* 1: 57–93.

Johnson, V.E. 2003. *Grade Inflation: A Crisis in College Education*. New York, NY: Springer-Verlag.

Justice, L. M., Petscher, Y., & Schatschneider, C. & Mashburn, A. J. 2011. Peer effects in preschool classrooms: classmates' abilities are associated with children's language growth. *Child Development 82* (6):1768-1777.

Karabel, Jerome. 2005. *The Chosen: The Hidden History of Admission and Exclusion at Harvard, Yale, and Princeton.* Boston, MA: Houghton Mifflin.

Kahlenberg, R. 2010. *Affirmative Action for the Rich: Legacy Preferences in College Admissions.* New York, New York: Century Foundation.

Kane, T. 1998. Racial and ethnic preferences in college admissions. In: C. Jencks & M. Phillips (eds.), *The Black-White test score gap*. Washington, D.C: Brookings Institution Press.

Kane, T. J., and Rouse, C.E.. 1995. Labor Market Returns to Two-Year and Four-Year Schools. *The American Economic Review* 85(3): 600-614.

Kao, G. 1995. Asian-Americans as model minorities? A look at their academic performance. *Am. J. Educ.* 103:121-59.

Karen, David. 1990. Toward a Political-Organizational Model of Gatekeeping: The Case of Elite Colleges. *Sociology of Education* 63: 227-240.

Katz, M.B. 1987. *Reconstructing American Education*. Cambridge, MA: Harvard University Press.

Keith, T.Z. 2006. *Multiple regression and beyond*. Boston, MA: Pearson Education.

Kinsler, J. and Pavan, R. 2015. The Specificity of General Human Capital: Evidence from College Major Choice. *Journal of Labor Economics* 23 (4): 123-176.

Kleinbaum D.G., Kupper L.L., Nizam A., and Muller K.E. 2008. *Applied Regression Analysis and Other Multivariable Methods.* 4th edition. Boston: Duxbury Press

Kleinbaum, David G., Kupper, Lawrence L., Nizam, Azhar, Muller, and Keith E. 2008. *Applied Regression Analysis and Other Multivariable Methods.* New York: NY: Thomson Cenage Learning.

Kobrin, J.L., Patterson, B.F., Shaw, EJ, Mattern, K.D. and SM Barbuti. 2008. *Validity of the SAT for predicting first-year college grade point average*. College Board Research Report 5, 1-10.

Kuh, G.D. and Sturgis, J.T. 1980. Looking at the university through a different set of lens: Adult learners and traditional age students' perceptions of the university environment. *Journal of College Student Personnel* 21: 483-490.

Kuncel, N. and Hezlett, S. 2010. Fact and Fiction in Cognitive Ability Testing for Admissions and Hiring Decisions. *Current Directions in Psychological Science* 19: 339-345.

Lavy, V., Silva, O., and Weinhardt, F. 2009. The good, the bad, and the average: Evidence on Ability Peer Effects in Schools. *NBER Working Papers*: 15600.

Lemke, R. and I. Rischall. 2003. Skill, Parental Income, and IV Estimation of the Returns to Schooling. *Applied Economics Letters* 10(5), 281-286.

Light, A. and Strayer, W. 2000. The determinants of college completion: school quality or student ability? *Journal of Human Resources* 35: 299–332.

Light, A., Strayer, W. 2002. From Bakke to Hopwood: does race affect college attendance and completion? *The Review of Economics and Statistics* 84: 34–44

Liu, O. L. 2011. *Examining American post-secondary education*. (Report No. ETS RR-11-22). Retrieved from http://www.ets.org/Media/Research/pdf/RR-11-22.pdf

Long, M. 2008. College Quality and Early Adult Outcomes. *Economics of Education Review* 27(5): 588-602.

Loury, L. D. and Garman, D. 1993. Affirmative Action in Higher Education. *American Economic Review* 83(2): 99-103.

Loury, L. D. and Garman, D. 1995. College selectivity and earnings. *Journal of Labor Economics* 13(2): 289–308.

Marsh, H. W. 1984. Students' evaluations of university teaching: Dimensionality, reliability, validity, potential biases, and utility. *Journal of Educational Psychology* 76: 707-754.

Marsh, H. W. 1990. Causal ordering of academic self-concept and academic achievement: A multiwave, longitudinal panel analysis. *Journal of Educational Psychology* 82(4): 646–656.

Marsh, H. W. 1991. The failure of high ability high schools to deliver academic benefits: The importance of academic self-concept and educational aspirations. *American Educational Research Journal* 28: 445-480.

Marsh, H. W. 2007. *Self-concept theory, measurement and research into practice: The role of self-concept in educational psychology.* Leicester, UK: British Psychological Society.

Marsh, H. W., and Hau, K. 2003. Big-fish-little-pond-effect on academic self-concept. A cross-cultural (26 country) test of the negative effects of academically selective schools. *American Psychologist* 58(5): 364–376.

Mashburn, A. J., Justice, L. J., Downer, J. T., and Pianta, R. C. 2009. Peer effects on children's language achievement during pre-kindergarten. *Child Development* 80(3): 686-702.

Massey, D. and Denton, N. 1993. *American Apartheid: Segregation and the Making of the Underclass.* Cambridge: Harvard University Press.

Melguizo, T. 2008. Quality matters: Assessing the impact of selective institutions on minority college completion rates. *Research in Higher Education* 49(3): 214-236.

Melguizo, T., and Wolniak, G. 2012. The Earnings Benefits of Majoring in STEM Fields Among High Achieving Minority Students. *Research in Higher Education* 53 (4): 383-345.

Meredith, M. 2004. Why Do Universities Compete in the Rankings Game? An Empirical Analysis of the Effects of the US News and World Report College Rankings. *Research in Higher Education* 45(5): 443-461.

Monks, J. and Ehrenberg, R. G. 1999. The impact of U.S. News & World Report college rankings on admissions outcomes and pricing policies at selective private institutions. *NBER Working Paper Series*: 7227.

Muska, M., de Oliveira, P., Dwane, A., and Cohen, S. 2011. *Getting In!* Boston, MA: Houghton Mifflin Harcourt.

Nieli R. K. 2004. The changing shape of the river: affirmative action and recent social science research. *Academic Questions* 17:17–59.

Oakes, J. 1985. *Keeping track: How schools structure inequality*. New Haven, CT: Yale University Press.

Ogbu, J. U. 2003. *Black American students in an affluent suburb: A study of academic disengagement.* New Jersey: Lawrence Erlbaum.

Oldman, M. and Hamadeh, S. 2005. *The Internship Bible*. Princeton Review Press, Princeton, NJ.

O'Mara, A. J., & Marsh, H. W. 2007. Big-fish-little-pond-effect: The pervasive self-concept frame-of reference phenomenon. *The Psychology of Education Review* 31: 2-7.

Parker, J., Revenburg, J., Beaman, J., & Christopherson, N. 2010. "Learning from your classmates: A Multi-Method Assessment of Peer-Effects in First-Year Core Courses at Three Colleges." Working Paper. Available at: http://www.pnairp.org/conference/conf2010/presentations/JParkerSupp02.pdf

Pascarella, E. 1985. College environmental influences on learning and cognitive development: A critical review and analysis. In *Higher Education: Handbook of Theory and Research.* edited by John C. Smart. New York: Agathon.

Pascarella, E., & Terenzini, P. 2005. *How College Affects Students*. San Francisco: Jossey Bass, Inc.

Pedhazur, E. J. 1997. *Multiple regression in behavioral research* (3rd Ed.). Fort Worth, TX: Harcourt Brace.

Pedhazur, E. J., and Schmelkin, L. P. 1991. Measurement, design, and analysis: An integrated approach. Hillsdale, NJ: Erlbaum.

Pipper, T., Essenburg, L., and Matchett, E. 2013. We've got minorities, yes, we do: visual representations of racial and ethnic diversity in college recruitment materials. *Journal of Marketing for Higher Education* 23 (2): 258-282.

Roderick, M., Coca, V., Nagaoka, J. 2011. Potholes on the road to college: High school effects in shaping urban students' participation in college application, four-year college enrollment and college match. *Sociology of Education* 84(3): 178-211.

Rojstaczer, S.and Healy, C. 2012. Where A Is Ordinary: The Evolution of American College and University Grading, 1940–2009. *Teachers College Record* 114(7): 1–23.

Rosenbaum, P. and Rubin, D. 1983. The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika* 70: 41-55

Rosnow, R. L., Rosenthal, R. and Rubin, D. 2000. Contrasts and correlations in effect-size estimation. *Psychological Science* 11(6): 446-453.

Rothstein, R. 2004. *Class and schools: Using social, economic, and educational reform to close the black-white achievement gap.* New York: Teachers College Press.

Sacerdote, B. 2001. Peer Effects with Random Assignment: Results for Dartmouth Roommates. *Quarterly Journal of Economics* 116 (2): 681-704.

Sanford, T. and Rivera, N. 1994. Parents' Perceptions of Students' Time to Degree. Paper presented at the Annual SAIR/SCUP Conference, Memphis, TN, October 31 – November 2, 1993, and at the AIR Annual Forum, New Orleans, LA, May 29 – June 1, 1994.

Sauder, M. & W. N. Espeland. 2009. The Discipline of Rankings: Tight Coupling and Organizational Change. *American Sociological Review* 74: 63-82.

Schneider, M., and Lin, Y. 2011. The high cost of low graduation rates: How much does dropping out of college really cost? Washington, DC: American Institutes for Research. Available at: <http://www.air.org/focusarea/education/index.cfm?fa=viewContent&content_id=1404>

Sewell, W. H. and Hauser, R.M. 1972. Causes and Consequences of Higher Education: Models of the Status Attainment Process. *American Journal of Agricultural Economics* 54(6): 851-61.

Sirin, S. R. 2005. Socioeconomic status and academic achievement: A Meta-analytic review of research. *Review of Educational Research* 75(3): 417-453.

Skretny, J.D. 1998. *Color Lines: affirmative action, immigration and Civil Rights options in America.* Chicago: University of Chicago Press

Smith, J., Pender, M., and Howell, J.S. 2012 .The Full Extent of Student-College Academic Undermatch. *Economics of Education Review* 32: 247-261

Sowell, T. 1972. *Say's Law: A Historical Analysis*. Princeton, NJ: Princeton University Press.

Sowell, T. 2004. *Affirmative Action Around the World.* New Haven, CT: Yale University Press.

Sternberg, R. 1979. The Nature of Mental Abilities. *American Psychologist* 34: 214-230.

Sternberg, R. 1985. *Beyond IQ.* Cambridge, UK: Cambridge University Press.

Stevens, Mitchell L. 2007. *Creating a Class: College Admissions and the Education of Elites*. Cambridge: Harvard University Press.

Stipek, D. 1998. *Motivation to learn: From theory to Practice* (3rd ed.). Needham Heights, MA: Allyn and Bacon

Tinto, V. 1993. *Leaving college: Rethinking the causes and cures of student attrition* (2nd Ed.). Chicago: University of Chicago Press.

Tinto, V. 2005. Epilogue: Moving from theory to action. In A. Seidman (Ed.), *College student retention: Formula for student success*. Westport, CT: ACE/Praeger.

Todd, P. 2007. Matching Estimators. In P. Newman, M. Milgate, and J. Eatwell, eds., The New Palgrave—A Dictionary of Economics. New York: Macmillan.

University of Chicago. 2013. "More than 30,000 prospective College students apply to UChicago" Accessed on March 17, 2013. Available at: <http://news.uchicago.edu/article/2013/01/24/more-30000-prospective-college-students-apply-uchicago#sthash.AmJe1qn6.dpuf>

Urciuoli, B., 1999. Producing multiculturalism in higher education: who's producing what for whom? In:Collins, J., Calagione, J., Thompson, F. (Eds.), *Culture, Dream and Political Economy: Higher Education and Late Capitalism*, Vol. 12(3). International Journal of Qualitative Studies in Education, 287–298

U.S. Department of Education. 2008. Organization of US Education. Available at: http://www2.ed.gov/about/offices/list/ous/international/usnei/us/edlite-org-us.html

Vardardottir, Arna. 2012. Peer Effects and Academic Achievement : A Regression Discontinuity Approach. *Economics of Education Review* 36 (10): 108–121.

Vernez, G., & Abrahamse, A. 1996. *How immigrants fare in U.S. education*. Santa Monica, CA: Rand.

Wang, L., Zhang, Z., McArdle, J. J., & Salthouse, T. A. 2008. Investigating ceiling effects in longitudinal data analysis. *Multivariate Behavioral Research* 43(3): 476–496.

Weingold, S. 2012. "The Three Year College Degree: A Trend on the Rise?" <http://www.collegemadesimple.com/3-year-college-degree-trend/>

Williams, R. 2012. Using the margins command to estimate and interpret adjusted predictions and marginal effects.*The Stata Journal* 12 (2): 308-331.

Winston, G. C., and. Zimmerman, D. J. 2004. Peer effects in higher education. In *College Choices: The Economics of Where to Go, When to Go, and How to Pay for It*, edited by Caroline H. Hoxby. Chicago: National Bureau of Economic Research and University of Chicago Press.

Webb, N., and Farivar, S. 1999. Developing productive group interaction in middle school mathematics. In A. M. O'Donnell & A. King (Eds), *Cognitive Perspectives on Peer Learning* Mahwah, NJ: Lawrence, Erlbaum Associates, 117-149.