UNPACKING THE BLACK BOX: ESTIMATING THE HIGH SCHOOL-LEVEL EFFECTS OF UNDERMATCHING AMONG UNDERREPRESENTED STUDENTS

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DEDICATION

I dedicate this to those who did all they could with what they were given, especially my mother.

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ABSTRACT

UNPACKING THE BLACK BOX: ESTIMATING THE HIGH SCHOOL-LEVEL EFFECTS OF UNDERMATCHING AMONG UNDERREPRESENTED STUDENTS

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Recent studies have revealed how large shares of college-ready students *undermatch,* or enroll in colleges with less competitive admissions processes than they are eligible to attend. Undermatch sits at the nexus of both college access and completion agendas, as undermatching to a less selective institution results in a decreased likelihood of graduating from college. Latino, low-income, and potential first generation college graduates are more likely to undermatch than their nonunderrepresented peers. Many underrepresented students rely on their high schools to help navigate the college choice process, yet we have a limited understanding of how high school characteristics can inhibit or promote the likelihood of undermatch. This study used ELS:2002 data to model within the HGLM framework the likelihood of undermatch. In order to explain the observed variations in undermatch at the high school-level, I measured high school-level predictors in two distinct ways: confirmatory factor analysis to identify individual high school-level measures of college-promoting resources and norms; as well as latent class analysis to create a typology of high school contexts. Findings suggest that students who attend high schools with above average, rather than average, college-promoting resources and norms are less likely to undermatch at the time of application and enrollment, after controlling for student-, school-, and state-level characteristics. Net of other variables, students who were not high income and whose parents did not have a bachelor's degree

were more likely to undermatch than their peers. Smaller shares of Black, Latino, low-income, and first-generation students were eligible to attend selective institutions, larger shares undermatched by qualification level, and larger shares were in low-resourced high schools. Policy implications and directions for future research are discussed.

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CHAPTER 1: INTRODUCTION

More Black, Latino, low-income, and first-generation college students than ever before are participating in higher education – a fact that is leading some to question whether efforts to improve equity should be repurposed on college completion rather than access (Adelman, 2007). However, a closer examination of college participation rates reveals the representation of Black, Latino, low-income students, as well as first-generation college graduates drops precipitously as institutional selectivity increases (Education Trust, 2010; Hill & Winston, 2008; Winston & Zimmerman, 2004). Of high school sophomores nationwide in 2002, one out every six White and one out of every four Asian students compared to an alarming one out of every 25 Hispanic and one out of every 20 Black students attended a highly selective institution (Bozick & Lauff, 2007). The disparities were wider across family income, as one out of every three students from a high-income background enrolled in a highly-selective institution, compared with only one in every 25 of their fellow low-income counterparts.

Recent studies have revealed how large shares of college-ready students *undermatch*, that is enroll in colleges with less competitive admissions processes than their academic qualifications permit or forgo college altogether (Bowen et al., 2009; Roderick et al., 2008; Roderick et al., 2009; Roderick et al., 2011). Many of these studies have also found that students from "underrepresented groups" (defined as African Americans, Hispanics, low-income students, and potential first-generation college students) undermatch at higher rates than their non-underrepresented counterparts, suggesting access to postsecondary institutions continues to be inequitable when considering *where* students enroll.

The implications of undermatch are far-reaching, as students who undermatch forfeit the personal benefits of attending an institution that matches their academic abilities and society fails to fully cultivate the human capital of its members. For all stakeholders, the most pertinent benefit of selective institution attendance is the increased likelihood of college completion, as

Bowen and his colleagues (2009) have demonstrated how the big-fish-little-pond circumstance of undermatching to a less selective institution actually results in a decreased likelihood of graduating from college. Therefore as a policy lever, undermatch sits at the nexus of both college access and completion agendas, since improving the intentionality of college enrollment to matched institutions would inevitably improve completion rates. Increased wages and lifetime earnings, greater job satisfaction, greater likelihood of receiving healthcare and pension benefits, and decreased likelihood of facing unemployment are all personal benefits associated with attaining higher levels of education (Baum, Ma, & Payea, 2010). For selective institutions in particular, other personal benefits include access to greater institutional resources (Gansemer-Topf & Schuh, 2006), greater likelihood of subsequent enrollment in graduate school (Bowen and Bok, 1998; Carnevale and Rose, 2003) particularly at major research institutions (Eide et al., 1998), and greater earnings (Bowen and Bok, 1998**;** Perna, 2003; The College Board, 2003; Zhang, 2005).

The phenomenon of undermatch is situated in the college choice literature, which has revealed how underrepresented students experience the various components of the college choice process in ways that are different from their non-underrepresented peers. Research demonstrates that, compared to their peers, underrepresented students are less likely to be academically prepared and more likely to attain lower levels of academic achievement (Bell et al., 2009; College Board, 2012; Engberg & Wolniak, 2010; Manski & Wise, 1983; Oakes, 1992); less likely to understand college costs and the financial aid process (Avery & Kane, 2004; Avery et al., 2006; Heller, 1997; Horn, Chen, & Chapman, 2003; Perna, 2004); and less likely to complete the necessary steps in the application process (Avery & Kane, 2004; Plank & Jordan, 2001; Roderick et al., 2011). These outcomes are attributable in part because these underrepresented groups are less likely to have parents who attended college and thus have experience with the college choice process.

Underrepresented students who enroll in college immediately after high school rely primarily on their high schools to help navigate the college choice process (Kimura-Walsh et al., 2009; Muhammad, 2008; Perna, 2000). Research confirms that the college-promoting resources (e.g., academic preparation or availability of college guidance) and norms (e.g., the college-going climate or parental involvement) found in high schools have an influence on students' postsecondary decisions (Engberg & Wolniak, 2010; Hill, 2008; McDonough, 1997; Perna & Titus, 2005), and in particular at the application stage – where undermatch is most likely to occur (Bowen et al., 2009; Smith et al., 2012).

Nonetheless, we have a limited understanding of how high school characteristics can inhibit or promote the likelihood of undermatch. We know there is large variation across high schools in the representation of students who are qualified to attend some form of competitive four-year college as well as the percentage of students who undermatch (Roderick, 2006), yet the handful of undermatch studies addressing the high school context have found mixed results in the high schools' role in undermatch (Bowen et al., 2009; Roderick et al., 2011), and only one study to date considered college-going climate as a high school-level measure (Roderick et al., 2011). Moreover, no study has examined the relationship between student-level variations in undermatch and the various measures of college-promoting resources and norms. In addition, findings from previous college choice studies suggest that variations in high schools as organizations also produce variations in college-going outcomes (Hill, 2008; McDonough, 1997). As a natural extension of such findings, different high school contexts (as defined by combinations of college-promoting resources and norms) may promote or inhibit undermatch, but this relationship has not yet been tested.

This study contributes to the existing literature of the college choice process for underrepresented students; furthers the understanding of undermatch; and expands understanding

of how the high school context influences the college choice process by answering the following questions:

1. What is the extent of undermatch for college-ready students at the application and enrollment stages? Does undermatch vary by students' race/ethnicity, family income, and parental education? Does it vary by the types of high school resources and structures provided or by high school contexts?

2. To what extent do these high school resources and structures and high school contexts account for the observed variation in undermatch in the application and enrollment stages above and beyond individual student characteristics?

3. To what extent do the potential gaps in the likelihood of undermatch vary by high school resources and structures or high school contexts by students' race/ethnicity, family income, and parental education?

Students do not make colleges decisions in a vacuum. Therefore solely examining student-level characteristics when trying to understand the forces that explain undermatch omits the role (and responsibility) high schools have in the college-choice process. Better understanding the variations in college-promoting resources and norms across high schools may help to identify policy levers that address undermatch. In turn, findings from this study have the potential to reduce the current stratification and the resultant opportunity structure that is currently perpetuated in higher education.

CHAPTER 2: REVIEW OF LITERATURE

The review of literature opens with a discussion of existing perspectives and models of the college choice process, followed by the conceptual model used to guide this study. Next, I examine student-level predictors of college choice, including measures of human, cultural, and social capital and how they vary for underrepresented students. Previous research relating to the high school-level predictors (e.g., high school structures and resources) that influence college choice is subsequently considered. I then synthesize the existing literature on undermatch, how undermatch estimates vary for underrepresented students, and what the previous research reveals about the high school-level predictors of undermatch. This section concludes with an identification of gaps in the literature of high school-level effects on undermatch.

The College Choice Process

There are many models of college choice that describe the various processes that govern a student's decision to enroll (or not enroll) in postsecondary education. Many studies (Avery & Hoxby, 2003; Perna, 2000) have examined college choice through an econometric lens, which assumes a rational decision-making process by which students weigh the benefits of attending higher education against the costs. Information is one of the major components of the econometric model, as an individual bases their actions on the information he or she possesses. This approach has the advantage of taking into account the variations in college choice across groups, but is limited in explaining the processes by which individuals gather information, develop preferences, or consider contextual influences in order to render a decision (Perna, 2000).

Other researchers (Ceja, 2006; Gonzalez, Stoner, & Jovel, 2003; McDonough, 1997) have used a sociological approach, specifically Bourdieu's theory of social and cultural reproduction, to understand how an individual's background contributes to his or her decisions. Bourdieu uses sociological constructs of social capital, cultural capital and habitus to explain

observed phenomena. Cultural capital is derived from one's class status through the transmission of customs, norms, preferences, knowledge and behaviors transferred from parent to child (Bourdieu, 1986; Bourdieu & Passeron, 1977; Perna, 2000). While all groups have some form of cultural capital, the dominant groups' (middle and upper class) cultural capital is perceived as most valuable (McDonough, 1997). In college choice, a student's cultural capital can inform and shape various dimensions of the college enrollment process including: the expectations and information he or she receives from parents, how students prepare for postsecondary education, the manner in which students navigate the college admissions process, and the set of institutions students consider (Engberg & Wolniak, 2010; Perna & Titus, 2005). Social capital refers to the resources acquired through one's system of social networks that can be transformed into other types of capital, such as economic capital, and is dependent upon the summative strength of the social networks of the individuals within one's network in addition to the resources acquired through these networks (Bourdieu, 1986; Bourdieu & Passeron, 1977; Perna, 2006). Habitus is one's belief system, including one's embodied proclivities and tastes, which are born from one's environment (Bourdieu & Passeron, 1977; Perna, 2006). The sociological approach can inform how individuals acquire information through their environments and other individuals, but does not explain the decision-making process of an individual (Perna, 2006). Both econometric and sociological approaches, therefore, complement each other in examining college choice.

With particular attention to how context influences choice, Perna (2006) integrates the econometric model of human capital investment with the sociological constructs of habitus, social capital, and cultural capital in a conceptual model of student college choice, as illustrated in Figure 1. At its core, this four-tiered model is driven by the rational human capital theory of the expected benefits of higher education (both monetary and non-monetary) contrasted with the expected costs (costs of attending college as well as foregone earnings), and is tempered by the student's demand for higher education (in the form of academic preparation and achievement)

along with the availability of resources to cover the costs of college (family income and financial aid). Recognizing that choice cannot be examined sans context (Lin, 2001; Perna, 2006), the first layer of influence is habitus. Perna (2006) takes into account the demographic characteristics, social capital and cultural capital that inform an individual's perceptions of expected benefits and costs of higher education, and thereby his or her choice process. The second layer acknowledges the school and community context's influences, where the resources provided by the school and community can either enhance or inhibit choice. The higher education context accounts for the institutional characteristics and the information institutions share directly and indirectly that affect the other contextual dimensions (school and community context; habitus) as well as the analysis of costs versus benefits. Finally, the social, economic, and policy context is broader in scope and includes the demographic, economic, and public policy characteristics of the area, which may have direct and indirect influences on choice. This model encompasses the multi-step, multi-tiered process that is student college choice. In addition, Perna's (2006) model has been modified to explicitly reflect Hossler-Gallagher's three stages (predisposition, search, and choice) embedded within the many layers of (Figure 1).

Perna's (2006) model was selected to guide this study for its nuanced approach and its acknowledgement of the many actors (as near as a parent or remote as federal legislation) that influence an individual's college choice process. Outside of the home, the school and community have the largest potential to influence the college choice process (Kimura-Walsh et al., 2009; Plank & Jordan, 2001). Students who lack the resources from the forms of social and cultural capital that are necessary to successfully navigate the college application process will rely more on their high schools. This dependence on school resources can be particularly perilous if the high schools are under-resourced (Gonzalez et al., 2003; McDonough, 1997; Perna, 2007).

The conceptual model predicts that "undermatch" (at both the application and enrollment stages) is a form of college choice where students make rational decisions based on available

information. Characteristics of students' homes, schools and communities as well as the preferences they develop from these environments are expected to influence information and other aspects of the decision-making process (Dejardins & Toutkoushian, 2005). The remainder of this review brings together three sets of literature that drive undermatch: the student-level characteristics and preferences of college choice (layer 1); the resources and structures provided in the high school context (layer 2); and the student and school-level characteristics specific to undermatch.

Student-Level Predictors of College Choice

A student's decision to apply to or enroll in an institution, according to the guiding conceptual model, is based on an analysis of the cost versus the benefits of attending college, the availability of financial resources and aid, and the extent to which students are academically prepared and demonstrate academic achievement (human capital). This rational analysis is influenced by a student's personal tastes (cultural capital) and the information about college they acquire from their networks (social capital; Perna, 2006). Underrepresented students experience all of these components of choice in different ways than their non-underrepresented counterparts.

Human Capital: Supply of Resources & Expected College Costs

The availability of financial resources plays a large role in how students approach the college choice process, particularly for low-income students, as per human capital theory. Students whose families have fewer resources were less likely to be academically qualified and ultimately enroll in college (Bozick & Ingels, 2007; Bozick & Lauff, 2007). Another associated challenge with having fewer financial resources is the cost families may incur in the search process (e.g., campus visits, private college advising, and other resources that are considered advantages in college admissions; Hossler et al., 1999). Lower-income families are also less likely to save for college (Miller, 1997 as cited in Cabrera and La Nasa, 2000) and less willing to

take out college loans (Bell et al., 2009). The likelihood of college enrollment for students from low-income families decreases as tuition increases (Heller, 1997). As the availability of need-based financial aid increases, the likelihood of enrolling in a postsecondary institution increases as well (Perna & Titus, 2004), especially among students from low-income families (Heller, 1997) who are high-achievers attending selective institutions (Harper & Griffin, 2011).

The amount students will be expected to pay for college as well as foregone earnings are also part of the determination of whether and what type of college is worth the investment (Perna, 2006). Students' perceptions of costs are more accurate determinants of college-going behavior than actual college costs (Perna & Steele, 2011), as people act on the information they possess, regardless of veracity or accuracy (Desjardins & Toutkoushian, 2005). The general lack of exposure to information about college costs as well as financial aid and how to apply for it is also an impediment in the college choice process, as this lack of information often leads to an overestimation of college costs (Avery & Turner, 2010). Avery and Turner (2010) found that students with lower household income and parental education were less likely to know of college prices and the availability of tax credits than their socio-economic counterparts. Parents of Black and Latino students were also less likely to have accurate information about college costs than White parents (Avery & Kane, 2004). Of students who decide not to continue to postsecondary education after high school, low-income students are more likely to cite they cannot afford school (Chen, Wu, & Tasoff, 2010b). In addition, as Black students' reported importance of controllable costs increases, their likelihood of enrolling in a four-year institution decreases (Perna & Titus, 2005). Underrepresented students, therefore, may opt out of certain institutions because they may perceive the costs of attending to outweigh the benefits.

Human Capital: Academic Preparation & Achievement

Academic preparation and achievement are core components of the conceptual model and major determinants of college choice. Yet, there remain well documented gaps in academic

achievement between underrepresented students and their counterparts (National Center for Education Statistics, 2010) which start in the early grades (Hurtado et al., 1997; National Center for Education Statistics, 2011) and are typically measured by students' GPAs or test scores (Perna, 2006). Academic preparation, and in particular course rigor, is also an important predictor of college enrollment (Engberg & Wolniak, 2010; Roderick et al., 2006). However, underrepresented students are less likely to have the opportunity to be in the most rigorous academic tracks or take the most rigorous courses, such as higher level math courses,[1] Advanced Placement (AP), or International Baccalaureate (IB) programs (Bell et al., 2009; College Board, 2012; Engberg & Wolniak, 2010; Oakes, 1992; Perna et al., under review; Roderick et al., 2006). As a result of these disparities in preparation and achievement, many underrepresented students are underprepared and/or unable to demonstrate sufficient levels of achievement in order to be competitive for selective four-year college admissions.

Cultural Capital: Value of College Attainment

A student who participates in and shares the dominant class's cultural knowledge and behaviors (cultural capital) will also have access to more college-promoting resources (McDonough, 1997; Perna, 2006).

Measures of parental encouragement and expectations are used in previous research (Perna, 2006), and have both been found to positively predict college enrollment (Perna and Titus, 2005). Nonetheless, there are differences across race/ethnicity, income, and parental education in how often high school seniors reported discussing college with their parents, as well as how much postsecondary education parents expected their children to attain (Chen, Wu, & Tasoff, 2010b). In summary, while all individuals have cultural and social capital, students from underrepresented backgrounds are less likely to possess the types of knowledge of the cultural

[1] Highest math course taken is an ideal measure of preparation as high school math courses have a clear course sequence (Perna, 2006).

norms and expectations that are valued by the dominant culture and would help them negotiate the college choice process (McDonough, 1997).

Social Capital: Networks & Information about college

Drawing on the conceptual model, social capital is how a student's network (parents and siblings, peers, and school personnel) transmits information about, and assistance with, the college process. Similar to other elements of the conceptual model, the nature of the sources and information, however, are different for underrepresented students.

Social Networks & Information about College

Parents transmit college-promoting social capital through their relationships with their children, school personnel, and the parents of their children's friends (Coleman, 1988; Perna, 2006). The likelihood of enrolling in postsecondary education increases as the measures of college-related parent-student discussions, parent contact with school personnel, and parent interactions with other parents also increase (Perna and Titus, 2005). However, other research suggests that parents of underrepresented students may be constrained in their ability to serve as purveyors of college information. In a qualitative study of 20 first-generation low-income Chicana seniors in California, Ceja (2006) used a social capital lens to better understand how parents and siblings serve as sources of information in the college choice process. The author concluded that regardless of the participants' academic ability, parents were limited to "emotional and financial support" because they did not possess knowledge of how to prepare for or apply to college (p. 93). The author also points to language barriers as a major impediment to parental involvement and their inability to acquire information about the college application process.

There is also evidence that supports college-going siblings and other family members may serve as surrogates in their parents' stead (Ceja, 2006; Perez & McDonough, 2008; Perna & Titus, 2005). In a qualitative study of 106 high-achieving Latino juniors and seniors in California,

Perez and McDonough (2008) apply chain migration theory, a concept that describes how migrants leverage networks to facilitate their relocation, to better understand college choice. The authors illustrate how Latino high school students use their networks of current college students in their college decision processes, including siblings, extended family members, and peers. Similarly, college enrollment is also closely related to the number of friends who are college-bound (Perna and Titus, 2005).

Assistance with the College Process

Due to their historic underrepresentation in higher education, Black, Latino, low-income and potential first-generation college students will rely on their high schools' resources, and primarily guidance counselors, to provide them with the information they need to successfully negotiate the college choice process (Kimura-Walsh et al., 2009; Muhammad, 2008; Perna, 2000). Perna (2000) reported Black and Latino students are more likely to receive help on the college application process from school personnel than White students. Kimura-Walsh et al. (2009) found that in a majority-Latino urban high school, students "relied exclusively on school resources to navigate their college preparation process" (p.298), which included college and career information provided through school personnel and resource centers. Of the students surveyed in their study, 60 percent indicated either a teacher or counselor as their primary source for college information. Using critical race theory to guide her study and regression procedures to analyze the data, Muhammad (2008) contended that in addition to academic ability and aspirations, Black students need "cultural support" in their college choice process and counselors' expectations can have a positive impact on college predisposition for Black students. For better or worse, many underrepresented students look to the school guidance counselor and other high school resources to bridge the gap in knowledge and support.

In summary, previous research shows that underrepresented students are disadvantaged in the college choice process in several ways: they are less likely to think they can afford college

(Avery & Turner, 2010; Perna & Steele, 2011), are less likely to be academically prepared (Bell et al., 2009; College Board, 2012; Engberg & Wolniak, 2010; Oakes, 1992; Roderick et al., 2006), and are less often exposed to the dominant culture's college-going norms at home (Ceja, 2006; Perez and McDonough, 2008). As a result, they are more likely to rely on their high schools for college-promoting norms and resources (Kimura-Walsh et al., 2009; Muhammad, 2008; Perna, 2000).

High School-Level Predictors of College Choice

While in high school, students are exposed to various resources (e.g., academic preparation, the delivery of college guidance) and structural supports (e.g., a network of peers, parents, and school personnel) that shape "tastes for particular types of postsecondary education" (Hill, 2008, p. 67). However, the nature and availability of these resources vary greatly across high schools (Engberg & Wolniak, 2010; Hill, 2008; McDonough, 1997; Perna & Titus, 2005; Perna, Rowan-Kenyon, Thomas, Anderson, & Li, 2008). Examining an individual's choice process in the context of his or her organizational environment will better inform the undermatch phenomenon.

Studies have shown that the high school context as both the availability of high school resources and the structural supports or norms matters (Hill, 2008; McDonough, 1997). McDonough (1997) conceptualized "organizational habitus" as an extension of Bourdieu's construct of habitus. In her case study analysis of the college choice process for white female students in four high schools in California, McDonough underscored how variations in high school structures and norms are associated with variations in resultant college choices across socio-economic class. The concentration of social and cultural capital preferred by the dominant culture in high schools attended predominantly by upper middle class students facilitated the transfer of valuable information about college. Students made decisions based on many sources of information, with much input from their social network of school personnel, parents, and friends.

In contrast, at high schools with higher representation of students from lower socio-economic backgrounds, the availability of high school resources and structural supports directed students towards different postsecondary options. These students had more constrained college search experiences and had fewer resources from which to draw upon. The findings illustrate how the organizational habitus of each case study high school created an opportunity structure that perpetuated class structures.

Using longitudinal data from the 30 largest Metropolitan Statistical Areas, Hill (2008) used latent class modeling to group high schools by three college-linking strategies, or strategies that "facilitate college transitions" (p. 53): traditional, clearinghouse and brokering. The high schools that provided the least amount of resources and support (traditional) were also more likely to have a higher concentration of students from racial/ethnic minority groups and lower levels of parental education and income and had higher student-teacher ratios than high schools with clearinghouse or brokering approaches. Clearinghouse and brokering high schools provided moderate to high encouragement of college visits, assistance with college and financial aid applications as well as contact with college representatives. Findings from multilevel analyses suggested that college-linking strategies matter to college outcomes. Using the traditional strategy as a reference, students who attended a high school falling under the clearinghouse or brokering college-linking strategies were 600 percent and 800 percent more likely to attend a four-year college versus a two-year college, respectively. When considering two-year college enrollment versus choosing no college, students were much more likely to opt for the latter in high schools that had clearinghouse and brokering strategies, when compared to the traditional strategy. Overall, the findings illustrate that the availability and delivery of information needed to successfully navigate college application and enrollment processes produce differential results across varying compositions of high school structures and resources.

High School Resources: Academic Preparation & Achievement

The overall level of academic achievement of a high school's student body as well as the resources the high school provides to students in the form of academic preparation matter to college-going outcomes. There is a positive relationship between high schools' average levels of academic achievement and the strength of academic preparation programs (Handwerk et al., 2008). Conversely, academically low-performing schools tend to shift resources to provide more support to students at risk of not graduating (Perna et al., 2008) and send fewer students to college (Roderick et al., 2006).

With regard to academic preparation, not all high schools provide the same opportunities for students to participate in intense academic tracks and develop their human capital (Handwerk, 2008; Oakes, 1992; Oakes & Guiton, 2005). Latino, Black, and low-SES students are less likely than White, Asian, and high-SES students to attend high schools that offer calculus and trigonometry (Adelman, 2006). A high school-level descriptive analysis of AP course offerings revealed that Black students were most likely (19 percent) of any racial/ethnic group to attend a high school that did not offer any AP courses, whereas Asian students were least likely (6 percent). Similar patterns were shown by students' family income, where nearly 1 out of every 5 low-income students attended a high school that did not offer any AP exams, compared to 1 of every 8 non-low-income students (Handwerk et al., 2008). Underrepresented students also have less access to college-track courses (e.g., college-prep math) within high schools than their respective non-underrepresented counterparts of similar academic ability as the result of non-neutral implicit practices (Oakes & Guiton, 2005). Income, parental education and academic performance are intertwined, as students who are underrepresented in higher education are also concentrated in low-preparation high schools.

High School Resources: College Guidance

As conceptualized in the guiding framework, high school guidance counselors function as a formal high school resource. While the information guidance counselors impart through their relationships with students is considered part of the first layer as social capital, in the second layer, the extent to which high schools make counseling available is the major focus. The way in which college guidance is structured within a high school and the types of college-going resources high schools provide depends on the high school's college-going mission, explicit roles for their college guidance professionals, the number of students they are expected to serve and the resultant time they have to interface with students (McDonough, 1997). As high school missions vary (college preparatory, vocational, etc.), so do the responsibilities and structure of college guidance. A nationally-representative sample of public high school counselors surveyed revealed counselors ranked their departmental responsibilities differently than counselors at private high schools, where public high schools have a focus on helping students complete high school rather than prepare them for postsecondary options (The College Board Advocacy & Policy Center, 2011). At low-resource public high schools with low passing rates on high-stakes state exams, counselors cited the basic milestone of helping students pass (Perna et al., 2008) or "helping students with their academic achievement in high school" as their top priority. In contrast private high school counselors were more likely to rank "helping students plan and prepare for postsecondary education" first (Clinedinst, Hurley, & Hawkins, 2011). Taken together, these studies suggest that the college guidance structure is linked with high school goals and priorities.

Related to school priorities, another facet of the college guidance structure is the share of time that counselors have to actually perform college guidance duties. Research has shown guidance counselors are typically responsible for many administrative tasks beyond counseling, including testing administrators and disciplinarians, which disproportionately affects schools with high representation of underrepresented students (Clinedinst et al., 2011; McDonough, 2005; Perna et al., 2008). A survey administered by the National Association for College Admission

Counseling (NACAC) of 1,846 high school counselors found the average student-to-counselor caseload is over 407:1, with high schools serving students who predominantly receive free and reduced lunch burdened with the largest caseloads. NACAC's survey also revealed that in public high schools, where the majority of underrepresented students attend, counselors spend only 23 percent of their time providing college counseling, as compared to the 55 percent of the time spent by their private school counterparts (Clinedinst et al., 2011, Table 26).

Differences in the quality and quantity of college guidance have also been shown to exist within high schools (Hossler et al., 2009; Kimura-Walsh et al., 2009; Linnehan, Weer & Stonely, 2011; Perna et al., 2008). Constraints on resources coupled with competing interests have a triaging effect on the attention of high school guidance counselors, with the neediest students becoming the main beneficiaries for non-college related matters (Perna et al., 2008). High-achieving students also spend more time with their counselors than their peers (Kimura-Walsh et al., 2009) and tend to be singled out and provided more resources by teachers and counselors (Hossler et al., 1999). Other research has found that college guidance within a school can vary by race and socioeconomic status, where counselors are more likely to recommend two-year institutions to low-income students than their higher-income counterparts of similar academic ability (Linnehan, Weer, & Stonely, 2011).

High School Structure: College-Promoting Networks

Researchers have used multi-level modeling to examine parent and peer effects on college enrollment (Engberg and Wolniak, 2010; Perna and Titus, 2005). While the extent to which high schools encourage parental involvement had little effect on the likelihood of enrolling in a postsecondary institution, the likelihood of enrollment in a four-year institution increased as the average parent-initiated contact increased (Perna and Titus, 2005) and the number of parents knowing the other students' parents in school increased (Engberg and Wolniak, 2010). Moreover, friends' postsecondary plans are highly associated with the likelihood of a student having similar

plans (Engberg and Wolniak, 2010; Perna and Titus, 2005). As the number of students in a high school whose friends planned to enroll in a two-year or four-year institution increased, the probability of enrolling in a two-year or four-year institution increased, respectively.

Summary

The previous section highlighted how underrepresented students come to rely on high schools for resources and supports in order to navigate the college choice process. While academic preparation, social networks, and college guidance provided at the high school-level are all predictive of college enrollment, underrepresented students are less likely to have access to or benefit from these high-school supports and resources. This lack of access suggests that aspects of the college choice process that result in undermatch may fall at the feet of high schools and their structures. Therefore, examining the availability of these high school-level resources may help explain why underrepresented students undermatch at higher rates.

The Study of Undermatch

The notion of a student's college "match" or "mismatch" arose from empirical analyses that tested whether students who were admitted into selective institutions under affirmative action policies were not as qualified as other students (and thus a "mismatch" of student qualification and institutional selectivity; Alon & Tienda, 2005; Bowen & Bok, 1998). However, the foci of these studies were not the college choice process, but student performance and persistence once they were enrolled at these selective institutions. Other studies have coarsely examined match as whether students who are college-ready enrolled in college (versus no college; Department of Health, Education, and Welfare, 1969) or students who are eligible to attend four-year institutions match by institution level (versus two-year college or no college; Plank & Jordan, 2001). The last decade, however, has seen a growing interest in examining the extent to which students' academic credentials are aligned with the institutional selectivity of where students choose to

apply and enroll; the groups of students who are most likely to undermatch; and how the high school context influences the likelihood of undermatch.

Estimating Undermatch

Undermatch is an *estimate* of the highest level of selectivity for which a student is likely to gain admission compared to where the student applies or enrolls. Previous studies have estimated undermatch in various ways. Studies have examined a variety of populations (i.e., district, state, national), used several definitions of institutional selectivity, with different methods of estimating student qualifications.

Researchers have previously studied undermatch in populations in a variety of geographical locales (e.g., a single state or school district). For example, The Chicago Consortium studies (Roderick et al., 2006, 2008, 2009, 2011) focused on Chicago Public Schools students and postsecondary institutions in and around Illinois. In *Crossing the Finish Line*, the authors study North Carolina high school graduates who attended state public postsecondary institutions (Bowen et al., 2009). Not nationally representative but transcending state lines, Hurowitz et al. (2012) used an SAT test-taking sample of public high schools in 17 states with high SAT participation rates. Recently, Smith and colleagues (2012) published the first nationally representative estimates of undermatch using data from ELS:2002.

Many studies used the Barron's Admissions Competitiveness Index to define institutional selectivity, which includes seven levels of selectivity for four-year postsecondary institutions ranging from “Most Competitive” to “Non-Competitive.” These ratings are compiled using SAT/ACT scores of admitted students, the GPA and class rank required for admission and the percentage of applicants accepted (Barron’s Educational Series Inc., 2004). However, there is variation in how studies defined selectivity categories in their studies. In many cases (Bowen et al., 2009; Roderick et al., 2008), the authors defined the selective categories based on the most prevalent institutions in their respective samples.

Studies have also estimated qualifications for admission in different ways. Using a combination of ACT scores, GPA, and a measure of course rigor (participation in IB or AP), the Chicago Consortium (2006) developed a rubric for identifying student eligibility for their four levels of institutional selectivity by using enrollment information. Establishing a similar rubric of exam scores and GPA to determine student eligibility, students were identified in Bowen et al.'s (2009) study as academically qualified if 90 percent of students with a combination of SAT scores and GPA were admitted to the most selective institutions in their study. Using application and admission data, Smith and his colleagues (2012) predicted the probabilities of students gaining admission to each level of selectivity defined in their study using admissions data from ELS:2002, a nationally representative dataset.

Irrespective of how researchers have estimated undermatch, all studies found rather high rates of undermatch. The Chicago Consortium found an overall undermatch rate of 62 percent in the district, with large variation across ability levels (Roderick et al., 2008). Their 2009 study that focused on high-achieving students also revealed that although CPS's expansion of AP and IB programs led to two-thirds of CPS's advanced program graduates possessing the test scores and GPA to be in contention for selective admissions, 63 percent did not enroll in selective institutions (Roderick et al., 2009). Bowen et al.'s (2009) state-level analyses concluded that up to 40 percent of the most academically qualified students in North Carolina did not enroll in selective institutions. Nationally, an estimated 41 percent of the Class of 2004 graduates undermatched (Smith et al., 2012).

Underrepresented Students Undermatch at Higher Rates

Consistent with the literature in other areas of college choice, many of the undermatch studies (Bowen et al., 2009; Roderick et al., 2006; Roderick et al., 2009) have found that the extent of undermatch varies by demographic characteristics. Latino students undermatch at higher rates than their racial/ethnic counterparts (Roderick et al., 2008; Smith et al., 2012), even after

controlling for demographic, academic, and high school characteristics. However, studies that were able to analyze Black student populations did not find them to undermatch at higher rates than White students (Smith et al., 2012). As explained by Smith and colleagues (2012), there are fewer observations of Black students undermatching than White students because fewer Black students are qualified to attend four-year institutions, "and so mechanically, they have less of an opportunity to undermatch" (p. 13).

In addition, students with lower rather than higher family income and whose parents have lower levels of education rather than higher levels were also more likely to undermatch (Bowen et al., 2009; Smith et al., 2012). Bowen et al. (2009) noted that only one-third of highly qualified students from parents who had no more than a high school diploma attended a selective institution. When controlling for measures of demographic, academic, and high school characteristics the propensity to undermatch by SES, parental education and family income remained (Bowen et al., 2012; Smith et al., 2012). However, one study found measures of mother's education as well as proxies of neighborhood poverty and educational attainment in Chicago for individual income and SES had no predictive power on the propensity to undermatch when controlling for other student and school-level variables (Roderick et al., 2011). This discrepancy in findings could be a result of differences in population, as poverty and SES measures may behave in distinct ways in Chicago.

How can we further explain this variation in the undermatch rates between underrepresented students and their non-underrepresented counterparts? First, there appears to be an issue of academic preparation and achievement. Because attaining the requisite academic benchmarks is a large barrier for underrepresented students, as noted in previous college access research, they are less likely to be eligible for some form of competitive college admissions. Roughly one-half of Black and Latino seniors in Chicago and over 70 percent nationally did not have the academic credentials to be eligible for any college admission (Roderick et al., 2006;

Smith et al., 2012). Moreover, the proportion of eligible underrepresented students decreases dramatically as the institutional selectivity (and thereby academic qualifications) increases. Second, underrepresented students were also less likely to take the steps necessary to enroll than their nonunderrepresented peers (Roderick et al., 2011). For example, even when controlling for four-year college aspirations, college-ready Latino student were less likely to plan to attend a four-year institution than any other racial/ethnic group. As the students progress through the college qualify-apply-admit-enroll process, Black and Latino students increasingly fell behind their White and Asian peers (Roderick, 2008).

However, these differences in undermatch rates between underrepresented students (except for Black students), and their non-underrepresented peers cannot be explained solely by student-level measures of academic preparation, academic achievement or college-going behaviors. The guiding framework and existing literature points to how the different levels of context yield varying college choice processes for students from underrepresented backgrounds – in particular high schools have the structures and resources to influence all aspects of the preparation, search, application and enrollment processes.

Understanding the High School Context's Role in Undermatch

Those who study undermatch converge around similar explanations for the observed phenomena: students lack the academic preparation as well as the particular college-promoting social and cultural capital necessary to navigate the admissions and financial aid processes (Roderick et al., 2009). Specifically, they discuss deficits in college planning and completing the various steps in the college admissions process, access to information about college and financial aid, and the encouragement needed to convert aspirations into college enrollment (Bowen et al., 2009; Roderick et al., 2008; Roderick et al., 2009; Roderick et al., 2011) – resources and structural supports that high schools can provide as a way to mitigate the chances of undermatch

(Roderick et al., 2006). However, there are a few studies that examine how measures of high school resources and supports have a role in the extent to which students undermatch.

Basic high school-level characteristics, such as size, urbanicity, and racial/ethnic composition, and district-level expenditures have some bearing on the likelihood of undermatch (Hurwitz et al., 2012). Hurwitz et al. (2012) used regression analysis to determine which high school characteristics explain undermatch. The authors found larger high schools, as well as suburban high schools are less prone to undermatch than smaller high schools and those in urban and rural areas. In addition, the high school's undermatch rate declined as the percentage of underrepresented minorities increased and increased as the share of students eligible for free and reduced lunch at the school increased. While it may be helpful to identify the characteristics of the high schools where undermatch is most likely to occur, one limitation of this study is their high school measures are not linked to policies or practices related to undermatch. Changing the racial/ethnic composition or urbanicity of a high school is not a viable option for improving undermatch.

In addition, the relationships between undermatch and the high school-level measures of academic preparation and achievement have also been examined (Bowen et al., 2009; Huwitz et al., 2012). Bowen et al. (2009) found that high schools that offered more AP courses as well as had higher average SAT scores had lower levels of undermatch than high schools that offered fewer AP courses and had lower average SAT scores. The authors of *Crossing the Finish Line* also looked at undermatch at the high school level. Bowen et al. (2009) combined ACT, College Board and NCES data to create a national database of high schools and used a combination of school-level measures (the percentage of seniors taking the SAT, average SAT scores of the students who took the SAT, an imputed average SAT score for students who did not take the exam, and the number of AP courses taken by students) to define three levels of high school academic rigor (Level I being the most academically rigorous and Level III the least).

Descriptively, students from the most academically rigorous Level I schools (32 percent) were much less likely to undermatch than Level II (48 percent) or Level III (55 percent), although the level of high school academic rigor was reported to be unrelated to undermatch, when controlling for other high school and student characteristics.

However, findings from a recent study suggest that preparation and achievement may not operate in the same ways. In their high school-level analyses, Hurwitz and his colleagues (2012) found high schools with higher percentages of students taking the SAT also had low undermatch rates. Larger shares of students taking the SAT could be a reflection of statewide or school-wide test-taking policies. In contrast, as schools' average SAT scores increased, the rate of undermatch increased as well. The authors offered that, as students' academic qualifications increase, so do their opportunities to undermatch. Disentangling high school measures of academic achievement and preparation may provide a better understanding of their relationships with undermatch.

With regard to college-promoting networks, the Chicago Consortium (Roderick et al., 2008; Roderick et al., 2011) has made strides in surveying teachers and students to better understand the culture in which students make their decisions. Their 2011 study revealed students who attended schools that reported high (rather than low) levels of teacher-reported college-going culture were more likely to enroll at institutions that matched their academic qualifications (Roderick et al., 2011). In addition, connections to school personnel seem to matter, as students who reported stronger connections with their teachers and having discussions about college planning at school also had improved students' likelihoods of matching (Roderick et al., 2008).

The way college guidance is structured and delivered within a school also has an association with undermatch outcomes (Roderick et al., 2011). As measures of college guidance, students who attend a high school that has a high (rather than low) percentage of students attending four-year institutions or high schools that have a high (rather than low) percentage of students completing the FAFSA are more likely, on average, to enroll at institutions that match

their academic qualifications. Unexpectedly, the extent to which students reported encountering supportive counselors or receiving structured college-going support from the school was also positively associated with the likelihood of undermatch. The authors offered several possible explanations for this unexpected finding, namely that students struggling with the college choice process are the ones most likely to seek the services of counselors, or selection bias, for which they did not account (Roderick et al., 2011).

Summary

Many aspects of the college choice processes for Black, Latino and low-income students are distinct from those of their counterparts, especially with respect to how they are academically prepared for postsecondary education (Bell et al., 2009; College Board, 2012; Engberg & Wolniak, 2010; Oakes, 1992), their understanding and responses to the availability of financial aid (Avery & Kane, 2004; Avery et al., 2006; Heller, 1997; Horn et al., 2003; Perna, 2004), and their likelihood of completing various components of the application process (Avery & Kane, 2004; Plank & Jordan, 2001; Roderick et al., 2011). Moreover, parents of underrepresented students may have minimal postsecondary experience and therefore serve as limited resources for acquiring information about their postsecondary options (Ceja, 2006; Perez & McDonough, 2008). As a result, research suggests that underrepresented students rely primarily on their high schools resources, to help them navigate the college choice process (Kimura-Walsh et al., 2009; Muhammad, 2008; Perna, 2000).

Previous research supports the assertion that the high school environment influences students' postsecondary decisions (Engberg & Wolniak, 2010; Hill, 2008; McDonough, 1997; Perna & Titus, 2005). There are large variations across high schools in the nature of college-promoting resources and structural supports (Engberg & Wolniak, 2010; McDonough, 1997; Perna & Titus, 2005; Perna et al., 2008). Strides have been made in understanding the high school context's influence on college outcomes by sector and the various high school-level forces that

shape these decisions (Engberg & Wolniak, 2010; Perna and Titus, 2005). However, significantly less is known about how the high school-level context - its resources and norms -influences the selectivity of the institutions to which students may apply and enroll, and possibly undermatch. Existing research on undermatch, generally, and high school-level explanatory measures, specifically, has many limitations regarding the studies' datasets and populations, estimations of undermatch, and attention to student- and school-level measures.

Many of the studies that examine undermatch are limited by their datasets and populations. While Chicago is the third largest school district in the country, the population (Chicago public high school students) from which all of the Consortium's works have focused does not allow for generalizability beyond this particular district. Many lessons can be learned from a high poverty urban district with a large share of underrepresented students. However, as the conceptual framework suggests, state policies (e.g., availability of student financial aid, higher education structure in the state), the institutions nearby, and district policies (e.g., implementation of IB program) are all specific to Chicago and shape student choice in these studies in unknown ways. Bowen et al.'s (2009) use of student-level data from North Carolina broadens the examination of undermatch from Roderick et al.'s (2009) district-level analyses but is limited by North Carolina's state-specific higher education policies. Moreover, the study could not draw conclusions around the extent of undermatch by race/ethnicity. The large presence of HBCU's in North Carolina attributed most of the undermatching of Black students in the sample to HBCUs. In addition, there were insufficient data for Hispanic students in order to assess their undermatch rates. Furthermore, while the College Board data used by Hurwitz et al. (2012) can provide rich information about student test taking history and high school characteristics, the inferences one can make about their findings is limited because the population of SAT test takers is not a nationally representative sample, but represented 17 states and high schools within those states that have high SAT participation rates. Students may opt to take the ACT exam in order to

apply to college and would therefore not be included in this study. In addition, students who undermatched into institutions that did not require the SATs or forego college altogether might not take the SATs or any other college entrance exam and would be omitted from the sample. Unlike Bowen et al.'s (2009) study, the conclusions drawn from Hurwitz et al. (2012) and others who may restrict their samples on the availability of test-taking data (Smith et al., 2012) are limited to those students who have experienced these exams during their college preparation and choice process.

In some studies, little attention has been paid to controlling for either the student- or high school-level effects (Hurwitz et al., 2012; Roderick et al., 2009). Roderick et al.'s study on high-achieving students did not control for any high school-level measures. On the other hand, other studies (Hurwitz et al., 2012) only consider high school-level measures without examining the student-level components that lead to how students select their colleges.

A handful of studies considered both student- and high school-level effects on undermatch (Bowen et al., 2009; Roderick et al., 2011; Smith et al., 2012), yet have limited high school-level measures. Smith and his colleagues' study used high school urbanicity, which speaks little of the structure and resources provided in high schools. Bowen et al. (2009) define high schools largely by measures of academic achievement (SAT scores) and academic preparation (availability of AP courses). Comparing undermatch rates across three levels of high school rigor, while useful, ignores other facets of a high school's organizational structure that previous research tells us matters in college choice, such as college guidance or college-promoting networks. In addition, Bowen et al.'s (2009) measure of rigor does not disaggregate academic achievement from academic preparation. Roderick et al. (2011) shed the most light on how school-level predictors influence the likelihood of undermatch. The authors used a multi-level model to examine the extent to which college-going climate (teacher assessment of college climate, percentage of prior year graduates attending a four-year college, percentage of prior year

graduates who applied to three or more colleges, percentage of prior year graduates who completed a FAFSA) can explain the variation in undermatch observed across high schools. College-going climate is of conceptual importance to the undermatch story. However, it is only one construct of many school-level predictors that can explain undermatch within the high school context, and the study does not take into account the high school resources or other measures of high school norms.

Few studies (Bowen et al., 2009; Roderick et al., 2011) have leveraged the various facets of the high school context and its explanatory power to better understand why underrepresented students undermatch at higher rates. Several conceptual as well as methodological contributions to the extant literature are needed in order to better understand undermatch. First, a nationally representative sample, such as the ELS:2002, would allow for generalizability. Second, ELS:2002's large sample size also allows for more complex modeling, particularly at the high school level. Third, the use of a multi-level model with high school-level measures of academic preparation, college-promoting networks, and college guidance structures reflect the various facets high schools have on college choice. The data-rich ELS:2002 has information on all of these measures (Engberg & Wolniak, 2010). Empirically testing whether high school effects can explain the differences in undermatch for underrepresented students beyond student-level effects is essential in estimating the high school's role in undermatch.

CHAPTER 3: RESEARCH DESIGN

Through this study I examined high school-level effects on undermatch—the phenomenon of students who enroll in less-selective institutions than they are academically qualified to attend – at both the application and enrollment steps in the college admissions process after controlling for student-level effects. Using descriptive statistics, latent class modeling and generalized HLM on data from the Education Longitudinal Study of 2002 (ELS:2002), this study answered the following sets of research questions:

1. What is the extent of undermatch for college-ready students at the application and enrollment stages? Does undermatch vary by students' gender, race/ethnicity, family income, and parental education? Does it vary by the types of high school resources and structures provide or by high school contexts?

2. To what extent do these high school resources and structures and high school contexts account for the observed variation in undermatch in the application and enrollment stages above and beyond individual student characteristics?

3. To what extent do the potential gaps in the likelihood to undermatch vary by high school resources and structures or high school contexts by students' race/ethnicity, family income, and parental education?

Data

This study used data from the ELS:2002, a nationally representative longitudinal survey administered by the National Center for Education Statistics (NCES). NCES surveyed students as sophomores in 2002, seniors in 2004, and two years after students were scheduled to complete high school in 2006. NCES also collected information from the participants' parents, teachers, and other school personnel.

High schools were stratified by geography and urbanicity, with an oversampling of private schools; 750 schools were sampled in total, including public, Catholic and other private schools. Using a two-level stratified sampling technique, NCES first selected schools on the basis of probability proportional to size, a technique where the chances of a unit being selected to participate increase with the number of members within the unit. At the second stage of the sampling, students were sampled within the selected schools, with an oversampling of Asians.

The base year surveys yielded an 87 percent weighted student response rate and a 68 percent school response rate. The final dataset included 15,400 sophomores, 13,500 parents, 7,100 teachers, 740 principals, and 720 librarians. In the first follow up in 2004, the sample was freshened, with a weighted student response rate of 89 percent and a school response rate of 93 percent. The second follow-up, when students were scheduled to be two years out of high school yielded a weighted student response rate of 88 percent (Ingels et al., 2007).

The aim of the ELS:2002 base study was to collect data around seven components: student performance in reading and mathematics; student demographics; aspirations and experiences; parent characteristics; teacher demographics and perspectives; school characteristics; library and media resources; and the condition of school facilities. Math assessments were also administered to students in the 10^{th} and 12^{th} grades. Approximately six months after students were scheduled to graduate, NCES collected high school transcripts from 91 percent of the weighted sample. Information regarding school course offerings was also collected from base-year schools. During the second follow-up study, information on college and labor force participation was gathered, including self-reported data on the institutions to which students applied and were admitted, as well as the institutions where they enrolled, along with institutional characteristics (e.g., selectivity), and retrospective information about college choice. Additional institutional characteristics (e.g. tuition costs, aid, and HBCU status) were merged on from the Integrated Postsecondary Education Data System (IPEDS) 2004 Institutional Characteristics Survey File.

Selectivity was defined using Barron's Admissions Competitiveness, which includes seven levels of selectivity derived which range from “Most Competitive” to “Non-Competitive” for four-year postsecondary institutions.

I extracted the data used in this study from the NCES ELS:2002 restricted use database using the electronic codebook application provided by NCES. After I selected the relevant variables, the electronic codebook produced a SAS syntax file that extracted the data as well as formatted and labeled the variables. It also outputted a variable codebook that includes a description of the variable, any imputation or manipulation done to create the values, distribution (unweighted) of the values found in the sample, and the survey item from which each variable was derived.

Since the ELS:2002 is a national sample design, there are design variables associated with each student regarding the strata; primary sampling unit (PSU), that is, the school; and individual student weights. Since this study used students who are present in the base year, first and second follow up studies, the variable F2F1WT is applied when weighting to the population. For the purpose of hypothesis testing, the weight was normalized, or divided by the mean weight, in order to adjust for the sampling design and preserve the national representation of groups without inflating the sample size and finding spurious relationships.

Analytic Sample

All three waves (2002, 2004, 2006) of data collection have information pertinent to college choice decisions. The sample of students was therefore limited to those who were present in all three waves of the data collection (F2UNIV1 = 101). Following the approach of Roderick et al. (2011), the sample included students who are college-bound: students who are not enrolled in special education (F1RSSPFLG = 1 or 4); have on-time high school completion (F2HSSTAT = 1); who indicated an intention to go to college (F1S45 = 1) and are not attending vocational or alternative high schools (CP02STYP is not 3 or 4). Following the example of Smith et al. (2012),

students who did not enroll in college remained in the sample, as not enrolling in college is considered a form of undermatch. Per NCES guidelines, counts in descriptive tables are rounded to the nearest 10 in order to protect the identity of subjects.

The original ELS:2002 base sample includes 16,120 observations from 750 high schools that represent 3,343,110 U.S. sophomores in 2002. After limiting the sample to the conditions above, the resultant analytic sample is 8,960 students in 730 high schools (or 2,029,340 students weighted, Table 1). For the analyses that have the additional condition of enrollment at a postsecondary institution, the analytic sample is 7,950 (or 1,762,430 students, weighted) in 730 high schools.

Table 1. Unweighted and Weighted Sample Counts for Selection Criteria and Resultant Analytic Samples

Selection Criteria	Unweighted N	Weighted N
Number of students in the base year ELS:2002	16,120	3,343,110
Number of students also present in both follow-ups	12,590	3,095,790
Number of students also not in special education and attending a regular high school	11,910	2,906,310
Number of students who also graduated in the spring of 2003	10,570	2,480,690
Number of students who also indicated they planned to go to college	8,960	2,029,340
Number of students who applied to a college with known selectivity	8,600	1,927,560
Number of students who enrolled in college with known selectivity	7,950	1,762,430

Source: Education Longitudinal Survey (ELS:2002)
Notes: Figures weighted using F2F1WT and rounded to nearest 10

The ability to generalize to the larger population of American sophomores in 2002 is one of the major draws of using a national dataset, and restricting the data to certain subpopulations

may threaten the generalizability of the study's findings. Per NCES guidelines (Buckley, 2011), while I am restricting the sample by certain criteria I did not delete cases, as this produces erroneous standard errors. Instead, I created a variable that denoted whether a student is part of the analytic sample in order to use in PROC SURVEYFREQ and in the DOMAIN statements in PROC SURVEYMEANS and SURVEYLOGISTIC in SAS. This enables SAS to calculate the proper standard errors and preserves generalizability. A comparison of ELS:2002 full sample to the analytic sample by key variables of interest revealed very little to no percentage point differences in the representation of female, Black, or Latino students (Table 2). There is a slight decrease in the analytic sample in the representation of low-income and potential first-generation students (8 percentage points for both). With regard to student-level academic indicators, the students in the analytic sample are academically higher performing students. On average, these students had GPAs that were 0.32 points higher (a difference between a C and B-), scored higher on the math assessment administered in the base year of the study (3.16 point difference, or about one-third of a standard deviation) and for students with college entrance exam scores (SAT score or ACT scores converted to SAT scores), the restrictions resulted in a one-tenth of a standard deviation increase in the average college entrance exam score (24 points). These differences in academic achievement measures are expected, as the population of interest is the population of students who are college-eligible. There is almost no difference in the means of the high school characteristics after restricting the sample.

Table 2. Comparison of ELS:2002 and Analytic Sample by Select Student and School Characteristics[a]

	ELS:2002			Analytic Sample[b]			
Student Characteristics	N	Mean	S.D.	N	Mean	S.D.	Change in Proportion
Female	15,370	0.50	0.50	8,960	0.55	0.50	.05
Black, non-Hispanic	15,240	0.13	0.34	8,960	0.11	0.32	-.02
Latino	15,240	0.15	0.35	8,960	0.12	0.32	-.03
Families earning <$50,000	16,200	0.51	0.50	8,960	0.43	0.49	-.08
Potential first-generation college graduates	15,320	0.48	0.50	8,960	0.40	0.49	-.08
	N	Mean	S.D.	N	Mean	S.D.	Change in Mean
GPA, grade 12[c]	14,780	2.57	0.84	8,460	2.89	0.70	0.32
ELS Math exam score[d]	15,890	50.66	9.88	8,960	53.81	9.08	3.16
SAT Scores[e]	9,530	1005	208	7,210	1028	202	24
High School Characteristics	N	Mean	S.D.	N	Mean	S.D.	Change in Mean
% of student body is FRL, 2002/3	520	0.25	0.19	510	0.25	0.19	0.00
% of student body is minority, 2002/3	740	0.34	0.31	720	0.34	0.31	0.00
% of student body in AP or IB courses	670	0.15	0.14	660	0.15	0.14	0.00
Counselor-Student Ratio	620	331	164	610	332	164	1.40
% of 2003 graduates went to 4-year colleges	690	0.05	0.01	670	0.05	0.01	0.00
% of 2003 graduates went to 2-year colleges/vocational school	680	0.03	0.01	660	0.03	0.01	0.00

Note: (a) Figures are unweighted; (b) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (c) GPA for all academic courses reported on the transcript (mathematics, science, English, social studies, fine arts), unweighted and based on a 4.0 scale; (d) Math standardized T Score; (e) Combined highest Math and Verbal SAT score; possible values range from 400-1600. NCES converted ACT composite scores to SAT.

Source: Education Longitudinal Survey (ELS:2002)

Variables

Dependent variable

The two outcomes of interest in this study are the likelihood of undermatch at the application step and the likelihood of undermatch at the enrollment step. The application step considered all institutions to which the applicant reported applying (UNITID where F2NAPPLY>0), and the enrollment step considered the institution flagged in ELS:2002 as the first postsecondary institution the student attended after high school (F2EVRATT=1 and F2PS1=UNITID). In order to identify undermatch, I (a) defined levels of institutional selectivity, (b) determined the highest level of selectivity to which each student is most likely to gain admission, and (c) identified the highest selectivity of the institutions to which each student applied and enrolled (explained in detail below).

Selectivity

NCES verified where students enrolled as well as provided self-reported information on where students applied and were admitted. Barron's Competitiveness Index is compiled using SAT/ACT scores of admitted students, the GPA and class rank required for admission and the percentage of applicants accepted (Barron's Educational Series Inc., 2004) and were merged onto the institutions reported in the dataset. Similar to previous studies (Bowen et al., 2009; Roderick et al., 2006, 2008, 2009, 2011; Smith et al., 2012), this study used a modified version of Barron's Competitiveness Index.

Table 3). I also assigned selectivity levels to institutions based on the Barron's Competitiveness Index found in the 2004 IPEDS Institution file. Institutions that were in IPEDS but that did not have a corresponding Barron's rating were also coded. Not-for-profit institutions that were two-years-or-less were combined with two-year institutions. I excluded several institutions from the analyses: Barron's "Special Schools" category that includes institutions like music conservatories; theological seminaries; and institutions with unknown selectivity (e.g., a branch campus of a research institution). As a result, if students only applied to or enrolled at institutions that were excluded, they were excluded from the analyses, which resulted in a minor reduction in the analytic sample (1.1 percent at the application step and 2.7 percent at the enrollment step). Recognizing underrepresented students enroll in for-profit institutions at higher rates than their nonunderrepresented peers, for-profit institutions with unknown selectivity remained in the analyses. However, because on average, they are more expensive than their public sector counterparts and have less financial aid available, for-profit institutions were not combined with the two-year options, but ranked below.

Table 3 shows the categorization of the institutions. A large share of institutions in the analytic sample (56 percent) and student enrollments (45 percent) are in the least selective categories ("Nonselective," "Two-Year NFP," "For Profit," and "No Enrollment").

Table 3. Distribution of IPEDS Institutions and Student Enrollment in 2004 using Barron's Competitiveness Index

Selectivity[a]	Institutions in IPEDS	Institutions in Analytic Sample	Student Enrollment in Analytic Sample[bc]
N	6,107	2,594	8,696
Total	100	100	100
Most Competitive	1.15	2.62	4.90
Highly Competitive	1.67	3.82	7.28
Very Competitive	4.63	10.41	16.13
Competitive	10.32	21.97	23.85
NonCompetitive	5.44	10.64	8.12
Two-Year NFP[d]	29.16	31.46	28.38
For Profit	40.51	13.69	2.71
Not Applicable/Unknown	7.12	5.4	2.74
No Enrollment			5.89

Notes: (a) Institutions with unknown selectivity and the "Special" category were omitted; (b) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (c) Sample is unweighted; (d) Two-year or Less-than-two-year not for profit institutions

Sources: ELS:2002; IPEDS Institutional File (2004); Barron's Competitiveness Index (2004)

As Bowen and his colleagues (2009) discuss, one challenge in the study of undermatch pertains to the consideration of application and enrollment of Blacks in Historically Black Colleges and Universities (HBCUs). The college choice process for students who enroll at HBCUs can be considered distinct (Freeman & Thomas, 2002; Tobolowsky, Outcalt & McDonough, 2005), where a student's preference to attend an HBCU may be driven by cultural or personal reasons rather than a desire to maximize on institutional selectivity. In other words, a student who is qualified to attend a "Most Selective" institution may forego an acceptance at a "Most Selective" institution to attend a prestigious HBCU that is deemed only as "Selective" by Barron's Index. This behavior poses analytical as well as philosophical challenges with regard to how students who enroll in HBCUs should be considered in a study of undermatch, from the

analytic sample or considering enrollment in an HBCU for high achievers as an undermatch. Bowen et al. (2009) did not exclude students from HBCUs from their analyses, yet had a separate category. Most HBCUs and resultant enrollments are concentrated in the less selective categories (see Appendix A). Therefore Black students who are qualified to attend "Most" or "Very Selective" institutions invariably undermatch if they choose to enroll at an HBCU. Since the study of undermatch is nascent and little is known about its implications on HBCU enrollees, I analyzed the enrollment step undermatch rates using both approaches: undermatch at the enrollment step with the full sample and undermatch at the enrollment step without HBCU enrollment.

Qualifications

In order to identify the highest institutional selectivity to which each student is likely to be admitted this study used an approach similar to Smith et al.'s study (2009) by predicting the probability of gaining admission based on the admissions decisions for students who have application and admission data. While there are various ways to determine who is qualified (Bowen et al., 2009; Roderick et al., 2008, 2009, 2011), directly predicting students' probabilities leverages more student information in order to get an accurate determination of eligibility (Rodriguez, under review).

I used a series of four logistic regression models that include academic achievement (SAT scores, GPA, math test administered during ELS:2002 data collection); preparation (highest level math, participation in IB or AP, whether participated in in-school sports, performing arts, student government, community service, academic clubs, or hobby-based clubs); and demographic characteristics (gender, race/ethnicity, parental education, parental income, whether native English speaker) to produce parameter estimates in PROC SURVEY LOGISTIC in SAS for students with available application and admission information in ELS:2002. While the admission process is typically seen as complex with many other student characteristics weighing

in (e.g., personal statement, teacher recommendations, etc.), prior research has demonstrated that the variables included in this analysis are highly predictive of admission (Clinedinst et al., 2011; Roderick et al., 2006; Smith et al., 2012). In order to avoid placing more weight on students who applied or were admitted more than once to a selectivity level, I counted students once if they applied or were accepted within a level. For every student, I then used the parameter estimates to compute the predicted probability of being admitted to the four selectivity levels (Most Selective to Selective). I selected the highest selectivity level with a probability of admission greater than 80 percent as the student's qualification level. Students who were not identified as being qualified to attend any of the four categories of selective admissions were identified as being qualified for nonselective four-year or two-year institutions.

Finally, in order to determine an undermatch, I compared students' qualification levels to the most selective institutions they applied to and enrolled in. If a student's qualification level exceeded the selectivity of their application, then the student was identified as undermatched at the application step. This classification was repeated for enrollment as well.

Independent variables

In order to better understand the relationships between student- and school-level predictors and the likelihood of undermatch, I identified student- and school-level variables that aligned with the study's conceptual model to use in the analyses. Student-level measures included the demographic variables of interest (gender, race/ethnicity, parental education, parental income) as well as measures of human, social, and cultural capital resulting from a confirmatory factor analysis (discussed later). At the school level, measures of academic preparation, academic achievement, college guidance, college-going climate, and parental influence were derived from a confirmatory factor analysis of school-level data. Table 4 provides a full description of all of the variables used in this study, including the indicators used in the factor analyses.

Student-Level Predictors

Demographics

Drawing from prior research, there are variations in how students with different demographic characteristics are academically prepared (Bell et al., 2009; College Board, 2012; Roderick et al., 2006), how they perceive college costs and financial aid (Avery & Kane, 2004; Avery & Turner, 2010; Perna & Steele, 2011), and there are variations across gender and race in college-going behaviors. Parental education is positively associated with the completion of steps to prepare for college (Chen, Wu, & Tasoff, 2010a), enroll in college (Perna and Titus, 2005), and attendance at a more selective institution (Bozick & Lauff, 2007). Therefore I included gender, race/ethnicity (i.e., Asian, Black, Latino, Other race, and White), and parental education as predictors in the analyses.

Human Capital: Demand for Higher Education & Supply of Resources

A student's competitiveness in college admissions is based on their ability to demonstrate they are academically prepared and are likely to persist and graduate. Measures of academic achievement and preparation are also directly related to a student's qualification level and can be considered to be the student's demand for higher education. NCES calculates a student's 12^{th} grade unweighted academic GPA from the transcript data,, which includes grades in mathematics, science, English, social studies, and fine arts. I also used the highest SAT scores available as a predictor. NCES converted scores using a concordance table for students who had ACT scores instead. Subsequent reference to SAT scores, therefore, includes students who were ACT test takers. The number of AP or IB courses as well as the highest level of math taken by students was extracted from student transcript data by NCES. In addition, measures of family financial resources, or the supply of resources in the conceptual framework guiding this study, and have also been shown to be associated with undermatch (Bowen et al., 2009; Smith et al., 2012). The

family's 2002 income is included as the supply of resources, which asked in the Parent Survey. Missing values were imputed by NCES.

Human Capital: Expected Costs versus Expected Benefits of Higher Education

In order for students to apply to and enroll in college, students must believe the return (in the form of higher pay, improved quality of life, etc.) will be greater than their investment (in the form of foregone earnings and time). Several questions in the ELS:2002 dataset captured this cost-benefit tradeoff by asking students about the extent to which they agree with the following statements: "education is important for getting a job later on"; as well as the frequency with which they study to "increase job opportunities" or "ensure financial security," and are included in the study.

In order to represent college costs, the average cost of in-state public four-year tuition has been used in previous research (Perna & Titus, 2004). However, because the models used in the analyses include state-level fixed effects (discussed later), students were compared with other students within the same state rendering the average in-state tuition redundant. Therefore recognizing students propensity to enroll at institutions close to home (Mattern & Wyatt, 2009), I included the average sticker price as well as the average net price of institutions within a 50-mile radius to model postsecondary costs and availability of financial aid. These data on college costs and ZIP codes were drawn from IPEDS 2004 Institutional Characteristics and Student Financial Aid and Net Price files and distances were calculated using the ZIPCITYDISTANCE command in SAS.

Social Capital

Students' exposure to information is expected to shape the college choice process (Ceja, 2006; McDonough, 1997; Perna, 2000; Perna & Titus, 2005). Therefore, this study identified the persons (family members, friends, counselor, teachers) and sources (college publications, search

guides) students report accessing for college entrance information. In addition, friends' postsecondary intentions (four-year college, two-year college, or job/military) were included. Parental involvement in school (whether parents contacted the school about plans after high school, are involved in school-based activities, gave advice to the student about teachers or courses) as well as the interactions that parents have with other parents (know parents of student's friends, received or performed favors for other parents) reflect the belief that parental involvement and interactions can serve as a form of social capital (Coleman, 1988; Perna & Titus, 2005) and were included in the analyses.

Cultural Capital: Value of College Attainment & Habitus

Cultural capital, or the set of embodied behaviors and preferences passed down from parent to child (Bourdieu, 1986) is challenging to measure, as ELS:2002 provides only a limited set of variables. I derived several measures of cultural capital through proxies used in previous research; parental education, a composite measure of the value of college attainment, and a composite measure of habitus, or college-promoting home environment. In order to better understand the actions students take during the application and enrollment processes, it is important to acknowledge that the level of their parent's education may shape what students know or perceive regarding the college choice processes (Bowen et al., 2009; Smith et al., 2012). College expectations from parents can be illustrated through whether they provided advice to the student regarding applying for college, or their communication with the school regarding plans after high school. Moreover, the educational expectations of friends, parents, and other adults (teachers, counselor, etc.) as well as the extent to which students value their own educational attainment influence the institutions students consider applying to and enrolling in (Engberg & Wolniak, 2010; Perna & Titus, 2005). Other commonly used measures of the college-promoting home environment, or habitus, try to capture the presence of certain behaviors valued by the dominant culture, such as whether students have at least 50 books in the home, whether parents

take their children to the movies/concerts/plays, and whether parents provide information about community, national, or world events to their children.

High School-Level Predictors

The high school-level measures in this study represent academic achievement; structural college-promoting norms (college-going climate and parental influence); and resources (academic preparation and college guidance) that may influence students to undermatch.

High School Resource: Academic Achievement and Preparation

School-wide academic achievement is represented through the imputed and weighted averages for SAT scores (Bowen et al., 2009), the test administered by NCES, as well as GPA. High school-level measures of academic preparation reflect the extant literature on the benefits of programs such as AP, IB, and dual enrollment in preparing students for college (Roderick, Nagaoka, Coca, & Moeller, 2009; Saavedra, 2011). Measures of these programs and participation include: the percentage of students who are enrolled in AP or IB, the number of advanced math courses offered, and the number of AP or IB courses offered. ELS:2002 provides information on high school course offerings for 695 high schools in the sample. In order to standardize course offerings across high school, NCES assigns the Secondary School Course Classification System (CSSC) that codes every course offered in high schools. Using these CSSC definitions, I identified the number of AP and IB, as well as advanced math courses offered in these high schools.

High School Resource: College Guidance

The extent to which college guidance is provided in the high school context is important, as many students (particularly underrepresented students) come to rely on these services. Four out of five students in a national sample report a school counselor, teacher, or coach as a source of information about college entrance requirements (Chen, Wu, & Tasoff, 2010a). The extent to

which high schools provide college guidance and make available college guidance activities and services was measured through several variables, including the student-to-counselor ratio, the percentage of students who have indicated they have gone to the counselor for college information, as well as the percentage of seniors who accessed college guidance programming provided by the high school (college fairs, SAT prep courses, college application program, Engberg & Wolniak, 2010).

High School Structure: Expectations & College-going Climate

At the high school level, the shares of students who enroll in two- or four-year sectors after graduating from high school, as well as students who decide to enter the job market or military are indicators of the overall college-going climate. In addition, research has shown that the expectations of students and school personnel influence the expectations and college choice process of individuals (Engberg & Wolniak, 2010; McDonough, 1997). This climate of expectation is reflected in several variables included in the study: "Counselors/teachers encourage students to enroll in academic classes," as well as aggregate measure of average parental contact with school, parental involvement in school-based activity, responses to parents receiving or performing favors for other parents, and parents giving advice to their children about teachers or courses (Engberg & Wolniak, 2010; Perna & Titus, 2005).

State Policy Context

Finally, while NCES did not stratify its sampling of ELS:2002 by state, it is important to recognize that state-level policies and environment that may affect directly and indirectly the college choice process, particularly with regard to the availability of financial aid, the structure of the higher education system, strength of community college system, and other characteristics. Comparing students within their own state will account for these differences in state context.

Table 4. Description of Variables

Variable	Definition
Variables Used to Determine Undermatch	
Institutional Selectivity	A condensed version of Barron's Competitiveness Index. 1 = "Most Selective;" 2 = "Highly Selective;" 3 = "Very Selective;" 4 = "Selective;" 5 = "Less Selective & NonSelective;" 6 = "Two-Year College" (the "Special" Category was omitted); 7 = "No College"
Student Qualifications	Derived variable. 1 = "Most Selective;" 2 = "Highly Selective;" 3 = "Very Selective;" 4 = "Selective;" 5 = "Less Selective & NonSelective;" 6 = "Two-Year College" (the "Special" Category was omitted)
Student-Level Predictors of Undermatch	
Human Capital: Academic Achievement	
SAT Scores	Combined Math and Verbal SAT score; possible values range from 400-1600. ACT composite scores were converted to SAT scores by NCES (TXEESATM).
High School GPA, 12th grade	for all academic courses reported on the transcript (mathematics, science, English, social studies, fine arts), unweighted and based on a 4.0 scale (F1RAGP)
ELS Cognitive Test	Standardized test composite score of averaged reading and math scores in T-score (BYTXCSTD)
Human Capital: Academic Preparation	
Highest Math	The highest level of half a year or more of math coursework attempted by the 12th grade; derived using years of math coursework in several courses. 1 = Algebra 1, 2 = Algebra 2/Geometry, 3 = Pre-calculus /Trigonometry, 4= Calculus (F1S17C-H)
Number of AP or IB courses	The number of Advanced Placement or International Baccalaureate courses reported on students' transcripts, in Carnegie units, over the course of high school. (F1RAPIB)
Human Capital: Supply of Resources	
Total Income	Family income reported by parent in 2001-02; imputed by NCES if missing (BYINCOME). 1 = $0 to $25,000, 2 = $25,001 to $50,000, 3 = $50,001 to $75,000, 4 = $75,001 to $100,000, 5 = over $100,000.
Human Capital: Expected Benefits & Costs	
Studies to increase job opportunities	Response to the question: "How often do these things apply to you?" 1 = "Almost never;" 2 = "Sometimes;" 3 = "Often;" and 4 = "Almost always" (BYS89H)
Studies to ensure financial security	Response to the question: "How often do these things apply to you?" 1 = "Almost never;" 2 = "Sometimes;" 3 = "Often;" and 4 = "Almost always" (BYS89P)
Importance of getting good education	Response to the question: "How important is each of the following to you in your life? Getting a good education" 1 = "Not important;" 2 = "Somewhat important;" 3 = "Very important" (BYS37)

Education is important to get a job later	Response to the question: "How much do you agree or disagree with the following statements about why you go to school? I go to school because education is important for getting a job later on." 1 = "Strongly Disagree;" 2 = "Disagree;" 3 = "Agree;" 4 = "Strongly Agree;" (BYS27D)
"Sticker price" tuition	The average published tuition and fees from IPEDS 2004 Student Financial Aid File.
Net tuition	The average cost of tuition and fees after considering institutional, state, and federal aid from IPEDS 2004 Student Financial Aid File.

Habitus: Demographics

Gender	Male = 0, Female = 1 (BYSEX)
Race/Ethnicity	A series of dummy variables representing Asian, Black, Latino, White, and Other (BYRACE_R)
Native Language is English	Response to the question: "Is English your native language (the first language you learned to speak when you were a child)?" (BYSTLANG)

Social Capital: Sources of Information about College

Has gone to counselor for college info	Response to the question: "Where have you gone for information about the entrance requirements of various colleges?" 0 = "No;" 1 = "Yes;" (F1S48A)
Has gone to teacher for college info	Response to the question: "Where have you gone for information about the entrance requirements of various colleges?" 0 = "No;" 1 = "Yes;" (F1S48B)
Has gone to college publications/websites for info	Response to the question: "Where have you gone for information about the entrance requirements of various colleges?" 0 = "No;" 1 = "Yes;" (F1S48I)
Has gone to college representatives for info	Response to the question: "Where have you gone for information about the entrance requirements of various colleges?" 0 = "No;" 1 = "Yes;" (F1S48H)
Has gone to college search guides for info	Response to the question: "Where have you gone for information about the entrance requirements of various colleges?" 0 = "No;" 1 = "Yes;" (F1S48J)
Has gone to friend for college info	Response to the question: "Where have you gone for information about the entrance requirements of various colleges?" 0 = "No;" 1 = "Yes;" (F1S48G)
Has gone to parent for college info	Response to the question: "Where have you gone for information about the entrance requirements of various colleges?" 0 = "No;" 1 = "Yes;" (F1S48D)
Has gone to sibling for college info	Response to the question: "Where have you gone for information about the entrance requirements of various colleges?" 0 = "No;" 1 = "Yes;" (F1S48E)
Has gone to other relative for college info	Response to the question: "Where have you gone for information about the entrance requirements of various colleges?" 0 = "No;" 1 = "Yes;" (F1S48F)

Social Capital: Peer Networks

How many friends plan to attend two-year	Response to the question: "How many of your friends plan to attend a two-year community college or technical school?" 1 = "None of

college	them;" 2 = "A few of them;" 3 = "Some of them;" 4 = "Most of them;" 5 = "All of them" (F1S65C)
How many friends plan to attend four-year college/university	Response to the question: "How many of your friends plan to attend a four-year college or university?" 1 = "None of them;" 2 = "A few of them;" 3 = "Some of them;" 4 = "Most of them;" 5 = "All of them" (F1S65D)
How many friends plan to have full-time job after high school	Response to the question: "How many of your friends plan to have a regular full-time job after high school?" 1 = "None of them;" 2 = "A few of them;" 3 = "Some of them;" 4 = "Most of them;" 5 = "All of them" (F1S65B)

Social Capital: Parent & Family Networks

Parent involved in school-based activities w/student	Response to the question: "In this school year, do you or your spouse/partner do any of the following? Belong to the school's parent-teacher organization; attend parent-teacher organization meetings; take part in parent-teacher organization activities; act as a volunteer at the school; belong to other organization with parents from school" 0 = "No;" 1 = "Yes" (BYP54)
Parent knows parents of students' friends	Response to the question: "For up to 3 of your tenth grader's close friends, please indicate the following: Do you know this friend's mother? Father?" 0 = "None;" 1 = "One friend's parent/s;" 2 = "Two friends' parent/s;" 3 = "Three friends' parent/s;" (BYP59DA; BYP59EA; BYP59DB; BYP59EB; BYP59DC; BYP59EC)
Friend's parent gave advice about teachers/courses to parent	Response to the question: Looking back over the past year, how many times did the following occur? gave me advice about teachers and/or courses at my tenth grader's school" 1 = "None;" 2 = "Once or twice;" 3 = "Three or four times;" 4 = "More than four times" (BYP60A)
Friend's parent did favor	Response to the question: "Looking back over the past year, how many times did the following occur? did me a favor" 1 = "None;" 2 = "Once or twice;" 3 = "Three or four times;" 4 = "More than four times" (BYP60B)
Friend's parent received favor	Response to the question: "Looking back over the past year, how many times did the following occur? received a favor from me" 1 = "None;" 2 = "Once or twice;" 3 = "Three or four times;" 4 = "More than four times" (BYP60C)

Cultural Capital: Value of College Attainment

Highest Level of Parental Ed	Highest level reported for either parent. NCES imputed where missing. Dummy variables were coded for "High school or less;" "Some College, no degree;" "Associate's degree;" "Bachelor's degree or higher;" (BYPARED)
Close relative's desire for 10th grader after high school	Response to the question: " What do the following people think is the most important thing for you to do right after high school? A close relative" 1 = "Go to college;" 0 = "Get a full-time job; Enter a trade school or an apprenticeship; Enter military service; Get married; They think I should do what I want" (BYS66D)
School counselor's desire for 10th grader after high school	Response to the question: " What do the following people think is the most important thing for you to do right after high school? School counselor" 1 = "Go to college;" 0 = "Get a full-time job;

	Enter a trade school or an apprenticeship; Enter military service; Get married; They think I should do what I want" (BYS66E)
Favorite teacher's desire for 10th grader after high school	Response to the question: "What do the following people think is the most important thing for you to do right after high school? Favorite teacher" 1 = "Go to college;" 0 = "Get a full-time job; Enter a trade school or an apprenticeship; Enter military service; Get married; They think I should do what I want" (BYS66F)
Parents' desire for 10th grader after high school	The maximum response of mother and father's responses to the question: "What do the following people think is the most important thing for you to do right after high school? Mother/Father" 1 = "Go to college;" 0 = "Get a full-time job; Enter a trade school or an apprenticeship; Enter military service; Get married; They think I should do what I want" (BYS66A; BYS66B)
Friend's desire for 10th grader after high school	The maximum response of mother and father's responses to the question: "What do the following people think is the most important thing for you to do right after high school? Friend" 1 = "Go to college;" 0 = "Get a full-time job; Enter a trade school or an apprenticeship; Enter military service; Get married; They think I should do what I want" (BYS66A; BYS66B)
Cultural Capital: Habitus	
Parent contacted school about plans after high school	Response to the question: "Since your tenth grader's school opened last fall, how many times have you or your spouse/partner contacted the school about the following? Your tenth grader's plans after leaving high school" 1 = "None;" 2 = "Once or twice;" 3 = "Three or four times;" 4 = "More than four times" (BYP53C)
Family has more than 50 books	Response to the question: " Does your family have the following in your home? More than 50 books" 0 = "No;" 1 = "Yes" (BYS84H)
Parent provides advice about applying to college after high school	Response to question: " In the first semester or term of this school year, how often have you and/or your spouse/partner provided advice or information about the following to your tenth grader? Applying to college or other schools after high school" 1 = "Never;" 2 = "Sometimes;" 3 = "Often" (BYP56C)
Parent provides info about comm/national /world events	Response to the question: "In the first semester or term of this school year, how often have you and/or your spouse/partner provided advice or information about the following to your tenth grader? Community, national, and world events" 1 = "Never;" 2 = "Sometimes;" 3 = "Often" (BYP56E)
Attend Concert/ plays/movies with 10^{th} grader	Response to the question: "Looking back over the past year, how frequently did you and your tenth grader participate in the following activities together? Attending concerts, plays, or movies outside of school" 1 = "Never;" 2 = "Rarely;" 2 = "Sometimes;" 3 = "Frequently" (BYP57C)
`School-Level Predictors of Undermatch	
Academic Achievement	
Average SAT score	Imputed score from student-level SAT score and weighted at the high school-level. Values range from 400-1600.
Average ELS score	Imputed score from student-level SAT score and weighted at the high school-level.

Average GPA	Average (imputed & weighted) academic GPA at the high school-level.
Academic Preparation	
Pct. of student body in AP courses	Values greater than 80% were set to 81% by NCES. (F1A22F)
Number of AP/IB courses available at school	From course offering file. Codes that were identified by NCES as Advanced Placement courses are summed for each school. (F1OCSSC)
Number of advanced math courses available at school	From course offering file. Codes that were identified by NCES as International Baccalaureate courses are summed for each school. (F1OCSSC)
College Guidance	
Counselor-Student Ratio	# full-time guidance counselors in 2001-2002 (BYA23K) / Total school enrollment-2001/02 (CP02STEN)
Pct. of 12th graders attend college application programs	Response to the question: "What percentage of 12th grade students do the following at or through your school? Attend programs on college application procedures" 1 = None; 2 = 1-10%; 3 = 11-24%; 4 = 25-49%; 5 = 50-74%; 6 = 75-100% (F1A20A)
Pct. of 12th graders attend school SAT /ACT courses	Response to the question: " What percentage of 12th grade students do the following at or through your school? Attend school SAT or ACT courses" 1 = None; 2 = 1-10%; 3 = 11-24%; 4 = 25-49%; 5 = 50-74%; 6 = 75-100% (F1A20C)
Pct. of 12th graders attend college fairs	Response to the question: " What percentage of 12th grade students do the following at or through your school? Attend college fairs" 1 = None; 2 = 1-10%; 3 = 11-24%; 4 = 25-49%; 5 = 50-74%; 6 = 75-100% (F1A20D)
Pct. of 10th graders who have gone to counselor for college info	Average (and imputed) number of students who have gone to counselor for college information (F1S48A)
College-Going Climate/College-Promoting Networks	
Pct. 10th graders in college prep program	Response to the question: "Approximately what percentage of your 10th grade students is in each of the following instructional programs? College prep, academic, or specialized academic (such as science or math)" Values range from 0-100. (BYA14B)
Counselors/teachers encourage students to enroll in academic classes	Response to question: "Indicate how much each of the characteristics listed below describes your school's environment? Counselors and teachers encourage students to enroll in academic classes" 1 = "Not at all accurate;" 2 = "Not at all accurate--Somewhat accurate;" 3 = "Somewhat accurate;" 4 = "Somewhat accurate--Very accurate;" 5 = "Very accurate" (F1A38L)
Pct. of 2003 grads went to 4-yr colleges	1 = None; 2 = 1-10%; 3 = 11-24%; 4= 25-49%; 5 = 50-74%; 6 = 75-100% (F1A19A)
Pct. of 2003 grads went to 2-yr colleges	1 = None; 2 = 1-10%; 3 = 11-24%; 4= 25-49%; 5 = 50-74%; 6 = 75-100% (F1A19B)

Pct. of 2003 grads entered labor market or military	1 = None; 2 = 1-10%; 3 = 11-24%; 4= 25-49%; 5 = 50-74%; 6 = 75-100% (F1A19C)
Parental Involvement/Influence	
Avg parent contacts with school	Weighted school average of student-level measure BYP53C. Possible values range from 1.0 to 4.0.
Avg parent involved in school-based activities	Weighted school average of student-level measure BYP54. Possible values range from 0.0 to 1.0.
Avg response to friend's parent received favor	Weighted school average of student-level measure BYP60C. Possible values range from 1.0 to 4.0.
Avg response to friend's parent gave advice about teachers/courses	Weighted school average of student-level measure BYP60A. Possible values range from 1.0 to 4.0.
Avg response to friend's parent did favor	Weighted school average of student-level measure BYP60B. Possible values range from 1.0 to 4.0.

Source: ELS:2002

Missing Data

External validity is the extent to which findings can be generalized to a population. Missing data is one possible threat to validity. Some of the missing data in ELS:2002 arise from (a) legitimate skips of items or sections of the survey that were not pertinent, (b) respondents that did not know the answer to a question, or (c) incomplete responses. While a great deal of the missing data was minimized through the selection criteria used to restrict the sample (e.g., students who participated in all three waves of ELS), some missingness remains in the sample across the study's variables of interest (

Table 5).

Table 5. Proportion of cases in the analytic sample[a] missing data prior to imputation

Variable	Percent Missing[b]
Student-Level Predictors	
Human Capital: Academic Achievement	
SAT Scores	19.6
High School GPA, 12th grade	5.6
ELS Cognitive Test	0.0
Human Capital: Academic Preparation	
Highest Math	2.6
Number of AP or IB courses	5.6
Human Capital: Supply of Resources	
Total Income	0.0
Human Capital: Expected Benefits & Costs	
Studies to increase job opportunities	23.4
Studies to ensure financial security	24.9
Importance of getting good education	1.0
Education is important to get a job later	1.0
"Sticker price" tuition	
Net tuition	
Habitus: Demographics	
Gender	0.0
Race/Ethnicity	0.0
Native Language is English	0.0
Social Capital: Sources of Information about College	
Has gone to counselor for college info	16.9
Has gone to teacher for college info	16.9
Has gone to college publications/websites for info	16.9
Has gone to college representatives for info	16.9
Has gone to college search guides for info	16.9
Has gone to friend for college info	16.9
Has gone to parent for college info	16.9
Has gone to sibling for college info	16.9
Has gone to other relative for college info	16.9
Social Capital: Peer Networks	
How many friends plan to attend two-year college	1.2
How many friends plan to attend four-year college/university	1.5
How many friends plan to have full-time job after high school	1.0
Social Capital: Parent & Family Networks	
Parent involved in school-based activities w/student	13.1
Parent knows parents of students' friends	16.3
Friend's parent gave advice about teachers/courses to parent	15.1
Friend's parent did favor	15.1
Friend's parent received favor	15.1
Cultural Capital: Value of College Attainment	
Highest Level of Parental Ed	0.0
Close relative's desire for 10th grader after high school	3.1
School counselor's desire for 10th grader after high school	6.4
Favorite teacher's desire for 10th grader after high school	5.5
Parents' desire for 10th grader after high school	1.5

Friend's desire for 10th grader after high school	5.5
Cultural Capital: Habitus	
Parent contacted school about plans after high school	16.3
Family has more than 50 books	9.4
Parent provides advice about applying to college after high school	14.2
Parent provides info about comm/national/world events	14.1
Attend Concert/plays/movies with 10th grader	14.0
School-Level Predictors of Undermatch	
Academic Achievement	
Average SAT score	0.0
Average ELS score	0.0
Average GPA	0.0
Academic Preparation	
Percent of student body in AP courses	10.2
Number of AP/IB courses available at school	6.5
Number of advanced math courses available at school	6.5
College Guidance	
Counselor-Student Ratio	16.9
Percent of 12th graders attend college application programs	11.9
Percent of 12th graders attend school SAT/ACT courses	12.4
Percent of 12th graders attend college fairs	12.6
Percent of 10th graders who have gone to counselor for college info	0.0
College-Going Climate/College-Promoting Networks	
Percent 10th graders in college prep program	16.4
Counselors/teachers encourage students to enroll in academic classes	12.4
Percent of 2003 grads went to 4-yr colleges	8.3
Percent of 2003 grads went to 2-yr colleges	9.4
Percent of 2003 grads entered labor market or military	9.5
Parental Involvement	
Average parent contacts with school	0.0
Average parent involved in school-based activities	0.0
Average response to friend's parent received favor	0.0
Average response to friend's parent gave advice about teachers/courses	0.0
Average response to friend's parent did favor	0.0

Notes: (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:02 dataset; (b) Figures are unweighted.
Source: ELS:2002

In particular, approximately 1 out of every 5 students in the analytic sample (unweighted) is missing an SAT or ACT score. These students are more likely to be Latino or Black, have low academic performance, have parents who do not have a college degree or earn less than $50,000 a year than students who have SAT scores (

Table 6). The SAT score is a common indicator of academic achievement, an essential component in the algorithm used to determine undermatch in this study, and an application requirement for many colleges. Some students may possess the academic talent to qualify to attend a four-year institution but may not have taken either the SAT or ACT. Therefore, I used multiple imputation rather than listwise deletion on all missing data in order to preserve cases, representativeness of the sample, and external validity. Multiple imputation was carried out through an expectation maximization (EM) algorithm, which uses all information available to produce estimates for missing data using Mplus software.

The resultant imputation showed very little change along the key student characteristics (Table 7). After imputation, the average SAT scores for the sample dropped by less than one-fifth of a standard deviation (17%). This was expected because lower performing students were more likely to have missing SAT scores then higher performing students.

Table 6. Proportion of cases in the analytic sample[a] missing data on SATs prior to imputation

	Unweighted			Weighted[b]		
Variable	*N*	Data	No Data	*N*	Data	No Data
Total	8,960	80.4	19.6	2,029,340	77.4	22.6
Demographics						
Gender	8,960			2,029,340		
Male		79.7	20.3		76.8	23.2
Female		81.0	19.0		77.8	22.2
Race/Ethnicity***[b]	8,960			2,029,340		
Asian		77.9	22.1		78.2	21.8
Black		74.7	25.3		71.9	28.1
Latino		62.0	38.0		55.5	44.5
Other		79.6	20.4		75.8	24.2
White		85.5	14.5		82.7	17.3
Parental Education***	8,960			2,029,340		
Bachelor's Degree		86.6	13.4		84.9	15.1
Associate's Degree		80.6	19.4		78.9	21.1
Some College		76.6	23.4		73.0	27.0
High School or less		68.4	31.6		64.8	35.2
Income ***	8,960			2,029,340		
$100,001 or greater		89.5	10.5		88.1	11.9
$50,001 to $100,000		83.9	16.2		81.6	18.4
$50,000 or less		73.3	26.8		69.7	30.3
Academic Preparation						
GPA[d]***	8,460			1,916,350		
3.51 to 4.00		94.6	5.4		95.1	4.9
3.01 to 3.50		90.6	9.4		89.1	10.9
2.51 to 3.00		83.0	17.0		80.2	19.8
2.50 or less		62.1	37.9		57.6	42.4
Highest Math***	8,720			1,961,940		
Calculus or higher		91.1	8.9		90.4	9.6
Precalculus/Trigonometry		88.9	11.1		88.2	11.8
Algebra 2/Geometry		71.3	28.7		68.0	32.0
Algebra 1 or less		39.4	60.6		35.7	64.3

Notes: (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Figures weighted using F2F1WT and rounded to nearest 10; (c) Results of chi-square test for weighted sample, ***$p < .001$, **$p < .01$, *$p < .05$; (d) for all academic courses, 12th grade unweighted.
Source: ELS:2002

Table 7. Comparison of ELS:2002 and Analytic Sample by Select Student Characteristics

	Analytic Sample[ab]						
	Original			After Imputation[c]			
Student Characteristics	N	Proportion	S.D.	N	Proportion	S.D.	Change in Proportion
Female	8,960	0.6	0.5	8,960	0.6	0.5	0.0
Black	8,960	0.1	0.3	8,960	0.1	0.3	0.0
Latino	8,960	0.1	0.3	8,960	0.1	0.3	0.0
Families earning <$50,000	8,960	0.4	0.5	8,960	0.4	0.5	0.0
Potential first-generation college graduates	8,960	0.4	0.5	8,960	0.4	0.5	0.0
Highest math Pre-calculus or more	8,730	0.6	0.5	8,960	0.6	0.5	0.0
Has gone to counselor for college info	7,450	0.8	0.4	8,960	0.9	0.4	0.0
School counselor's wants student to go to college	8,460	0.9	0.3	8,960	0.9	0.3	0.0
	N	Mean	S.D.	N	Mean	S.D.	Change in Mean
GPA	8,460	2.9	0.7	8,960	2.9	0.7	0.0
SAT Scores	7,210	1028	202	8,960	993	210	-35
Number of AP and IB courses	8,460	1.1	1.9	8,960	1.1	1.9	0.0
Studies to increase job opportunities	6,870	2.8	1.0	8,960	2.8	0.9	0.0
Parent knows parents students' friends	7,500	4.2	1.7	8,960	4.1	1.6	-0.1
Parent contacted school about plans after HS	7,500	1.2	0.5	8,960	1.2	0.5	0.0

Notes: (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Figures are not weighted and are rounded to the nearest 10; (c) Multiple imputation of all missing data, expectation-maximization algorithm

Analytic Methods

Student-Level Latent Variables

Confirmatory factor analysis (CFA) tests the extent to which groups of variables are related to one another and represent an underlying process (Tabachnick & Fidell, 2007). The indicators selected for the study (Table 4) lend themselves to CFA, given the nature of the ELS:2002 survey data and the groupings of latent constructs based on the conceptual framework (e.g., college-promoting networks). CFA will also reduce the number of variables, confirm whether groups of variables identified in the dataset indeed represent a construct (e.g., college guidance), and strengthen the reliability of the constructs (Tabachnick & Fidell, 2007). I modeled the CFA using Mplus software, which is specifically designed for handling categorical variables (e.g. Likert scaled survey items) and modeling latent variables (e.g. parental involvement; Muthén & Muthén, 2012).

Drawing from the first level of the conceptual model, modeled the student-level latent constructs of "Expected Benefits and Costs," "Sources of College Information," "Peer Networks," "Parent and Family Networks," "Value of College Attainment," and "College-promoting Home Environment." Factor rotation improves the interpretability of the factor solution (Kim & Mueller, 1978). I used GEOMIN rotation; an oblique method of rotation that allows the underlying factors to be correlated. Since a CFA tests whether the indicators selected to measure the underlying constructs are a good fit, goodness-of-fit measures are the centerpiece in determining whether the model is acceptable. One goodness-of-fit measure is the comparative fit index (CFI) that has a range from 0 to 1.0. A CFI greater than 0.9 is considered a "good" fit. There is also the root mean square error of approximation (RMSEA). The RMSEA also has a range from 0 to 1, with a value less than .05 is considered a good fit. The chi-square test is not recommended as a goodness-of-fit measure for CFAs when modeling categorical variables, and was not considered in this study (Muthen & Muthen, 2012). The results for the six-factor CFA of

student-level indicators (Table 8) indicated a good fit for the six-factor model of student-level indicators (*CFI* = 0.948, *RMSEA* = 0.0467). Weighted standardized scales for the resultant six factors were saved by Mplus for further analyses.

High School-Level Latent Variables

Similar to the student-level analysis, the high school-level factors (Academic Achievement, Academic Preparation, College Guidance, College-going Culture, and Parental Influence/Involvement) are also drawn from the second level of the conceptual model. The latent variables are modeled using the CFA framework with school-level indicators. I allowed the error terms within a factor to co-vary, suggesting indicators within a factor are not expected to be completely independent of one another. The five-factor model of school-level indicators (Table 9) resulted in a good fit model (*CFI* = 0.943, *RMSEA* = 0.050).

Table 8. Unstandardized factor loadings and standard errors of a six-factor confirmatory factor analysis on student-level indicators of college choice

	1	2	3	4	5	6
	Human Capital	Social Capital			Cultural Capital	
	Expected Benefits & Costs	Sources of College Info	Peer Networks	Parent & Family Networks	Value of College Attainment	Home Envi-ronment
Studies to increase job opportunities	1.000					
	(----)					
Studies to ensure financial security	1.01					
	(0.02)					
Education is important to get a job later	-0.65					
	(0.02)					
Importance of getting good education	0.80					
	(0.02)					
Has gone to counselor for college info		1.000				
		(----)				
Has gone to teacher for college info		1.07				
		(0.05)				
Has gone to college representatives for info		1.14				
		(0.05)				
Has gone to college publications/websites for info		1.31				
		(0.05)				
Has gone to college search guides for info		0.98				
		(0.05)				
Has gone to friend for college info		1.10				
		(0.05)				

Has gone to parent for college info	1.16				
	(0.05)				
Has gone to sibling for college info	0.61				
	(0.04)				
Has gone to other relative for college info	1.08				
	(0.05)				
How many friends plan to attend four-year college/university		1.00			
		(----)			
How many friends plan to have full-time job after high school		-0.80			
		(0.02)			
How many friends plan to attend two-year college		-0.87			
		(0.02)			
Parent involved in school-based activities w/student			1.00		
			(----)		
Parent knows parents of students' friends			1.10		
			(0.04)		
Friend's parent gave advice about teachers or courses to parent			1.30		
			(0.04)		
Friend's parent did favor			2.08		
			(0.06)		
Friend's parent received favor			2.05		
			(0.06)		
Parent's desire for 10th grader to go to college				1.00	
				(----)	
Friend's desire for 10th grader to go to college				0.92	
				(0.02)	
Close relative's desire for 10th grader to go to college				1.03	

	(0.03)	
School counselor's desire for 10th grader to go to college	1.11 (0.03)	
Favorite teacher's desire for 10th grader to go to college	1.13 (0.03)	
Family has more than 50 books		1.00 (----)
Parent contacted school about plans after high school		0.77 (0.06)
Parent provides advice about applying to college after high school		0.99 (0.06)
Parent provides info about comm/national /world events		1.36 (0.07)
Attend Concert/plays/movies with 10th grader		0.90 (0.05)

Notes: Dashes (---) indicate standard errors were not calculated. CFI = 0.948; RMSEA = 0.047; χ^2 is not recommended for goodness of fit of categorical variables. The covariances between the latent variables are: 0.123 between F1 and F2; 0.105 between F1 and F3; 0.099 between F2 and F3; 0.008 between F1 and F4; 0.041 between F2 and F4; 0.077 between F3 and F4; 0.176 between F1 and F5; 0.115 between F2 and F5; -0.166 between F3 and F5; 0.037 between F4 and F5; 0.061 between F1 and F6; 0.071 between F2 and F6; 0.105 between F3 and F6; 0.095 between F4 and F6; 0.037 between F5 and F6.
Source: Analysis of ELS:2002

Table 9. Unstandardized factor loadings and standard errors of a five-factor confirmatory factor analysis on school-level indicators of college choice

	1	2	3	4	5
		School Resources		School Norms	
	Academic Achievement	Academic Preparation	College Guidance	College-Going Culture	Parental Involvement/ Influence
Average (imputed & weighted) SAT Score by high school	1.00 (----)				
Average (imputed & weighted) composite score for test administered for ELS	0.94 (0.02)				
Average (imputed & weighted) academic GPA in high school	0.71 (0.03)				
Number of AP or IB courses available at the high school (logged)		1.00 (----)			
Number of advanced math courses available at the high school (logged)		1.14 (0.05)			
% of students enrolled in AP courses in the school (logged)		1.16 (0.06)			
% of 12th graders attend college application programs			1.00 (----)		
% of 12th graders attend school SAT/ACT courses			0.83 (0.08)		
% of 12th graders attend college fairs			0.69 (0.07)		
Average (and imputed) number of students who have gone to counselor for college info			0.81 (0.08)		

% of 2003 graduates went to 4-year colleges	1.00	
	(----)	
% of 2003 graduates entered labor market or military	-0.73	
	(0.03)	
% of 10th graders in college prep program	25.25	
	(1.98)	
Counselors/teachers encourage students to enroll in academic classes	0.57	
	(0.05)	
Average high school parental involvement		1.00
		(----)
Average response to friend's parent received favor		0.95
		(0.08)
Average response to friend's parent gave advice about teachers/courses		0.94
		(0.07)
Average response to friend's parent did favor		1.04
		(0.08)
Average high school parental contact		-0.01
		0.06

Notes: Dashes (---) indicate standard errors were not calculated. CFI = 0.943; RMSEA = 0.050; χ^2 is not recommended for goodness of fit of categorical variables. The covariances between the latent variables are: 0.210 between F1 and F2; 0.232 between F1 and F3; 0.164 between F2 and F3; 0.623 between F1 and F4; 0.261 between F2 and F4; 0.415 between F3 and F4; 0.492 between F1 and F5; 0.055 between F2 and F5; 0.188 between F3 and F5; 0.371 between F4 and F5.
Source: Analysis of ELS:2002

The second way that high school-level measures will be created is through latent class analysis. As Hill (2008) and McDonough's (1997) research suggest, individual high school constructs do not operate in isolation, and many high schools possess similar characteristics. This study has drawn from Hill's (2008) use of latent class analysis to identify high school typologies. Latent class modeling is used to create a typology of high schools around high school contexts (the unobserved variable) – grouping high schools that exhibit similar patterns across several dichotomous observed variables (the five latent class indicators from the high school-level CFA) into classes (McCutcheon, 1987). Using a mixture model in Mplus, I modeled the probability of a school's membership in a class (or high school type) as the product of the conditional probabilities of five latent class indicators in the following:

$$\mathrm{P}_{abcdey} = \mathrm{P}_{y|a}\mathrm{P}_{y|b}\mathrm{P}_{y|c}\mathrm{P}_{y|d}\mathrm{P}_{y|e}$$

where a, b, c, d, and e are the five latent class predictors (academic achievement; academic preparation; college guidance; parent networks and college-going climate).

Latent class models are also evaluated using goodness-of-fit measures. In determining the number of classes which best describe the typology (in this study, the number of high school contexts that exist in the sample), I used Akaike information criterion (AIC), Sample-Size Adjusted Bayesian information criterion (SABIC), and entropy measures (i.e., how distinct the classes are from one another) along with conceptual grounding to determine the best fitting model and the resultant number of classes. Models using continuous indicators do not have Pearson Chi-Squared or Likelihood Ratio Chi-Square measures. Generally, models with smaller AICs and SABICs are considered a better fit. In addition, the entropy measure ranges between 0 and 1, with a value of 0.80 or greater indicating an acceptable model fit (Appendix C).

Table **10** illustrates the probabilities of latent class membership for a five-class model (*AIC* = 6279.8, *SABIC* = 6328.9, Entropy = 0.871). The resultant classes align along the availability of high school resources and extent of college-going norms present in the high schools. I have named the five high school contexts as: very low college-promoting high school resources and norms; low college-promoting high school resources and norms; average college-promoting high school resources and norms; high college-promoting high school resources and norms; and very high college-promoting high school resources and norms. These five high school contexts will be used in subsequent analyses to address the research questions in this study.

Table 10. Results of Latent Class Model of High School Contexts[a]

	High School Contexts				
	1	2	3	4	5
	Low Resources & College Norms	Very High Resources & College Norms	Very Low Resources & College Norms	Average Resources & College Norms	High Resources & College Norms
Latent Classes	Average Latent Class Probabilities for Most Likely Latent Class Membership				
Class 1	0.923	0.000	0.002	0.075	0.000
Class 2	0.000	0.947	0.000	0.000	0.053
Class 3	0.052	0.000	0.948	0.000	0.000
Class 4	0.048	0.000	0.000	0.895	0.057
Class 5	0.000	0.033	0.000	0.051	0.915
Latent Class Indicators	Indicator Means by Latent Class Membership				
Academic Achievement	-0.786	1.704	-1.386	-0.045	0.673
High School Resources					
Academic Preparation	-0.245	0.548	-1.794	0.064	0.231
College Guidance	-0.421	0.799	-1.179	-0.012	0.443
College-Promoting Norms					
College-Going Climate	-0.704	1.426	-1.674	-0.032	0.685
Parental Involvement/Influence	-0.474	1.046	-0.831	-0.051	0.433
	Latent Class Counts and Proportions				
N=730	260	70	20	250	160
Percent	33.96	9.06	2.40	33.02	21.57

Notes: AIC = 6279.8; SABIC = 6328.9; Entropy = 0.871
Sources: Analyses of ELS:2002

Producing Undermatch Rates

After determining students' qualifications, I compared these qualifications to the selectivity of the institutions where students apply and enoll. If the most selective institution to which the student applied is less selective than the selectivity for which the student is qualified, $undermatch_{apply}= 1$, otherwise $undermatch_{apply}= 0$. Similarly, if the institutional selectivity of the institution in which he or she enrolled is less selective than where he or she was qualified to attend, then $undermatch_{enroll} = 1$, else $undermatch_{enroll} = 0$. In line with Bowen (2009), *overmatch*, defined as a student enrolling in an institution more selective than their qualification level, was not examined in this study.

To address the first set of research questions, I used baseline descriptive information to describe overall differences in undermatch rates across all student-level predictors as well as high school-level factors and contexts. I determined if any observed differences in undermatch rates were statistically significant with t-tests and chi-squared tests.

Estimation of School-Level Effects

The second research question employed hierarchical generalized linear modeling (HGLM). HGLM is ideal for isolating the effects of the high school environment that are related to the student-level dichotomous outcomes by producing unbiased estimates and standard errors (Raudenbush & Bryk, 2002). This method is also appropriate because it recognizes the nested nature of both the conceptual framework and the sampling structure of the ELS:2002 data, as individuals function within the context of their high schools. HGLM allows for the separation of student-level effects on undermatch in order to better understand the relationship between high school resources and the college application and enrollment process. Comparing these estimates across high school resources is useful in understanding the varying impacts high schools have on the college application and enrollment processes of its students. The following model estimated

the likelihood of undermatch at both application and enrollment steps using high school- and student-level factors:

Level 1

$$\log[{}^{\varphi_{ij}}\!/_{(1-\varphi_{ij})}] = \beta_{0j} + \beta_{1j} * (Demographics) + \beta_{2j} * (Human\ Capital) +$$

$$\beta_{3j} * (Social\ Capital) + \beta_{4j} * (Cultural\ Capital)$$

where *i* denotes the student, and *j* denotes the high school

Level 2

$$\beta_{0j} = \gamma_{00} + \gamma_{01} * (Academic\ Preparation) + \gamma_{02} * (College\ Guidance) + \gamma_{03} * (College - Going\ Culture) + \gamma_{04} * (Parental\ Involvement) + u_{oj}$$

$$\beta_{\rho j} = \gamma_{\rho 0}, \text{where } \rho = 1 \text{ to n student variables}$$

where *j* denotes the high school. Academic achievement was not included in the model, as an examination of the variance inflation factor (VIF) confirmed that it was colinear with the other high school-level measures. In addition, the model does not use sample weights, as the multi-level model requires weighting at both the student- and school-levels in order to produce appropriate estimates and standard errors – a current limitation of the PROC GLIMMIX procedure. However, estimates and standard errors are typically similar when modeling sample data without weights (Winship & Radbill, 1994).

The second part of the second research question refers to explaining the variation in undermatch using high school types from the latent class analysis. Therefore, I employed a

second HGLM model using the same student-level predictors as above and the five high school contexts (coded as dummy variables) that resulted from the latent class analyses:

Level 1

$$\log[{}^{\varphi_{ij}}\big/_{(1-\varphi_{ij})}]$$

$$= \beta_{0j} + \beta_{1j} * (Demographics) + \beta_{2j} * (Human\ Capital) + \beta_{3j} * (Social\ Capital) + \beta_{4j} * (Cultural\ Capital)$$

where *i* denotes the student, and *j* denotes the high school

Level 2

$$\beta_{0j} = \gamma_{00} + \gamma_{01} * (Very\ high\ resources\ \&\ norms\ ) + \gamma_{01} * (High\ resources\ \&\ norms\ ) + \gamma_{01} * (Low\ resources\ \&\ norms\ ) + \gamma_{01} * (Very\ low\ resources\ \&\ norms\ ) + u_{oj}$$

$$\beta_{\rho j} = \gamma_{\rho 0}, \text{where } \rho = 1 \text{ to n student variables}$$

where *j* denotes the high school.

I repeated both models above with the same predictors to estimate the likelihood of undermatch at the application and enrollment steps, as the conceptual framework suggests both steps of the college admission process are influenced by similar forces. However, the likelihood of undermatching at the enrollment step was modeled conditional on applying to the selectivity level for which the student was qualified by restricting the dataset, similar to previous studies (Roderick et al., 2012; Smith et al., 2012). Put simply, if a student was qualified for a selectivity

level and he or she applied to an institution within that level, did they undermatch at the enrollment step?

The model specifications for both application and enrollment included fixed effects at the student level – in other words, high schools were assumed to influence students in similar ways. I group centered the continuous variables, which improves interpretation However, I modeled random effects at the high school-level, meaning the model allowed for different high schools to have varying levels of influence. In order to understand the relationship between groups of variables and the outcome, I added blocks of predictors to the model with attention to the gaps between underrepresented students and their respective reference groups, similar to Bowen and his colleagues (2009). For example, the analysis began with an unconditional model using race/ethnicity as the only predictor. Next, I added student-level measures of human, social, cultural capital and other student characteristics to the unconditional model. High school-level measures noted above were added to the model last. With regard to the analysis of race/ethnicity, I reported odds-ratios for Black and Latino students (as they are considered underrepresented groups and populations of interest) for every additional step in the regression to illustrate how additional measures account for differences between the Black-White as well as Latino-White gaps in undermatch,. This analysis was repeated for gaps in family income and parental education. Fixed effects at the state-level allowed for students to be compared with other students from their state.

I used PROC GLIMMIX in SAS to model the likelihood to undermatch with a logit link function because undermatch is a dichotomous variable. Hypothesis testing compared the unconditional model (which does no partition variation at the high school-level) to the full model in order to determine the extent of variation further explained by the high school-level predictors. I reported odds ratios for the student- and high school-level predictors.

In order to address the final research question I examine the variation in potential differences, or gaps, in the likelihood of undermatch across high schools by race/ethnicity, parental income, and parental education. This would test whether some high schools with particular characteristics are more equitable than others with regard to undermatch. Similar to the models above, I used multiple regression within the HGLM framework but allowing for the slopes of (1) race/ethnicity, (2) parental income, and (3) parental education to vary across high schools in separate models and for undermatch at the (1) application and (2) enrollment steps. I then perform hypothesis tests to discern whether the variance of the gaps is equal to zero (e.g., if the Black-White gap in the likelihood to undermatch varies across high schools). This analyses was done for (1) individual and (2) aggregate (i.e., high school contexts) high school measures.

Limitations

This study has several limitations. The use of ELS:2002 comes with a set of shortcomings. The students in this study graduated in 2004, nearly a decade ago. Since then the higher education landscape has changed, as more students are enrolling in college and colleges have become more selective. However, ELS:2002 is the most recently available nationally representative dataset with both postsecondary and high school student-level information . Although the confirmatory factor analyses models fit well, the dataset has a finite set of measures and was not constructed to test Perna's (2006) conceptual model, therefore creating the potential for omitted variable bias. Measures of college guidance are only captured in a few items within the set of surveys. It would have been useful to survey guidance counselors regarding professional development and credentialing, similar to the information that was collected for teachers. Therefore, the analyses do not describe the quantity or nature of counselor-student interactions. Similar limitations are associated with the variables that measure the various sources of college information. Also, there are limitations to the measures of college-going behaviors, which only capture whether students enroll in four-year versus two-year institutions and do not

measure the selectivity of postsecondary enrollment. In addition, there are no variables regarding the perceived or actual costs of attending college, where other variables had to serve as proxies. Finally, there are only a limited number of variables to measure cultural capital – a complex construct.

A second set of limitations relate to the estimation of undermatch. Undermatch is not an observed measure, but an estimate of how a student's qualifications would fare in selective admissions, and as such has inherent assumptions. This study does not address issues of institutional capacity in estimating probabilities of gaining admission. There are not enough seats, in practice, to accommodate all students who are likely to gain admission, if they were to apply. With regard to selectivity, institutions within a selectivity grouping are assumed homogenous. However, particularly at more selective institutions, admission is highly variable from institution to institution. Therefore, a student could very well apply to only one institution within their qualification level yet is not admitted. In addition, the admissions process for selective institutions can be complex, and certain critical application components (e.g., quality of writing in personal statement or letters of recommendation) were not captured by any variable or proxy. The availability of financial aid across institutions is also variable within a selectivity grouping. By asserting that higher achieving students should enroll in more selective institutions, proponents of match assume a relationship exists between institutional selectivity and institutional quality. By using a single indicator, one is not able to "[capture] the complexity of higher education institutions" (Zhang, 2005). In addition, it may not be rational for a student to apply to or enroll in an institution that is aligned with the student's qualifications if, for example, he or she may need to stay close to home due to familial obligations; it is not the lowest cost postsecondary option; or they have a particular interest in attending an institution such as a Historically Black Colleges and Universities, that has a strong program in their field of interest, or an honors program.

CHAPTER 4: FINDINGS

The purpose of this study is to examine the extent to which high school-level measures predict the likelihood of undermatch above and beyond student characteristics, and how the effect of attending a particular type of high school on undermatching might differ for underrepresented students. First, I calculated undermatch rates both at the time of application and enrollment by (1) determining the selectivity of the institutions to which each student was most likely to be admitted and (2) comparing that to the selectivity of the institutions where each student actually applied and enrolled. Second, I modeled students' likelihood of undermatch at both the application and enrollment steps in a three-level HGLM using student-level predictors, state-level fixed effects, and two different types of high school-level predictors: (1) high school factors measuring average academic achievement, academic preparation, availability of college guidance, college going culture, and parental involvement and (2) measures of five high school contexts – *Very high resources and norms*; *High resources and norms*; *Average resources and norms*; *Low resources and norms*; and *Very low resources and norms*. Finally, in order to test whether there are differences in the likelihood of undermatch between underrepresented students and nonunderrepresented students across high schools, I modeled a three-level HGLM allowing for differences within schools (i.e., slopes) to vary across high schools by (1) race (2) income and (3) parental education. I then tested whether the variance of the slopes was equal to zero (meaning there are no differences across schools).

Estimating Undermatch

Overall Student Qualification

In my first research question, I examined the extent of undermatch in the analytic sample – college-bound students who graduated from high school on time and have indicated a desire to continue on to postsecondary studies. In order to estimate undermatch, I first estimated the

selectivity of the institutions to which each student was most likely to be admitted and examined these qualifications by different student and high school characteristics.

Table 11 illustrates students from underrepresented backgrounds (Black, Latino, low-income, potential first-generation college graduates) are less likely to have the academic profiles that make them eligible for any form of selective admissions ("Most Selective," "Highly Selective," "Very Selective," and "Selective"). Substantially greater shares of Asian and White students were eligible for "Most Selective," "Highly Selective" and "Very Selective" institutions than any other racial/ethnic groups (49 percent of Asian and 51 percent of White students versus 15 percent of Black and 20 percent of Latino students). When examining undermatch rates by family income, students from families with higher income backgrounds were more likely to be eligible for admission at more selective institutions than students from low-income backgrounds. Students who were from very high-income families (over $100,000) were about three times more likely than students who were from very low-income families (less than $25,000) to gain admission to "Most Selective" institutions, six times more likely at "Highly Selective" institutions, and three times as likely at "Very Selective" institutions, but as likely to gain admission at "Selective" institutions. Students from very low-income families were six times more likely than students who were from high-income families to be ineligible for selective college admissions. Similar patterns emerged along parental education. Students whose parents had a four-year college degree were more likely to be eligible for admission at more selective institutions (80 percent) than students whose parents did not have a college degree (58 percent for Some College, but no degree and 45 percent for no more than a high school degree).

Black, Latino, low-income students as well as students who are potential first-generation college graduates are limited in their college options because fewer students are eligible for selective admissions than their nonunderrepresented peers. This constraint of options has implications on the study of undermatch; many low-income, Black, Latino, and first-generation

college students can only undermatch by enrolling in or applying to for-profits; or opting out of postsecondary education altogether.

In terms of high school characteristics, Table 11 also shows that students who attended high schools that have high, rather than low, average academic achievement were more than twice as likely to qualify for selective admissions (87 percent versus 34 percent), a finding that is consistent with the strong role of academic achievement in predicting selective admissions eligibility. Attending a high school with high levels of academic preparation (defined by the number of rigorous courses offered) also increases the likelihood of being qualified to attend a selective college, particularly "Most Selective" institutions (26 percent versus 15 percent). Students who attend high schools with high availability of college guidance services are about twice as likely to be eligible to gain admission to the most and highly selective institutions when compared to students at high schools with little access to college guidance services (29 percent versus 17 percent). With regard to high school norms, the patterns are similar. A higher share of students who attend high schools with high, rather than low, levels of college-going culture and parental involvement qualify for selective college admissions (84 percent versus 43 percent and 83 percent versus 44 percent, respectively).

Examining high school measures in aggregate is distinct from examining each separate measure, as the literature suggests the high school environment as a whole influences college choice beyond separate high school characteristics (Hill, 2008; McDonough, 1997). Attending a high school that exhibited a strong presence of the five high school characteristics identified in this study has compounding benefits. Table 11 shows that students who attend a high school with "Very high resources and norms," defined as having high levels of academic achievement, academic preparation, college guidance, college-going culture, and parental involvement, are twice as likely to qualify for some form of selective admission, compared to students who

attended high schools who showed low or very low presence of the five college-promoting high school characteristics (93 percent versus 48 percent and 46 percent, respectively).

Table 11. Student qualification by student and high school characteristics[ab]

	Qualifications[e]				
	Most	Highly	Very	Selective	Non
Total (*N* = 8,960)	3.24	16.87	21.39	23.00	35.49
Student Characteristics					
Gender***					
Female	4.14	14.08	22.42	20.60	38.77
Male	2.50	19.18	20.55	24.99	32.78
Race/Ethnicity***					
Asian	7.40	21.71	19.80	22.99	28.10
Black	2.65	1.87	10.63	19.95	64.89
Latino	2.94	6.07	11.07	12.48	67.45
Other race	2.94	13.70	17.28	27.33	38.74
White	3.14	21.71	25.85	25.32	23.98
Parental Income***					
$100K and over	8.38	29.43	33.09	17.69	11.42
$75K to $100K	4.19	19.36	25.04	34.80	16.60
$50K to $75K	1.09	16.95	25.94	24.19	31.83
$25K to $50K	1.78	14.67	13.78	22.99	46.78
$0K to $25K	2.62	5.18	12.86	15.55	63.79
Parental Education***					
Bachelor's or more	5.51	25.39	26.35	22.64	20.10
Associate's	.	14.83	12.12	24.13	48.47
Some College	1.00	8.89	22.20	25.42	42.49
High School or less	2.10	7.81	14.39	20.63	55.07
High School Characteristics[c]					
Academic Achievement***					
High	6.45	27.71	30.89	22.20	12.75
Mid	2.41	16.33	21.32	25.26	34.68
Low	1.48	4.95	9.89	18.07	65.61
School Resources					
Academic Preparation***[d]					
High	5.53	20.14	26.11	20.91	27.31
Mid	2.81	15.99	19.85	22.60	38.75

Table 11. Student qualification by student and high school characteristics[ab]

	Qualifications[e]				
	Most	Highly	Very	Selective	Non
Low	0.88	14.52	18.99	28.21	37.40
Availability of College Guidance***					
High	5.72	23.02	26.50	20.76	24.00
Mid	2.64	15.23	21.52	23.32	37.29
Low	2.21	14.65	16.35	24.44	42.36
School Norms					
College-Going Culture***					
High	6.53	26.15	28.97	22.46	15.90
Mid	2.44	16.02	21.89	23.87	35.78
Low	1.61	8.51	11.38	21.32	57.17
Parental involvement***					
High	5.60	26.06	29.07	22.32	16.95
Mid	2.75	15.91	22.11	24.49	34.75
Low	1.89	9.55	12.01	20.51	56.03
*High School Contexts****					
Very High Resources & Norms	11.24	33.28	32.52	15.87	7.10
High Resources & Norms	3.79	21.70	27.38	26.37	20.75
Average Resources & Norms	2.61	17.19	22.08	23.22	34.90
Low Resources & Norms	1.76	9.61	14.19	22.10	52.35
Very Low Resources & Norms	.	.	14.52	31.96	45.85

Notes: (a) Figures are weighted using the normalized F2F1WT. Cells with less than 5 individuals (unweighted) were not reported; (b) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (c) Schools were assigned "High," "Mid," and "Low" according to the top, middle two, and bottom quartiles, respectively; (d) ***$p < .001$, **$p < .01$, *$p < .05$ results of chi-square test (e) Qualifications were determined as the most selective institution to which students had over an 80 percent probability of gaining admission. The probability of admission was computed with student academic, demographic, and other characteristics.
Source: Analyses of ELS:2002

Overall Undermatch Characteristics

Once students were assigned eligibility by institutional selectivity, I compared their qualification to (a) the highest institutional selectivity to which they applied in order to determine undermatch at the application step; and (b) the selectivity of the institution they enrolled in order to determine undermatch at the enrollment step. I then examined the undermatch rates by student and high school characteristics in order to address the first research question. Table 12 shows the undermatch rates for each qualification level at the application and enrollment steps by student and high school characteristics.

Among high school students who graduated on-time in 2004 and indicated a desire to go to college, 27 percent undermatched at the application step and 31 percent of those who applied to an institution for which they were qualified undermatched at the enrollment stage. A higher share of students who were eligible to attend "Highly Selective" institutions undermatched at the application (45 percent) and enrollment (44 percent) stages. It is unclear why this occurred, yet it is consistent with previous findings (Smith et al., 2012).

Undermatch by Student Characteristics

There were small but consistent differences in the rate of undermatch by gender, with males undermatching at slightly higher rates. These gender differences were reduced from the application (25 percent of women versus 29 percent of men) to the enrollment (30 percent of women versus 31 percent of men) step.

Differences in undermatch rates between racial/ethnic groups were large at the application step, with White students undermatching at the highest rates (33 percent of Whites versus 12 percent Asian, 13 percent Black, 18 percent Latino and 20 percent Other race/ethnicity). However, aggregate undermatch rates are misleading as they mask the variation in undermatch rates by student qualifications. Of the highest achieving students – those who were qualified to attend "Most Selective" and "Highly Selective" institutions - Black students had the

highest undermatch rates at the application step (40 percent of those who qualified for "Most Selective" and 56 percent of those who qualified for "Highly Selective"). Latino students had the highest undermatch rates among students who were eligible for "Nonselective" institutions (7.9 percent of Latino students versus 5.6 percent overall), meaning the most selective institution to which these students applied were for-profit. Asian students had the lowest undermatch rates of any group across all qualification levels at the application (e.g., 10 percent versus 30 percent of students qualified to attend the "Most Selective" institutions).

Undermatch at the time of enrollment is conditional on students applying to institutions in their qualification level. While Asian students were most likely to apply to schools that matched their qualification levels, their undermatch rates were similar to those of White students across all qualification levels at the enrollment step (29 percent of Asians versus 32 percent of Whites). Among students qualified to attend "Most Selective" or "Highly Selective" institutions, Black students had the highest rates of undermatch at the time of enrollment (64 percent and 65 percent, respectively) even after omitting students who elected to attend HBCUs (Appendix D). While Latino students may have *applied* to institutions that matched their qualifications at similar rates as White students, they undermatched at much higher rates than Whites when it came time to enroll by student qualifications (e.g., 56 percent versus 43 percent of students qualified to attend the "Highly Selective" institutions). The undermatch rates of Latino students eligible to attend "Highly Selective" institutions were second to Black students (56 percent). Among students qualified for "Very Selective" or "Selective" admissions, Latino students had the highest rates of undermatch across all racial/ethnic groups (56 percent and 43 percent, respectively). Latino students also had the second highest rate of undermatch (20 percent) among those qualified for nonselective four- or two-year admission; only students from other racial/ethnic backgrounds had a higher rate (29 percent).

Among high-achieving students – those qualified to attend "Most Selective" and "Highly Selective" institutions - students from families with incomes over $100,000 were generally less likely to undermatch at both the application and enrollment step than students who were from low-income families (less than $50,000), with few exceptions. At the enrollment step, there was no undermatch trend for students who were eligible to attend the "Most Selective" institutions, although this could be due to a lack of balance in the enrollment sample, as many low-income students are lost due to not being qualified to gain admission to a selective institution and undermatching at the application step. For students eligible for nonselective institutions, about 8 percent of students whose families earned $100,000 undermatched at the enrollment step, compared with about one-fifth students from lower-income families.

The likelihood of undermatch rates also varies by parental education. At the application step, students whose parents have more, rather than less, parental education are less likely to undermatch at every level of selectivity. The likelihood of undermatch is between 1.5 to 2 times lower for students whose parents have a four-year degree than those whose parents have no more than high school education for each level of qualification at the application step (e.g., 27 percent versus 44 percent for those qualified to attend "Most Selective" institutions). Students whose parents have at least a bachelor's degree are also less likely to undermatch than students whose parents have no more than a high school education at the enrollment step (e.g., 41 percent versus 49 percent for those qualified to attend "Highly Selective" institutions), although the differences are smaller than in the application step.

Undermatch by High School Characteristics

In support of the hypothesis that the resources and norms of a high school are related to undermatch, Table 12 shows clear differences in undermatch rates by individual measures of high school resources and norms, as well as high school contexts. At both the time of application and enrollment, the likelihood of undermatch declined as the average academic achievement at the

school increased. For instance, for those qualified to attend "Most Selective" institutions, considerably smaller shares of those attending schools with high average achievement than of those attending schools with low average achievement undermatched at the application and enrollment steps (19 percent versus 41 percent, and 28 percent versus 46 percent, respectively).

Gaps in undermatch were more pronounced when considering academic preparation. High-achieving students who attended high schools with low academic preparation were about two times more likely to undermatch at selective institutions at the application step than students who attended high schools with high academic preparation. The gaps in undermatch at enrollment based on the availability of academic preparation were smaller. For instance, for those qualified to attend highly selective institutions, 40 percent of those from the highest preparation schools and 44 percent of those from the lowest preparation schools undermatched.

The availability of college guidance services is also negatively related to the likelihood of undermatch at both the application and enrollment steps. For instance, among those qualified to attend the most selective institutions, smaller shares of students who attended schools with the most guidance services than of those who attended schools with the fewest guidance services undermatched at the application (24 percent versus 37 percent) and enrollment (28 percent versus 54 percent) steps.

Table 12 shows that the college-going culture is also related to the likelihood of undermatch. Students who attended high schools with a high college-going culture have lower rates of undermatch at the application step when compared to students enrolled in high schools with low college-going culture (e.g., 28 percent versus 62 percent of those qualified for admission to "Highly Selective" institutions).

The relationship between the average amount of parental involvement found in the high school and the likelihood of undermatch is less linear. Students who go to high schools with above average parental involvement typically undermatch at lower rates at both the application

and enrollment steps than students who attend high schools with average or below-average parental involvement. However, the gaps are not as large as in other high school factors and the differences between schools with average and low parental involvement are small. To illustrate, among students qualified to attend the "Highly Selective" institutions, smaller shares of students who attended schools with the most reported parental involvement than of those who attended schools with the least parental involvement undermatched at the application (37 percent versus 56 percent) and enrollment (39 percent versus 46 percent) steps.

Table 12 also shows patterns in students' likelihoods of undermatch by the aggregate measure of high school context. Students who attended high schools marked by very high availability of resources and college-going norms had the lowest rate of undermatch at the application step. For instance, among students qualified to attend the "Very Selective" institutions, considerably smaller shares of students at schools with very high resources and norms undermatched than at schools with low resources and norms at both the application (18 percent versus 51 percent). Evaluation of students who attended schools with the lowest college-promoting resources proved challenging due to small sample sizes. When it came to undermatch at the enrollment step, the gaps remained. Students at very high resourced high schools were 2 to 3 times less likely to undermatch than students at low resourced high schools. For example, among those qualified to attend the most selective institutions, 65 percent of those attending low-resource schools but only 25 percent of those attending very high-resourced schools undermatched.

Table 12. Undermatch rates by academic qualification and student and high school characteristics[ab]

	Application Step						Enrollment Step[d]					
	Total	Most	Highly	Very	Selective	Non	Total	Most	Highly	Very	Selective	Non
Overall Undermatch	27.20	30.25	45.24	39.28	32.18	5.63	30.51	35.25	43.73	42.17	35.88	18.19
Student Characteristics												
Gender												
Female	24.87	30.01	43.10	38.40	29.08	5.65	29.80	35.33	42.71	41.55	38.38	17.39
Male	29.03	30.57	46.53	40.07	34.30	5.61	31.12	35.14	44.38	42.73	34.04	18.97
Race/Ethnicity												
Asian	12.18	10.13	12.36	14.88	19.94	3.99	28.56	36.55	37.07	39.12	29.61	12.57
Black	13.10	40.22	55.60	35.17	22.12	3.71	27.19	63.92	65.42	51.97	40.42	19.08
Latino	17.69	26.42	38.86	39.42	34.81	7.85	27.52	33.64	55.52	56.38	42.57	19.85
Other race	19.99	32.74	38.00	30.37	22.42	4.66	33.49	31.20	45.02	43.72	30.61	28.46
White	33.15	32.51	48.03	41.33	34.98	5.67	31.93	31.52	43.44	40.26	35.39	16.20
Parental Income												
$100K and over	26.14	24.96	33.91	28.07	24.08	.	31.51	35.06	38.75	34.61	32.37	7.59
$75K to $100K	30.90	33.31	45.10	36.27	30.37	4.43	31.80	41.97	41.44	39.54	28.03	19.83
$50K to $75K	29.58	18.89	44.29	44.07	33.30	5.40	33.19	.	45.96	47.26	38.89	18.77
$25K to $50K	27.90	33.17	56.80	48.63	35.66	6.97	28.64	49.19	51.18	46.73	38.42	17.62
$0K to $25K	19.45	46.39	59.40	43.90	34.26	4.86	27.87	30.52	49.50	51.52	45.56	20.32
Parental Education												
Bachelor's or more	26.60	27.34	37.92	32.33	26.08	2.94	30.64	33.83	41.23	37.46	31.59	12.55
Associate's	26.03	.	62.71	46.70	35.87	2.68	25.90	.	57.23	45.43	35.52	15.49
Some College	27.97	35.71	59.91	44.28	36.06	6.25	31.58	.	52.76	50.35	38.18	19.96
High School or less	28.16	44.36	62.69	55.95	39.72	8.71	31.44	45.29	48.67	52.73	45.43	22.92
High School Characteristics[c]												
Academic Achievement												
High	24.95	18.95	35.95	26.49	22.42	3.71	29.60	27.68	36.94	34.03	29.76	10.19
Mid	30.58	41.96	50.74	45.56	34.92	5.32	31.74	45.81	50.90	47.08	35.00	17.86
Low	20.76	40.79	61.41	52.99	36.73	6.56	28.70	46.12	43.27	58.91	50.72	20.77
School Resources												
Academic Preparation												
High	20.60	20.61	27.54	26.18	25.62	5.28	29.77	23.18	39.94	40.66	29.49	15.94
Mid	27.80	36.87	49.81	42.25	32.04	5.90	30.38	46.51	46.92	42.49	36.18	18.30
Low	36.55	56.04	68.97	59.32	41.17	5.03	32.75	.	44.03	47.10	45.25	20.73
Availability of College Guidance												

High	21.41	23.83	28.62	28.61	22.47	4.33	27.20	28.32	32.89	36.41	26.40	15.30
Mid	27.37	33.62	50.06	40.35	31.91	5.24	31.49	35.93	50.30	43.49	36.43	19.34
Low	32.42	37.14	59.05	52.67	40.55	7.17	32.00	53.55	53.60	50.71	44.45	17.63
School Norms												
College-Going Culture												
High	21.23	20.22	28.37	23.46	22.10	4.23	28.26	25.28	36.55	35.60	27.72	8.47
Mid	29.33	43.79	53.72	44.06	31.08	4.90	31.30	39.51	50.97	44.16	35.89	18.56
Low	28.49	22.08	62.20	61.10	47.74	7.40	31.41	69.77	47.77	65.21	50.68	21.19
Parental Involvement												
High	27.02	19.97	36.86	32.05	28.03	3.01	28.48	26.36	38.82	33.72	26.42	13.10
Mid	29.43	42.25	48.79	43.03	33.46	5.90	32.35	39.09	48.03	47.67	37.35	18.40
Low	22.24	23.96	55.97	42.36	33.53	6.14	28.85	54.35	45.78	45.52	43.62	19.64
High School Contexts												
Very High Resources & Norms	15.77	16.89	18.15	17.68	10.40	.	25.71	25.19	29.11	29.41	22.03	5.85
High Resources & Norms	24.90	22.57	39.52	28.21	26.48	2.97	30.16	27.58	44.48	39.73	30.73	10.55
Average Resources & Norms	30.74	43.60	52.82	46.91	32.06	5.39	31.28	37.91	48.47	43.38	34.59	19.73
Low Resources & Norms	26.99	38.45	60.07	50.86	39.52	6.45	31.44	65.38	56.75	55.41	45.93	19.82
Very Low Resources & Norms	41.35	.	.	.	63.72	.	26.20	.	.	.	.	.
N (unweighted)	8,600						6,300					

Notes: (a) Figures are weighted using the normalized F2F1WT. Cells with less than 5 individuals (unweighted) were not reported; (b) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (c) Schools were assigned "High," "Mid," and "Low" according to the top, middle two, and bottom quartiles, respectively; (d) conditional on not undermatching at the application step
Source: Analysis of ELS:2002.

Odds of Undermatching by School- and Student-Level Predictors

Table 12 uses descriptive statistics to identify relationships between the likelihood to undermatch and student- and school-level characteristics. I used a three-level hierarchical linear model (student, school, and state) to test the extent to which high school-level measures explain observed differences in undermatch based on individual characteristics for four different models using student characteristics and (1) individual high school characteristics at the application step (i.e. academic preparation, the availability of college guidance, college-going culture, and parental involvement); (2) individual high school characteristics at the enrollment step; (3) aggregate high school characteristics at the application step (i.e. Very high to very low high school resources and norms); and (4) aggregate high school characteristics at the enrollment step.

The first step is to test the intraclass correlation coefficient, or the proportion of variance in the likelihood of undermatch that is attributable to differences between high schools (Raudenbush & Bryk, 2002). If the coefficient is statistically significant from zero, the use of a hierarchical linear model is appropriate. At the application step, 14 percent of the variance in undermatch was due to differences between high schools. The intraclass correlation coefficient was much smaller in the enrollment model (2 percent), but still statistically significant. Appendix E provides detailed information for the above models. After confirming the appropriate use of the multi-level model, I modeled the likelihood of undermatch at both the application and enrollment steps, controlling for student, school (individually and in aggregate) and state characteristics. In the following section I discuss the results for student-level predictors - including the demographic groups of interest, other student variables I identified through the conceptual model – and individual and aggregate high school-level measures.

High School-Level Predictors

After controlling for student-level and state-level characteristics, high school factors accounted for 94 percent of the variation in undermatch across high schools at the application step and (although there was very little variation to begin with) 100 percent at the enrollment step. An increase in the availability of college guidance services was associated with an increase in odds of undermatching (odds-ratio of 1.96), which is a counter-intuitive finding. *Before* controlling for student-level characteristics, the availability of college guidance services is associated with a reduction in the likelihood of undermatch (Appendix E). Table E1 in Appendix E shows a series of models with blocks of predictors entered in at a time. An increase in college-going culture is associated with a 69 percent reduction in the likelihood of undermatch at the application step, which is contrary to findings in previous research (Roderick et al., 2011). None of the high school-level factors were statistically significant in the enrollment step, even before entering student-level characteristics in the model.

Measuring high school contexts using an aggregate indicator accounted for 85 percent of the variation across high schools after controlling for student-level characteristics. Findings (columns 3 and 4 in Table 13) revealed the advantage to undermatch of attending a high school with high college-promoting resources and norms. Students who attended high schools where the availability of college-promoting resources and norms were "Very High" or "High" were less likely to undermatch at the application step (72 percent and 28 percent, respectively) and the enrollment step (45 percent and 19 percent, respectively) than students who attended high schools with "Average" college-promoting resources and norms, even after controlling for student characteristics. There were no differences after controlling for student-level characteristics in the undermatch rate of students who attended high schools that had "Very Low," "Low," or "Average" availability of college-promoting resources and norms.

Student-level predictors

As Table 13 illustrates, male and female students were as likely to undermatch at both the application and enrollment steps after controlling for other student characteristics; either individual or aggregate high school measures; and state contexts. After controlling for individual high school measures and other student characteristics, Asian and Black students were less likely to undermatch at the application step (odds-ratios of 0.46 and 0.58, respectively), than White students. There were similar findings when controlling for aggregate high school-level measures (column 3) at the application (odds-ratios of 0.47 for Asian and 0.62 for Blacks). Net of other variables, the likelihood of undermatch at the enrollment step did not vary by race/ethnicity for either individual high school measures or in aggregate.

After taking into account high school factors and student characteristics, only students whose family incomes were between $25,000 and $50,000 as well as $75,000 and $100,000 were more likely than students from families with incomes above $100,000 to undermatch at the application step (odds-ratio of 1.39 and 1.32, respectively). The relationship between family income and undermatch was similar when controlling for aggregate measures of high school characteristics. Column 3 of Table 13 shows that students whose families with incomes between $25,000 and $50,000 as well as between $75,000 and $100,000 were more likely than students from families earning more than $100,000 to undermatch at the application step. Family income was unrelated to the likelihood of undermatch at the enrollment step regardless of the measurement of high school characteristics.

The final demographic group of interest was students by parental education. At the application step, students whose parents did not have at least a bachelor's degree are more likely to undermatch than students whose parents have lower levels of education whether controlling for student-level characteristics and high school characteristics individually (odds-ratios of 1.49 for no more than high school; 1.31 for some college; 1.37 for associate's degree) or in the aggregate (odds-ratios of 1.57 for no more than high school; 1.33 for some college; 1.37 for associate's

degree). Controlling for high school-level characteristics individually, students whose parents had no more than a high school degree were more likely to undermatch (odds-ratio = 1.41) than students whose parents have a bachelor's degree. Similarly, in the high school contexts model, students whose parents had no more than high school education (odds-ratio of 1.45) were more likely to undermatch than students whose parents had earned at least a bachelor's degree.

Other student characteristics are also related to the likelihood of undermatch. As suggested in the descriptive statistics, the level of student qualifications is related to the likelihood to undermatch. The likelihood of undermatch at the application and enrollment steps, and regardless of the measurement of high school characteristics, increases substantially with the level of student qualifications. In fact, student qualifications are a main driver of all models. Students who did not take Calculus fared no worse or better than students who did at either the application or enrollment steps or whether controlling for high school factors or context, but this finding may be due to a potential redundancy with qualifications also included in the models. However, for both high school factors and contexts models, students who took more AP or IB courses than average had an decreased likelihood of undermatch at both the application and enrollment step when controlling for individual high school-level measures (odds-ratios of 0.81 and 0.92, respectively) or aggregate high school-level measures (odds-ratios of 0.81 and 0.92, respectively).

As part of the conceptual framing of the study, the expected college costs are central to the cost-benefit analysis embedded in the college choice process. I therefore included a composite measure of the extent to which participants agreed with statements regarding the "expected benefits" of higher education. Since the model compares students within states, including state-level tuition and financial aid measures would be redundant. Instead, I used the cost of public institutions within a 50-mile radius to try to account for potential regional variation in costs (published tuition, or "sticker price") and the net tuition (tuition after financial aid). Table 13

shows that the measure of "Expected Benefits" did not have a relationship with undermatch at the application or enrollment step, and whether controlling for individual or school-level measures. While no other college cost measure was related to the likelihood of undermatch, as the net tuition of two-year institutions within a 50-mile radius increases, the likelihood of undermatch increases at the application stage (columns 1 and 3).

The study also included composite measures of social capital (sources of information, college-promoting peer networks, and parent and family networks). Students who reported having stronger college-promoting sources of information or peer network were less likely to undermatch at the application step in the individual high school characteristics model (odds-ratios of 0.60 and 0.70, respectively) and the high school aggregate model (odds-ratios of 0.61 and 0.68, respectively). At the enrollment step, students with college-promoting peer networks were also less likely to undermatch when controlling for other characteristics in the high school aggregate model (odds ratio of 0.77). The measure of parent and family networks was negatively associated with the likelihood to undermatch at the application step when controlling for high school factors or controlling for high school contexts.

The measures of cultural capital were negatively associated with the likelihood of undermatch at the application step, but not the enrollment step for both individual high school measures and in aggregate. The measures of the value of college attainment (parent's, friend's, close relative's, school counselor's and favorite teacher's desire for student to attend college) as well as the measure of college-promoting home environment (a composite measure of parent contact with the school, parent providing advice about plans after high school, family has more the 50 books in the home, parent provides information about community, national or world events, and parent attends concerts, plays or movies with the student) were negatively associated with the likelihood of undermatch at the application step. For example, the college-promoting home environment measure had an odds-ratio of 0.69 using individual high school measures and

also an odds-ratio of 0.69 using aggregate high school measures. There is no association between the value of college attainment and the college-promoting home environment with the likelihood to undermatch at the enrollment step after controlling for other variables.

Table 13. Odds-ratios for the likelihood of undermatch at the application and enrollment steps by student characteristics as well as individual and aggregate high school measures[a]

	Individual High School Measures				Aggregate High School Measures[c]			
	1		2		3		4	
Predictors	Application		Enrollment		Application		Enrollment	
High School Characteristics								
High School Factors								
School Resources								
Academic Preparation	1.09		1.01					
Availability of College Guidance	1.96	*	1.47					
School Norms								
College-Going Culture	0.31	*	0.57	~				
Parental Involvement/Influence	1.21	~	1.00					
High School Context (ref. Average)								
Very High Resources & Norms					0.28	*	0.55	*
High Resources & Norms					0.72	*	0.81	~
Low Resources & Norms					1.09		1.16	~
Very Low Resources & Norms					1.16		0.56	
Student-Level Predictors								
Demographics								
Female	1.17	*	1.01		1.18	*	1.01	
Native Language is English	1.12		1.08		1.13		1.08	
Race: Asian (ref. White)	0.46	*	0.81		0.47	*	0.81	~
Race: Black (ref. White)	0.58	*	1.14		0.62	*	1.18	
Race: Latino (ref. White)	0.82		1.06		0.88		1.10	
Race: Other (ref. White)	0.78	~	1.16		0.81		1.18	
Income: $0K to $25K (ref. over $100K)	1.19		1.07		1.24	~	1.07	
Income: $25K to $50K (ref. over $100K)	1.39	*	1.04		1.41	*	1.03	
Income: $50K to $75K (ref. over $100K)	1.20	~	1.09		1.20	~	1.08	
Income: $75K to $100K (ref. over $100K)	1.32	*	1.03		1.30	*	1.01	
Parent Ed: High School (ref. Bachelor's)	1.49	*	1.41	*	1.57	*	1.45	*
Parent Ed: Some College (ref. Bachelor's)	1.31	*	1.22	~	1.33	*	1.23	~
Parental Ed: Associate's (ref. Bachelor's)	1.37	*	1.17		1.37	*	1.18	
Qualification (ref. nonselective institution)								
Most Selective	134.36	*	12.49	*	118.73	*	11.71	*
Highly Selective	112.97	*	14.09	*	101.05	*	13.29	*
Very Selective	40.98	*	8.54	*	36.68	*	8.09	*
Selective	14.71	*	4.67	*	13.46	*	4.50	*
Human Capital: Academic Preparation								
Highest Math: Alg. I (ref. Calculus)	1.67		1.34		1.68		1.33	
Highest Math: Alg.II/Geo. (ref. Calculus)	1.01		0.97		1.02		0.98	
Highest Math: PreCalc./Trig (ref. Calculus)	1.00		1.00		1.00		1.00	
Number of AP or IB courses	0.81	*	0.92	*	0.81	*	0.92	*
Human Capital								
Expected Benefits & Costs	1.01		1.02		1.01		1.02	
"Sticker price" tuition for 4-years[b]	1.01		0.97		1.01		0.96	
Net tuition for 4-years[b]	1.06		1.00		1.05		1.00	
"Sticker price" tuition for 2-years[b]	1.07		0.89	~	1.01		0.88	~
Net tuition for 2-year institutions[b]	1.26	*	1.09		1.23	*	1.07	
Social Capital								
Sources of Information about College	0.60	*	0.79	~	0.61	*	0.80	~
Peer Networks	0.70	*	0.77	~	0.68	*	0.77	*
Parent & Family Networks	1.45	*	1.06		1.51	*	1.07	
Cultural Capital								
Value of College Attainment	0.81	*	1.02		0.82	*	1.03	
Habitus	0.69	*	0.95		0.69	*	0.94	

Variance Tests of Random Effects				
Intercept	0.03	0.00	0.08	0.00
High School Factors				
Academic Preparation	0.09 ~	0.00		
Availability of College Guidance	0.00	0.00		
College-Going Culture	0.04	0.00		
Parental Involvement/Influence	0.00	0.04		
High School Contexts (ref. Average[c])				
Very High Resources & Norms			0.16	0.07
High Resources & Norms			0.02	0.00
Low Resources & Norms			0.00	0.05
Very Low Resources & Norms			0.73	0.96
-2 Log Likelihood	7416	7007	7439	7011
AIC	7590	7177	7615	7185
% of High school-level variance explained				

Notes: *$p < .05$, ~$p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius; (c) reference category is "Average high schools resources and norms."
Source: Analysis of ELS:2002

Testing differences between underrepresented groups within high schools

In order to better understand differences among various demographic groups in the likelihood to undermatch, I examined whether some high schools have bigger gaps (e.g., Black-White gap) in undermatch than others. In order to test this variance of within-school differences across high schools, I allowed the slopes for these groups to vary across high schools in three separate analyses (1) random effects for race/ethnicity; (2) random effects for parental income; (3) random effects for parental education; while holding all other student- and school-characteristics as fixed effects (comparing students within schools). The analyses were done for both the application and enrollment steps, and with high school characteristics (individually as well as in aggregate) as fixed effects - for a total of twelve models. I then tested the hypothesis that the variances of these random effects (race/ethnicity, parental income, and parental education) are zero. If, for example, after controlling for measures of student, school and state characteristics, some high schools have larger differences between White and Black students' likelihood to undermatch at the application step than other high schools, the null hypothesis would be rejected ($p < .05$).

The analyses were then repeated to test the variance of the differences in likelihood in undermatch for the demographic groups, allowing for high school characteristics to vary across high schools. I therefore included both high school measures in the models as random effects along with the slopes for the demographic groups. These additional analyses examined the variance in potential gaps in undermatch by (1) race/ethnicity, (2) parental income (3) parental education across high schools after controlling for student, high school (i.e., high school measures individually or in aggregate) and state characteristics. This was modeled for both the application and enrollment steps for an additional 12 models.

Table 14 summarizes the results. The variance tests for random effects were unable to detect differences for any of the models. These results indicate that gaps in likelihood to

undermatch by group (racial/ethnic, parental income, parental education) within high schools do not vary across high schools. These findings could be due to low statistical power as sample sizes within high schools are small. Homogeneity by racial/ethnic, parental income, and parental education within high schools would also limit the ability to detect differences. Full models are available in Appendix F.

Table 14. Summary of results for variance tests[a] of random effects for race, income and parental education as random predictors for the likelihood of undermatch at the application and enrollment steps by modeling of high school measures.

		Random Effects		
Apply Step		Race[d]	Income[e]	Parental Education[f]
Fixed Effects:	High School Factors[b]	No	No	No
	High School Contexts[c]	No	No	No
Random Effects:	High School Factors	No	No	No
	High School Contexts	No	No	No
Enroll Step				
Fixed Effects:	High School Factors	No	No	No
	High School Contexts	No	No	No
Random Effects:	High School Factors	No	No	No
	High School Contexts	No	No	No

Notes: (a) H_0 is variance of the slope = 0; (b) High School Factors are Academic Preparation, College Guidance, College-Going Culture, and Parental Involvement; (c) High School Contexts include Very high resources and norms, High resources and norms, Average resources and norms, Low resources and norms, Very low resources and norms (d) Race included Asian, Black, Latino and Other race/ethnicity with White as the reference; (e) Income categories were $0-25K, $25-50K, $50-75K, $75-100K with $100K and over as the reference category; (f) Parental Education included High school or less, Some college (no degree), and Associate's degree with Bachelor's degree as the reference

Sources: Analyses of ELS:2002

CHAPTER 5: CONCLUSION

The purpose of this study is to examine whether high school-level characteristics explain variation in the likelihood of undermatch, above and beyond student characteristics. This objective was pursued within the HGLM framework, with a focus on the variation of student demographic groups. Drawing data from the ELS:2002, I derived high school-level measures in two distinct ways. The first approach was to generate five high school-level composite variables, measuring academic achievement, academic preparation, availability of college guidance, college-going climate and parental influence, using confirmatory factor analysis to combine indicators that are aligned with the study's conceptual model. The second approach derived a high school-level measure by generating an aggregate composite of the five preceding measures. This composite represents a typology of high schools' college promoting resources and norms—high schools that had very high, high, average, low, or very low college-promoting resources and norms—and was created using latent class analysis. This chapter identifies the primary conclusions that may be drawn from this study, situating these conclusions within the existing undermatch and college choice literature. I also discuss implications of the study for policy, practice, and future research.

Primary conclusions

Undermatch rates and student qualifications differ across student demographic groups

Among on-time high school graduates with a desire to continue on to postsecondary education, 27 percent undermatched at the application step in 2004. Of those who applied to match institutions, 31 percent undermatched at the enrollment step. Since undermatch is estimated, not observed, comparison of undermatch rates across studies may be dubious, due to discrepancies in techniques used to estimate undermatch, which lead to varying results (Rodriguez, under review). Nonetheless, in this study undermatch rates at the enrollment step are

slightly lower than the rates found in Smith et al.'s (2012) study, which used a similar sample of students drawn from ELS:2002 and a similar method to identify student qualifications. They did not calculate undermatch at the application step, nor were their estimates conditioned on not undermatching at the application step, so their study differs from this one in important ways. Other studies that used different samples and approaches to estimating undermatch (Bowen et al., 2009; Roderick et al., 2011) found higher undermatch rates than this study.

Recognizing the various individual and contextual forces that influence college choice, one cannot conclude in absolute terms whether the estimated undermatch rates are "high" or "low." As Bowen et al. (2009) point out; the expectation is not for undermatch to ever be zero, as students and their families will make decisions best suited to their particular circumstances. However, the disparity in undermatch rates across different demographic groups is concerning. High-achieving Black students undermatch at higher rates than their high-achieving Asian and White peers at both the application and enrollment steps. At the enrollment step, Latino students had the highest or second-highest undermatch rates in every level of student qualification. There were also differences across family income. Generally, high-achieving students from families with incomes over $100,000 were less likely to undermatch than low-income families (e.g., 25 percent versus 47 percent of students from families who earn less than $25,000 at the application step for students eligible to attend "Most Selective" institutions). For students eligible for nonselective admissions, one out of every five students from a lower-income (less than $100,000) family undermatched at the enrollment step, compared to one out of every thirteen students from a high-income background (over $100,000). Variations across parental education were also found. Students whose parents have no more than a high school education are more likely to undermatch than students whose parents have at least a bachelor's degree at the enrollment step (e.g., 53 percent versus 38 percent for those qualified to attend "Very Selective" institutions).

Characteristics of the high school attend influence the likelihood of undermatch

The descriptive data also show that students who attend high schools with low levels of academic achievement, academic preparation, college guidance, college-going climate, and parental influence, as well as high school contexts where there are low college-promoting resources and norms in aggregate, are less likely to be qualified for selective college admissions, or enroll in institutions that match their academic qualifications. Black, Latino, low-income and potential first-generation college graduates are disproportionately represented in high schools with lower-than-average-college-promoting resources and norms. Taken together, the descriptive information suggests a relationship, or structural inequality, between high school characteristics and observed differences in undermatch rates across demographic groups.

Multi-level regression analyses revealed students who attended high schools with "very high" or "high" college-promoting resources and norms were 72 percent and 28 percent less likely, respectively, to undermatch at the application step compared to students who attended high schools with "average" levels of college-promoting resources and norms, after accounting for student-, school-, and state-level characteristics. No differences were found in the likelihood to undermatch between high schools with "average" levels of college-promoting resources and norms and those with "low" or "very low" levels of resources and norms. In addition, students who attended high schools with "very high" resources and norms were 45 percent less likely to undermatch at the enrollment step than students who attended high schools with "average" resources and norms. This was the only high school-level measure that remained statistically significant in the enrollment model, which is largely driven by student-level characteristics.

The role of individual high school characteristics yielded mixed results. First, students who attended high schools that had higher college-going cultures were less likely to undermatch. Roderick et al.'s (2011) study had a contrary finding, where the odds-ratio for their measure of college-going climate was in the opposite direction. Second, the odds of undermatching increases by 96 percent as the availability of college guidance services increases, which is counterintuitive.

This finding does not suggest that providing more college guidance is detrimental to students' educational outcomes, but is rather a result of the students in schools with high levels of college guidance being most frequently qualified for highly selective schools. Students attending high schools with high availability of college guidance have more of an opportunity to undermatch because they are more likely to be highly qualified. Moreover, the analyses reveal that these high schools provided *more* college guidance services, which may not necessarily mean they were counseling students to apply to and enroll in matched institutions. At the enrollment step, the variance between high schools was rather small (intraclass correlation of 2 percent), which suggests that perhaps once students apply, individual characteristics (e.g., peer networks and academic qualifications) are better predictors of enrollment undermatch.

Student-level characteristics contribute to likelihood undermatch

While the focus of this study was to examine high school-level predictors, there were important findings at the student-level as well. After controlling for student-, high school-, and state-level characteristics, the individual and aggregate high school measures yielded similar results for racial/ethnic groups. Black and Asian students were less likely to undermatch than White students at the application steps. Latino students were as likely to undermatch as White students at both application and enrollment, after controlling for other characteristics. At the enrollment step, there were no differences between any racial/ethnic group and White students for either aggregate or individual high school characteristics.

At the application step, family income results were mixed. Students whose families earn less than $100,000 were more likely to undermatch when compared to students whose families make over $100,000, with the exception of students whose families make less than $25,000 and those whose families make between $50,000 and $75,000, There were no differences in the likelihood to undermatch by parental income at the enrollment step after controlling, net of other variables. With regard to parental education, students whose parents do not have a bachelor's

degree are more likely to undermatch than students whose parents have a bachelor's degree at the application step At the enrollment step, after controlling for aggregate high school measures, students who are potential first-generation college goers (whose parents have no more than a high school degree) were more likely to undermatch.

The strongest student-level predictor of undermatch was the qualification level. With only one exception, students who were qualified to attend some form of selective institution were more likely to undermatch than students who were only qualified to attend nonselective two- and four-year institutions, as students with more options have more chances to undermatch. This pattern holds true even at the enrollment step, although the magnitude of the likelihood was much smaller. Also, students who had taken more AP courses were also less likely to undermatch at the application and enrollment step.

Student-level composites measuring human, social, and cultural capital were also of note. Most measures of expected college costs and availability of financial aid of public institutions within a 50-mile radius were not statistically significant, which is unsurprising, given the models controlled for state-level fixed effects and four-year public tuition is typically set at the state level. As public two-year net tuition increased, however, the likelihood of undermatch at the application step increased as well, after controlling for student and high school characteristics as well as state-level fixed effects. It is unclear why this is the case. Perhaps an increase in net tuition would make two-year institutions less attractive, and therefore students opt out. Another possible explanation for this result is that the cost of public two-years is also capturing some unobserved regional effect that increases the likelihood of undermatch.

Students who came from homes with a greater college-promoting environment had a decreased likelihood of undermatch. This finding is consistent with social and cultural reproduction theory (Bourdieu, 1986), which would suggest that having and exhibiting more cultural capital that reflects the dominant culture's tastes and perceptions would be aligned with a

desire for greater institutional selectivity. College-promoting home environment was also a significant positive predictor of admission into "Most Selective" institutions.

There are large differences in qualification rates by demographic background

The study of undermatch is only one facet of the challenges in equitable college access and success. Gaps in academic preparation and achievement preceding senior year set the stage for gaps in student qualifications and a student's range of options. In this study, large shares of Black, Latino, low-income students, as well as potential first-generation college-goers did not qualify for selective admissions compared to White, high-income and students whose parents have a four-year degree. These alarmingly low qualification rates echo findings in Chicago (Roderick et al., 2006). The large disparity in qualifications, from the outset, undergirds every subsequent finding; as Black, Latino, low-income, and potential first-generation college graduates are concentrated in the sector with the least option to undermatch.

Contributions of this study

This study has contributed to the understanding of undermatch by addressing a gap in the existing undermatch literature. Findings from this study bring us closer to understanding the connections between students' application and enrollment decisions with the characteristics of their high schools. First, the extent of college-promoting resources and norms found at the high school a student happens to attend influences their chances of undermatch, after controlling for other characteristics. Second, underrepresented students are concentrated in schools with fewer college-promoting resources and norms, and these high schools tend to have higher undermatch rates than high schools with more resources and norms. Taken together, this contribution furthers the understanding of structural inequalities found at the high school-level that perpetuate stratification in higher education.

This study also provided several methodological contributions. First, robust high school-level measures that are linked to policy levers (e.g., academic preparation, availability of college guidance services) have previously gone unexplored in explaining the variation of undermatch. This contribution is particularly important for providing policy makers with next steps on how to mitigate undermatch. In addition, I extended Hill's (2008) use of latent class analysis in this study to produce a typology of high school contexts (e.g., very high college-promoting resources and norms). Finally, this study used confirmatory factor analysis by leveraging the data-rich ELS:2002 to test the conceptual model (Perna, 2006), which was yet to be done and is a contribution to college choice literature more broadly. In testing Perna's (2006) model, this study has employed one of the most comprehensive approaches to modeling student choice.

Implications for future research

While this study contributes to the literature on undermatch and college choice, there are several avenues for future research that can further the understanding of undermatch – understanding the enrollment decisions of students by qualifications, the role of institutional characteristics, and the state policy context.

Understanding student choice across the qualifications spectrum

While a large focus has been placed on the highest achieving students (Bowen et al., 2009; Roderick et al., 2008), Table 12 illustrates that of the students eligible for selective college admissions, students qualified to attend the "Most Selective" institutions undermatch at the lowest rates. Previous studies have also demonstrated similar findings (Smith et al., 2012). We need to better understand the tradeoffs faced by students who are qualified for selective admissions, but are not the highest achieving. The "Highly Selective" category, for example, represents a broad range of institutions - from small private liberal arts colleges such as Bryn Mawr, DePauw, and Muhlenberg to large state research universities like University of Michigan,

University of Texas at Austin, and University of Maryland College Park. One possible explanation is students who are qualified to attend these institutions yet undermatch may not apply or enroll because the institutions may not have the name recognition that many "Most Selective" institutions possess. Perhaps proximity or price trumps prestige for many of the students who are qualified to attend a selective institution, but are not the highest achieving.

More research is also needed to better understand the decision-making process of students who are qualified to attend nonselective two- and four-year institutions, as they constitute not only one-third of the overall sample, but two-thirds of Black and Latino students, and roughly half of low-income and potential first-generation college graduates. While undermatch rates may not seem as high for students qualified to attend a "Nonselective" institution compared to the overall rate (e.g., 18 percent versus 31 percent at the enrollment step, respectively), an undermatch for these students who completed high school and indicated a desire to continue onto higher education has high stakes. Students who are qualified for nonselective two- or four-year admissions can only undermatch to either for-profits, which on average, have low completion rates and high debt burdens, or not enroll in college at all. In order to improve overall college access for underrepresented students, further research should examine the nature of eligible students' choices when they are faced with the choice of attending a non-selective institution, attending a for-profit, or opting out of higher education.

The role of institutional characteristics in undermatch

The treatment of HBCUs in estimating undermatch is complex; as students who select HBCUs may have a distinct college choice process. A recent high-profile controversy where a Black engineering student who was accepted into Harvard and chose Florida A&M highlights some of the many tradeoffs. In an open letter explaining his decision, the student explained that FAMU had a better engineering school with a legacy of graduating Black engineers (Williams, 2010). While a separate analysis in this study showed that omitting students who enrolled in

HBCUs from the analyses produced little differences in undermatch rates at the enrollment step for high-achieving Black students and an increase of undermatch for students eligible for nonselective institutions, there were very few black students in the sample to be able to draw substantive conclusions. A thorough examination of the role of HBCUs in college choice using state-level data, in general, and specifically in undermatch is needed

One current limitation of the ELS:2002 is that postsecondary files do not distinguish a student's program of study. The Black engineering student's college choice cited above also reflects the case where students enroll in institutions less selective overall yet have superior programs in their field of study. One further step in the study of undermatch would consider matching based on the selectivity of programs within institutions (e.g., are high-achieving potential engineering students applying to the top engineering programs?) Similarly, the case where high-achieving students who are in honors programs at a less selective institution should, perhaps, not be considered an undermatch. College honors programs are typically designed with extra supports and structures to attract high achieving students and promote completion. Students who enroll in honors programs are an understudied group of students, whose outcomes need to be better understood before branding them as an undermatch.

State policies that may promote or inhibit undermatch

The state context is an integral part of the undermatch story, yet could not be fully examined because the ELS:2002's sampling design does not support state-level analyses. Many of the policies that intersect with college choice (e.g., academic preparation, college tuition, financial aid, higher education institutional landscape) occur at the state-level. For example, some states have popular dual enrollment programs that enable students to graduate from high school with a year or more of college credits. Students with dual enrollment credits may subsequently favor institutions that accept their dual enrollment credits, and weigh institutional selectivity less. As another example of how state policies shape choice, states that provide merit-based aid might

influence lower-achieving students' perceptions of college affordability, as they would be less likely to receive merit based aid. Future research should examine state-level data that considers the full spectrum of postsecondary options, with postsecondary information that allows for tracking students out of state, and leverages robust high school-level information. Many state longitudinal data systems can support this recommendation.

Implications for Policy and Practice

The focus on the high school-level measures on undermatch was deliberate. Students alone should not bear the onus of understanding the landscape of postsecondary options and selecting an institution during the application and enrollment processes. The two different approaches for creating high school measures used in this study were complimentary, as the individual high school measures allowed for understanding their distinct relationships to undermatch, and the aggregate measure demonstrated how these measures work in concert.

Need for more data

The ability to estimate undermatch has until recently been limited by the availability of data to track high school graduates. This limitation has partly been addressed with the availability of National Student Clearinghouse data that tracks most student enrollment postsecondary institutions and the advancement of state longitudinal data systems. Findings from this study show that the application rather than the enrollment step is where high schools wield more influence. However, few systems (e.g., Chicago Public Schools) capture where students apply and are admitted – essential components to understanding undermatch at the application step and estimating students' likelihood of admission. In order for districts and states to understand student college choice, they need to collect data on the institutions to which students are applying and gaining admission. As such, current funding incentives to build out state longitudinal data

systems (i.e., the federally-funded Statewide Longitudinal Data Systems Grant Program) should encourage such collection of data.

Improvements in College Guidance

The findings from the multivariate analyses suggest the nature rather than the quantity of college guidance services is perhaps more important with regard to the likelihood students apply to or enroll in institutions that match their qualifications. This finding has implications for (a) the practice of college guidance in high schools and (b) the training of school counselors. While these findings may seem counterintuitive, providing more college guidance services would not improve match unless the information high school counselors provide orient students to consider matched institutions. Most high school guidance services provided by high school counselors are not focused on match, but rather creating awareness of the college options available or the mechanics of completing college and financial aid applications. College guidance services should be restructured to allow for differentiation by academic qualifications - linking students' qualifications with the full spectrum of opportunities. As the study of undermatch expands, promising high school-level interventions in the form of college guidance programming have responded to issues of match (National College Advising Corps, 2012; Options Center, Goddard Riverside Community Center, 2012; Sherwin, 2012).

Also, few counselor preparation programs offer courses in college guidance (McKillip, Rawls & Barry, 2012; Perusse & Goodnough, 2005). The ever-changing higher education landscape necessitates for school counselor preparation programs to understand foundational college guidance practices, yet also be provided with regular professional development as well.

Increasing Access to Academic Preparation

Providing equitable access to rigorous academic coursework is not a novel idea, but one that has become an imperative as clamor grows for decreased remediation rates and increased

degree attainment. I found the availability of academic preparation resources at the high school-level was not significant, net of other variables, yet the number of AP/IB courses students accessed did decrease the likelihood of undermatch. These findings suggest that offering rigorous courses in a high school does not compensate for individual student access to rigorous coursework. Therefore the number of rigorous courses offered at the school-level is not as strong an indicator as the percentages of students who are actually gaining access to these resources. For many underrepresented students, both school-level availability and individual-level access to rigorous coursework remain elusive (Perna et al., under review). State-level efforts should ensure equity in rigorous course availability as well as individual course-taking. This would not only improve on student undermatch rates but increase the number of students from underrepresented backgrounds who are competitive for some form of selective admission process.

Increasing Institutional Recruitment & Capacity

While institutions have limited resources and time, the fact that students undermatch largely at the application suggests they did not even consider matched institutions. Whether they were unaware of these institutions or opted out at the application or enrollment step, institutions across the selectivity spectrum can do more to attract students. Institutions could and should be doing more to attract students who are good matches, and may have to rethink the type of information they send. Recently, researchers Caroline Hoxby and Sarah Turner (2013) demonstrated that a $6 mailer to high-achieving students that listed some of their matched institutional options, net costs, and fee waiver information increased the number students applying to these matched institutions.

One limitation of this study is the inability to account for institutional capacity, or the number of seats available at each level of selectivity. In the hypothetical case of perfect match where all students apply to schools to which they were academically qualified, there may not be space for them. For example, over the past decade (2001-2011) most of the capacity for first-time

college enrollees was created at two-year institutions (61 percent) and institutions that confer up to a Master's degree (39 percent). During this same time, liberal arts colleges and research universities – where many of the selective colleges are concentrated – absorbed very little growth (1 percent and 10 percent, respectively, NCES, 2013a, 2013b). While this has caused acceptance rates to plummet for many institutions, the dearth of seats at these top colleges is a contributor to the college access issue. States need to incent institutions with high completion rates to increase capacity in order to accommodate the growing number of qualified students. Without an increase in seats, improvements in college undermatch would only result in a reshuffling of students.

Conclusion

Whether seen through the lens of social justice and the commensurate need for the redistribution of students (Bowen et al., 2009) or viewed as an economic loss of human capital with negative implications for society (Glenn, 2009; Hill & Winston, 2008), many constituents stand to gain from properly matching students' abilities with the selectivity of their of higher education institutions. Universities would benefit from more diverse applicant pools, students would apply to and enroll in colleges that had the mechanisms to adequately support their persistence, as well as increase their likelihood of entering the middle class, and society would benefit from cultivating its intellectual talent, irrespective of race/ethnicity or family background.

As researchers and policymakers try to remedy inequities and improve inefficiencies in our higher education systems, findings from this study highlight policy levers to address both. This study clearly illustrates that inequitable inputs at the high school-level render inequitable outcomes for students at the post-secondary level.

Appendix A

Table A1. Categorization of HBCUs using Barron's Competitiveness Index

Selectivity	Institutions in IPEDS Universe	Representation of HBCU Student Enrollment in Analytic Sample[ab]
N	95	69,150
Most Selective	0.0	0.0
Very Selective	1.1	0.0
Selective	28.4	39.8
Non-Selective	53.7	51.4
2-Yr or Less NFP	12.6	7.5
Selectivity Unknown/Special	4.2	1.3
	100.0	100.0

Notes: (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset (b) Figures are weighted using F2F1WT
Sources: ELS:2002; IPEDS Institutional File (2004); Barron's Competitiveness Index (2004)

Appendix B

Table B1. Average number of postsecondary institutions (PSIs) within a 50-mile radius of sample high schools by institutional selectivity

	% of high schools with at least one PSIs within a 50-mile radius	Mean Number of PSIs within a 50-mile radius	*SD*
Total (*N*=750 high schools)	100.0	85.4	216.5
Most Selective	41.7	1.4	2.2
Very Selective	53.1	1.5	2.2
Highly Selective	76.7	3.2	4.0
Selective	90.0	6.6	8.0
NonSelective	100.0	4.8	4.9
2-Year or less NFP	100.0	20.2	18.4
For Profit	100.0	40.3	36.7

Notes: Distance calculated are linear distances (in miles) between the centers of two zip code areas. Selectivity categories are modified from Barron's Competitiveness Index. Institutions that have unknown selectivity, are administrative units, or that are not primarily undergraduate, or have a specialized focus (e.g., seminary schools or art institutions) have been omitted from the analysis.
Sources: ELS:2002; IPEDS 2004 Institutional File; Barron's Competitiveness Index

Appendix C

Table C1. Goodness-of-fit measures for Latent Class Analysis by number of Classes

Model	*AIC*[a]	*SABIC*[b]	Entropy
4 classes	6464.2	6504.7	0.887
5 classes	6279.8	6328.9	0.871
6 classes	6114.2	6172.0	0.906
7 classes	5935.6	6002.2	0.890

Notes: (a) Akaike Information Criterion (b) Sample-Size Adjusted Bayesian Information Criterion
Sources: Analysis of ELS:2002

Appendix D

Table D1. Comparison of undermatch rates at the enrollment step of Black students by academic qualification and inclusion of HBCU enrollees in sample

		Enrollment Step					
Analysis	*N*	Total	Most	Highly	Very	Selective	Non
With HBCU enrollees	820	27.19	63.92	65.42	51.97	40.42	19.08
Without HBCU enrollees	680	29.21	63.92	65.42	44.41	37.97	23.43

Source: Analysis of ELS:2002

Appendix E

Table E1. Odds-ratios for the likelihood to undermatch at the application step by student characteristics and high school factors[a]

Predictors	Empty 0	+ State 1	+ High School 2	+ Demo-graphics 3	+ Qual-ifications 4	+ Prep 5	+ Human Capital 6	+ Social Capital 7	+ Cultural Capital 8
High School Characteristics									
School Resources									
Academic Preparation			0.81 ~	0.87 ~	0.86 ~	1.01	1.05	1.09	1.09
Availability of College Guidance			0.50 *	0.80	1.72 *	1.88	1.93 *	1.98 *	1.96 *
School Norms									
College-Going Culture			1.07	0.73	0.29 *	0.26 ~	0.27 *	0.30 *	0.31 *
Parental Involvement/Influence			1.32	1.22 ~	1.21 ~	1.18	1.23 ~	1.20 ~	1.21 ~
Student-Level Predictors									
Demographics									
Female				1.33 *	1.14 ~	1.11 ~	1.10	1.19 *	1.17 *
Native Language is English				1.40 *	1.15	1.07	1.09	1.08	1.12
Asian (ref. White)				0.42 *	0.33 *	0.42 *	0.43 *	0.46 *	0.46 *
Black (ref. White)				0.29 *	0.52 *	0.52 *	0.52 *	0.56 *	0.58 *
Latino (ref. White)				0.48 *	0.81 ~	0.85	0.85	0.83	0.82
Other (ref. White)				0.64 *	0.72 ~	0.75 ~	0.75 ~	0.77 ~	0.78 ~
Qualification (ref. nonselective institution)									
Most Selective					16.73 *	71.64 *	88.13 *	118.38 *	134.36 *
Highly Selective					25.44 *	65.88 *	77.22 *	104.47 *	112.97 *
Very Selective					15.79 *	26.24 *	29.39 *	38.67 *	40.98 *
Selective					9.59 *	11.86 *	12.43 *	14.11 *	14.71 *
Human Capital: Academic Preparation									
Highest Math: Alg. I (ref. Calculus)						1.63	1.67	1.66	1.67
Highest Math: Alg.II/Geo. (ref. Calculus)						1.00	1.00	1.02	1.01
Highest Math: PreCalc./Trig (ref. Calculus)						1.00	1.00	1.00	1.00
Number of AP or IB courses						0.79 *	0.80 *	0.81 *	0.81 *
Human Capital									
Income: $0K to $25K (ref. over $100K)							1.56 *	1.47 *	1.19

Income: $25K to $50K (ref. over $100K)													1.68	*	1.61	*	1.39	*
Income: $50K to $75K (ref. over $100K)													1.38	*	1.32	*	1.20	~
Income: $75K to $100K (ref. over $100K)													1.41	*	1.39	*	1.32	*
Expected Benefits & Costs													0.85	*	0.97		1.01	
"Sticker price" tuition, 4-year institutions[b]													1.01		1.01		1.01	
Net tuition for 4-year institutions[b]													1.06		1.06		1.06	
"Sticker price" tuition, 2-year institutions[b]													1.05		1.07		1.07	
Net tuition for 2-year institutions[b]													1.25	*	1.24	*	1.26	*
Social Capital																		
Sources of Information about College															0.52	*	0.60	*
Peer Networks															0.63	*	0.70	*
Parent & Family Networks															1.26	*	1.45	*
Cultural Capital																		
Parent Ed: High School (ref. Bachelor's)																	1.49	*
Parent Ed: Some College (ref. Bachelor's)																	1.31	*
Parental Ed: Associate's (ref. Bachelor's)																	1.37	*
Value of College Attainment																	0.81	*
Habitus																	0.69	*
Variance Tests of Random Effects																		
Intercept (*ICC* = 0.14)	0.52	*	0.30	*	0.06		0.01		0.01		0.02		0.01		0.03		0.03	
Academic Preparation					0.06		0.08	~	0.09	~	0.09	~	0.09	~	0.09	~	0.09	~
Availability of College Guidance					0.00		0.00		0.00		0.00		0.00		0.00		0.00	
College-Going Culture					0.08		0.04		0.02		0.04		0.05		0.04		0.04	
Parental Involvement/Influence					0.09		0.11	~	0.08		0.07		0.02		0.00		0.00	
-2 Log Likelihood	9542		9371		9248		8986		7800		7649		7586		7463		7416	
AIC	9546		9473		9364		9114		7936		7791		7746		7627		7590	
% of High school-level variance explained			42%		88%		98%		98%		96%		98%		94%		94%	

Notes: *$p < .05$, ~$p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius.
Source: Analysis of ELS:2002

Table E2. Odds-ratios for the likelihood of undermatch at the enrollment step by student characteristics and high school factors

Predictors	Empty 0	+ State 1	+ High School 2	+ Demo-graphics 3	+ Qual-ifications 4	+ Preparation 5	+ Human Capital 6	+ Social Capital 7	+ Cultural Capital 8
High School Characteristics									
School Resources									
Academic Preparation			0.95	0.97	0.96	1.01	0.99	1.02	1.01
Availability of College Guidance			0.79	0.88	1.44	1.49 ~	1.50 *	1.51 ~	1.47
School Norms									
College-Going Culture			1.08	0.99	0.52 ~	0.51 *	0.52 *	0.54 ~	0.57 ~
Parental Involvement/Influence			1.04	1.00	1.00	0.98	1.00	1.01	1.00
Student-Level Predictors									
Demographics									
Female				1.10 ~	1.00	0.99	0.98	1.02	1.01
Native Language is English				1.23 ~	1.09	1.06	1.06	1.07	1.08
Asian (ref. White)				0.82 ~	0.70 *	0.78 ~	0.78 ~	0.80 ~	0.81
Black (ref. White)				0.75 *	1.07	1.08	1.07	1.12	1.14
Latino (ref. White)				0.75 ~	1.05	1.08	1.09	1.07	1.06
Other (ref. White)				1.03	1.11	1.14	1.14	1.14	1.16
Qualification (ref. nonselective)									
Most Selective					4.46 *	8.90 *	9.85 *	11.97 *	12.49 *
Highly Selective					6.28 *	10.41 *	11.12 *	13.39 *	14.09 *
Very Selective					4.98 *	6.73 *	7.07 *	8.30 *	8.54 *
Selective					3.56 *	4.12 *	4.26 *	4.57 *	4.67 *
Human Capital: Academic Preparation									
Highest Math: Alg. I (ref. Calc.))						1.34	1.35	1.35	1.34
Highest Math: Alg.II/Geo. (ref. Calc.))						0.96	0.96	0.97	0.97
Highest Math: PreCalc./Trig (ref. Calc.)						1.00	1.00	1.00	1.00
Number of AP or IB courses						0.92 *	0.91 *	0.92 *	0.92 *
Human Capital									
Income: $0K to $25K (ref. over $100K)							1.27 ~	1.22 ~	1.07
Income: $25K to $50K (ref. over $100K)							1.18 ~	1.14	1.04
Income: $50K to $75K (ref. over $100K)							1.19 ~	1.15	1.09
Income: $75K to $100K (ref. over $100K)							1.07	1.05	1.03

Expected Benefits & Costs										0.97		1.03		1.02		
"Sticker price" tuition for 4-year institutions										0.96		0.96		0.97		
Net tuition for 4-year institutions										1.00		1.00		1.00		
"Sticker price" tuition for 2-years										0.88	~	0.88	~	0.89	~	
Net tuition for 2-year institutions										1.09		1.09		1.09		
Social Capital																
Sources of Information about College												0.78	*	0.79	~	
Peer Networks												0.76	*	0.77	~	
Parent & Family Networks												1.02		1.06		
Cultural Capital																
Parent Ed: High School (ref. Bachelor's)														1.41	*	
Parent Ed: Some College (ref. Bachelor's)														1.22	~	
Parental Ed: Associate's (ref. Bachelor's)														1.17		
Value of College Attainment														1.02		
Habitus														0.95		
Variance Tests of Random Effects																
Intercept (*ICC* = 0.02)	0.07	*	0.02	0.00		0.00		0.00		0.00		0.00		0.00		
Academic Preparation				0.00		0.00		0.00		0.00		0.00		0.00		
Availability of College Guidance				0.00		0.00		0.00		0.00		0.00		0.00		
College-Going Culture				0.02		0.02		0.00		0.00		0.00		0.00		
Parental Involvement/Influence				0.04		0.03		0.05		0.05		0.04		0.04		
-2 Log Likelihood	7681		7612	7601		7571		7100		7068		7053		7023		7007
AIC	7685		7714	7713		7695		7230		7204		7207		7183		7177
% of High school-level variance explained			71%	100%		100%		100%		100%		100%		100%		100%

Notes: *$p < .05$, ~$p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius.
Source: Analysis of ELS:2002

Table E3. Odds-ratios for the likelihood of undermatch at the application step by student characteristics and high school factors

Predictors	Empty	+ State	+ High School	+ Demo-graphics	+ Qual-ifications	+ Prep-aration	+ Human Capital	+ Social Capital	+ Cultural Capital
	0	1	2	3	4	5	6	7	8
High School Contexts (ref. Average)									
Very High Resources & Norms			0.35 *	0.29 *	0.17 *	0.18 *	0.22 *	0.27 *	0.28 *
High Resources & Norms			0.77 *	0.72 *	0.57 *	0.58 *	0.64 *	0.71 *	0.72 *
Low Resources & Norms			0.78 *	0.93	1.27 *	1.24 ~	1.21 ~	1.15	1.09
Very Low Resources & Norms			0.82	0.80	1.37	1.45	1.41	1.21	1.16
Student-Level Predictors									
Demographics									
Female				1.33 *	1.15 ~	1.12 ~	1.11 ~	1.20 *	1.18 *
Native Language is English				1.45 *	1.15	1.06	1.10	1.09	1.13
Asian (ref. White)				0.39 *	0.32 *	0.43 *	0.43 *	0.47 *	0.47 *
Black (ref. White)				0.27 *	0.54 *	0.55 *	0.54 *	0.60 *	0.62 *
Latino (ref. White)				0.46 *	0.84	0.90	0.90	0.89	0.88
Other (ref. White)				0.63 *	0.74 ~	0.77 ~	0.77 ~	0.80	0.81
Qualification (ref. nonselective institution)									
Most Selective					14.10 *	63.32 *	78.39 *	104.26 *	118.73 *
Highly Selective					22.21 *	58.22 *	69.11 *	93.02 *	101.05 *
Very Selective					13.87 *	22.98 *	26.23 *	34.58 *	36.68 *
Selective					8.67 *	10.59 *	11.30 *	12.89 *	13.46 *
Human Capital: Academic Preparation									
Highest Math: Alg. I (ref. Calc.)						1.67	1.69	1.67	1.68
Highest Math: Alg.II/Geo. (ref. Calc.)						1.02	1.02	1.03	1.02
Highest Math: PreCalc./Trig (ref. Calc.)						1.00	1.00	1.00	1.00
Number of AP or IB courses						0.79 *	0.79 *	0.81 *	0.81 *
Human Capital									
Income: $0K to $25K (ref. over $100K)							1.67 *	1.56 *	1.24 ~
Income: $25K to $50K (ref. over $100K)							1.75 *	1.66 *	1.41 *
Income: $50K to $75K (ref. over $100K)							1.39 *	1.33 *	1.20 ~
Income: $75K to $100K (ref. over $100K)							1.39 *	1.37 *	1.30 *
Expected Benefits & Costs							0.85 *	0.98	1.01
“Sticker price” tuition for 4-year institutions							1.00	1.01	1.01
Net tuition for 4-year institutions							1.05	1.05	1.05
“Sticker price” tuition for 2-year institutions							1.00	1.01	1.01
Net tuition for 2-year institutions							1.22 *	1.21 *	1.23 *
Social Capital									

Sources of Information about College																			0.53	*	0.61	*		
Peer Networks																			0.61	*	0.68	*		
Parent & Family Networks																			1.30	*	1.51	*		
Cultural Capital																								
Parent Ed: High School (ref. Bachelor's)																					1.57	*		
Parent Ed: Some College (ref. Bachelor's)																					1.33	*		
Parental Ed: Associate's (ref. Bachelor's)																					1.37	*		
Value of College Attainment																					0.82	*		
Habitus																					0.69	*		
Variance Tests of Random Effects																								
Intercept (*ICC* = 0.14)	0.52	*	0.30	*	0.12	*	0.05		0.08		0.07		0.06		0.07		0.08							
Very High Resources & Norms					0.25	~	0.25	~	0.29	~	0.33	~	0.27	~	0.17		0.16							
High Resources & Norms					0.13		0.20	*	0.14		0.14		0.09		0.04		0.02							
Low Resources & Norms					0.16	~	0.00		0.00		0.00		0.00		0.00		0.00							
Very Low Resources & Norms					0.00		0.24		0.30		0.56		0.65		0.81		0.73							
-2 Log Likelihood	9542		9371		9301		8993		7853		7687		7622		7491		7439							
AIC	9546		9473		9417		9123		7989		7829		7782		7657		7615							
% of High school-level variance explained			42%		77%		90%		85%		87%		88%		87%		85%							

Notes: *$p < .05$, ~$p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius; (c) reference category is "Average high schools resources and norms."
Source: Analysis of ELS:2002

Table E4. Odds-ratios for the likelihood of undermatch at the enrollment step by student characteristics and high school factors

Predictors	Empty 0	+ State 1	+ High School 2	+ Demo-graphics 3	+ Qual-ifications 4	+ Preparation 5	+ Human Capital 6	+ Social Capital 7	+ Cultural Capital 8
High School Contexts (ref. Average)									
Very High Resources & Norms			0.78 ~	0.74 *	0.44 *	0.45 *	0.48 *	0.54 *	0.55 *
High Resources & Norms			0.95	0.93	0.73 *	0.73 *	0.76 *	0.8 *	0.81 ~
Low Resources & Norms			0.93	0.98	1.23 ~	1.22 ~	1.22 ~	1.2 ~	1.16 ~
Very Low Resources & Norms			0.36	0.37	0.66	0.7	0.67	0.63	0.56
Student-Level Predictors									
Demographics									
Female				1.10 ~	1.01	0.99	0.98	1.02	1.01
Native Language is English				1.24 ~	1.09	1.06	1.07	1.07	1.08
Asian (ref. White)				0.81 ~	0.70 *	0.80 ~	0.79 ~	0.81 ~	0.81 ~
Black (ref. White)				0.73 *	1.12	1.14	1.12	1.17	1.18
Latino (ref. White)				0.74 *	1.10	1.14	1.14	1.12	1.10
Other (ref. White)				1.01	1.13	1.17	1.16	1.17	1.18
Qualification (ref. nonselective institution)									
Most Selective					4.13 *	8.18 *	9.16 *	11.08 *	11.71 *
Highly Selective					5.84 *	9.58 *	10.38 *	12.50 *	13.29 *
Very Selective					4.70 *	6.26 *	6.64 *	7.82 *	8.09 *
Selective					3.42 *	3.91 *	4.08 *	4.38 *	4.50 *
Human Capital: Academic Preparation									
Highest Math: Alg. I (ref. Calculus)						1.34	1.34	1.34	1.33
Highest Math: Alg.II/Geo. (ref. Calculus)						0.98	0.97	0.98	0.98
Highest Math: PreCalc./Trig (ref. Calculus)						1.00	1.00	1.00	1.00
Number of AP or IB courses						0.92 *	0.91 *	0.92 *	0.92 *
Human Capital									
Income: $0K to $25K (ref. over $100K)							1.31 ~	1.25 ~	1.07
Income: $25K to $50K (ref. over $100K)							1.19 ~	1.15	1.03

Income: $50K to $75K (ref. over $100K)								1.18	~	1.14		1.08	
Income: $75K to $100K (ref. over $100K)								1.06		1.04		1.01	
Expected Benefits & Costs								0.97		1.03		1.02	
“Sticker price” tuition for 4-year institutions								0.95		0.95		0.96	
Net tuition for 4-year institutions								0.99		0.99		1.00	
“Sticker price” tuition for 2-year institutions								0.86	~	0.87	~	0.88	~
Net tuition for 2-year institutions								1.07		1.07		1.07	
Social Capital													
Sources of Information about College										0.79	*	0.80	~
Peer Networks										0.75	*	0.77	*
Parent & Family Networks										1.03		1.07	
Cultural Capital													
Parent Ed: High School (ref. Bachelor’s)												1.45	*
Parent Ed: Some College (ref. Bachelor’s)												1.23	~
Parental Ed: Associate’s (ref. Bachelor’s)												1.18	
Value of College Attainment												1.03	
Habitus												0.94	
Variance Tests of Random Effects													
Intercept (*ICC* = 0.02)	0.07	*	0.02	0.00	0.00	0.00	0.00	0.00		0.00		0.00	
Very High Resources & Norms				0.11	0.10	0.10	0.10	0.07		0.08		0.07	
High Resources & Norms				0.00	0.00	0.00	0.00	0.00		0.00		0.00	
Low Resources & Norms				0.08	0.08	0.06	0.06	0.05		0.04		0.05	
Very Low Resources & Norms				1.79	1.53	1.06	0.96	0.86		0.79		0.96	
-2 Log Likelihood	7681		7612	7599	7564	7108	7077	7060		7029		7011	
AIC	7685		7714	7713	7690	7242	7217	7218		7193		7185	
% of High school-level variance explained			71%	100%	100%	100%	100%	100%		100%		100%	

Notes: *$p < .05$, ~$p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius; (c) reference category is “Average high schools resources and norms.”
Source: Analysis of ELS:2002

Appendix F

Table F1. Odds-ratios for the likelihood of undermatch at the application and enrollment steps by student characteristics as well as high school factors with random effects for race.

	Application				Enrollment			
Predictors	Race		+ High School Factors		Race		+ High School Factors	
Student-Level Predictors								
Demographics								
Female	1.17	~	1.17	~	1.01		1.01	
Native Language is English	1.14		1.14		1.08		1.08	
Asian (ref. White)	0.46	*	0.46	*	0.81	~	0.81	
Black (ref. White)	0.53	*	0.53	~	1.14		1.14	
Latino (ref. White)	0.79		0.78		1.06		1.06	
Other (ref. White)	0.78	~	0.78		1.14		1.14	
Qualification (ref. nonselective institution)								
Most Selective	142.28	*	140.13	*	12.55	*	12.57	
Highly Selective	119.42	*	117.57	*	14.04	*	14.16	
Very Selective	42.90	*	42.54	*	8.55	*	8.57	
Selective	15.23	*	15.13	*	4.67	*	4.69	
Human Capital: Academic Preparation								
Highest Math: Alg. I (ref. Calculus)	1.70		1.68		1.34		1.34	
Highest Math: Alg.II/Geo. (ref. Calculus)	1.02		1.01		0.97		0.97	
Highest Math: PreCalc./Trig (ref. Calculus)	1.00		1.00		1.00		1.00	
Number of AP or IB courses	0.81	*	0.81	*	0.92	*	0.92	
Human Capital								
Income: $0K to $25K (ref. over $100K)	1.20		1.20		1.07		1.07	
Income: $25K to $50K (ref. over $100K)	1.40	*	1.39		1.04		1.04	
Income: $50K to $75K (ref. over $100K)	1.21	~	1.20		1.09		1.09	
Income: $75K to $100K (ref. over $100K)	1.34	*	1.33		1.03		1.03	
Expected Benefits & Costs	1.01		1.01		1.02		1.02	
"Sticker price" tuition for 4-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 4-years	1.76		1.67		1.02		1.03	
"Sticker price" tuition for 2-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 2-year institutions	4.40	*	4.35		1.88		1.82	
Social Capital								
Sources of Information about College	0.60	*	0.60	*	0.79	~	0.79	~
Peer Networks	0.70	*	0.70	*	0.77	*	0.77	
Parent & Family Networks	1.45	*	1.45	*	1.06		1.06	
Cultural Capital								
Parent Ed: High School (ref. Bachelor's)	1.50	*	1.50	*	1.41	*	1.41	
Parent Ed: Some College (ref. Bachelor's)	1.31	*	1.31	*	1.22	~	1.22	
Parental Ed: Associate's (ref. Bachelor's)	1.37	*	1.37	*	1.17		1.17	
Value of College Attainment	0.81	*	0.81	*	1.02		1.02	
Habitus	0.69	*	0.69	*	0.94		0.95	
High School Characteristics								
School Resources	1.07		1.08		1.01		1.01	
Academic Preparation	2.02	*	1.97		1.48	*	1.47	
Availability of College Guidance								
School Norms	0.31	*	0.31	*	0.57	*	0.57	
College-Going Culture	1.19	~	1.20		1.00		1.00	

Parental Involvement/Influence	1.07			1.08		1.01	1.01
Variance Tests of Random Effects							
Intercept	0.09	*		0.01		0.00	0.00
Race (ref. White)							
Asian	0.00			0.00		0.00	0.00
Black	0.41			0.42	~	0.00	0.00
Latino	0.19			0.22		0.00	0.00
Other	0.00			0.00		0.14	0.10
High School Factors							
Academic Preparation				0.09	~		0.00
Availability of College Guidance				0.00			0.00
College-Going Culture				0.05			0.00
Parental Involvement/Influence				0.00			0.04
-2 Log Likelihood	7417			7412		7008	7007
AIC	7591			7592		7178	7179

Notes: *$p < .05$, ~$p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius.
Source: Analysis of ELS:2002

Table F2. Odds-ratios for the likelihood of undermatch at the application and enrollment steps by student characteristics as well as high school contexts with random effects for race

	Application				Enrollment			
	Race		+ High School Contexts		Race		+ High School Contexts	
Predictors								
Student-Level Predictors								
Demographics								
Female	1.18	*	1.18	*	1.01		1.01	
Native Language is English	1.15		1.15		1.08		1.08	
Asian (ref. White)	0.46	*	0.46	*	0.81	~	0.81	~
Black (ref. White)	0.58	*	0.58	*	1.18	~	1.18	
Latino (ref. White)	0.84		0.83		1.10		1.10	
Other (ref. White)	0.81		0.81		1.17		1.18	
Qualification (ref. nonselective institution)								
Most Selective	127.41	*	125.38	*	11.70	*	11.75	*
Highly Selective	107.60	*	106.13	*	13.18	*	13.33	*
Very Selective	38.74	*	38.40	*	8.08	*	8.10	*
Selective	14.05	*	13.92	*	4.48	*	4.51	*
Human Capital: Academic Preparation								
Highest Math: Alg. I (ref. Calculus)	1.69		1.69		1.33		1.33	
Highest Math: Alg.II/Geo. (ref. Calculus)	1.03		1.02		0.98		0.98	
Highest Math: PreCalc./Trig (ref. Calculus)	1.00		1.00		1.00		1.00	
Number of AP or IB courses	0.81	*	0.81	*	0.92	*	0.92	*
Human Capital								
Income: $0K to $25K (ref. over $100K)	1.26	~	1.25	~	1.08		1.07	
Income: $25K to $50K (ref. over $100K)	1.43	*	1.42	*	1.04		1.03	
Income: $50K to $75K (ref. over $100K)	1.20	~	1.20	~	1.08		1.08	
Income: $75K to $100K (ref. over $100K)	1.31	*	1.30	*	1.01		1.01	
Expected Benefits & Costs	1.01		1.01		1.02		1.02	
“Sticker price” tuition for 4-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 4-years	1.56		1.50		0.97		0.97	
“Sticker price” tuition for 2-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 2-year institutions	3.76	*	3.77	*	1.76		1.61	
Social Capital								
Sources of Information about College	0.61	*	0.60	*	0.80	~	0.80	~
Peer Networks	0.67	*	0.68	*	0.76	*	0.77	*
Parent & Family Networks	1.51	*	1.51	*	1.06		1.07	
Cultural Capital								
Parent Ed: High School (ref. Bachelor’s)	1.58	*	1.58	*	1.44	*	1.45	*
Parent Ed: Some College (ref. Bachelor’s)	1.34	*	1.34	*	1.24	~	1.23	~
Parental Ed: Associate’s (ref. Bachelor’s)	1.37	*	1.37	*	1.18		1.18	
Value of College Attainment	0.82	*	0.82	*	1.03		1.03	
Habitus	0.69	*	0.69	*	0.94		0.94	
High School Characteristics								
High School Context (ref. Average)								
Very High Resources & Norms	0.29	*	0.28	*	0.56	*	0.55	*
High Resources & Norms	0.72	*	0.72	*	0.82	~	0.81	~
Low Resources & Norms	1.10		1.09		1.17	~	1.16	~
Very Low Resources & Norms	1.17		1.16		0.77		0.56	

Variance Tests of Random Effects					
Intercept	0.10	*	0.06	0.00	0.00
Race (ref. White)					
Asian	0.12		0.15	0.00	0.00
Black	0.36		0.36	0.00	0.00
Latino	0.23		0.26	0.00	0.00
Other	0.00		0.00	0.07	0.05
High School Contexts (ref. Average)					
Very High Resources & Norms			0.18		0.07
High Resources & Norms			0.03		0.00
Low Resources & Norms			0.00		0.05
Very Low Resources & Norms			0.78		0.96
-2 Log Likelihood	7439		7436	7013	7011
AIC	7615		7618	7183	7187
% of High school-level variance explained					

Notes: *$p < .05$, ~ $p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius.
Source: Analysis of ELS:2002

Table F3. Odds-ratios for the likelihood of undermatch at the application and enrollment steps by student characteristics as well as high school factors with random effects for income

	Application				Enrollment			
Predictors	Income		+ High School Factors		Income		+ High School Factors	
Student-Level Predictors								
Demographics								
Female	1.17	~	1.18	*	1.01		1.01	
Native Language is English	1.13		1.13		1.08		1.08	
Asian (ref. White)	0.46	*	0.46	*	0.80	~	0.80	
Black (ref. White)	0.58	*	0.58	*	1.14		1.14	
Latino (ref. White)	0.83		0.82		1.06		1.06	
Other (ref. White)	0.78	~	0.78	~	1.16		1.16	
Qualification (ref. nonselective institution)								
Most Selective	137.86	*	136.18	*	12.56	*	12.55	*
Highly Selective	115.89	*	114.42	*	14.05	*	14.14	*
Very Selective	41.72	*	41.45	*	8.56	*	8.57	*
Selective	14.88	*	14.82	*	4.68	*	4.69	*
Human Capital: Academic Preparation								
Highest Math: Alg. I (ref. Calculus)	1.69		1.67		1.34		1.34	
Highest Math: Alg.II/Geo. (ref. Calculus)	1.02		1.01		0.97		0.97	
Highest Math: PreCalc./Trig (ref. Calculus)	1.00		1.00		1.00		1.00	
Number of AP or IB courses	0.81	*	0.81	*	0.92	*	0.92	~
Human Capital								
Income: $0K to $25K (ref. over $100K)	1.20		1.18		1.06		1.06	
Income: $25K to $50K (ref. over $100K)	1.40	*	1.39	*	1.03		1.04	
Income: $50K to $75K (ref. over $100K)	1.20	~	1.19	~	1.09		1.09	
Income: $75K to $100K (ref. over $100K)	1.33	*	1.32	*	1.03		1.03	
Expected Benefits & Costs	1.01		1.01		1.02		1.02	
“Sticker price” tuition for 4-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 4-years	1.72		1.64		1.01		1.02	
“Sticker price” tuition for 2-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 2-year institutions	4.68	*	4.64	*	1.89		1.83	
Social Capital								
Sources of Information about College	0.60	*	0.60	*	0.79	~	0.79	~
Peer Networks	0.70	*	0.70	*	0.77	*	0.77	*
Parent & Family Networks	1.45	*	1.45	*	1.06		1.06	
Cultural Capital								
Parent Ed: High School (ref. Bachelor’s)	1.49	*	1.49	*	1.41	*	1.41	*
Parent Ed: Some College (ref. Bachelor’s)	1.30	*	1.31	*	1.22	~	1.22	~
Parental Ed: Associate’s (ref. Bachelor’s)	1.37	*	1.37	*	1.17		1.17	
Value of College Attainment	0.80	*	0.81	*	1.02		1.02	
Habitus	0.69	*	0.69	*	0.94		0.94	
High School Characteristics								
School Resources								
Academic Preparation	1.08		1.09		1.01		1.01	
Availability of College Guidance	2.00	*	1.96	*	1.48	*	1.47	~
School Norms								
College-Going Culture	0.31	*	0.31	*	0.57	*	0.57	~
Parental Involvement/Influence	1.19	~	1.21	~	1.01		1.01	
Variance Tests of Random Effects								

Intercept	0.10	*	0.02		0.00		0.00
Income (ref. over $100K)							
$0K to $25K	0.00		0.05		0.07		0.05
$25K to $50K	0.00		0.00		0.02		0.00
$50K to $75K	0.05		0.04		0.00		0.00
$75K to $100K	0.00		0.00		0.00		0.00
High School Factors							
Academic Preparation			0.09	~			0.00
Availability of College Guidance			0.00				0.00
College-Going Culture			0.04				0.00
Parental Involvement/Influence			0.00				0.04
-2 Log Likelihood	7420		7416		7008		7007
AIC	7594		7594		7180		7181
% of High school-level variance explained							

Notes: *$p < .05$, ~ $p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius.
Source: Analysis of ELS:2002

Table F4. Odds-ratios for the likelihood of undermatch at the application and enrollment steps by student characteristics as well as high school contexts with random effects for income

	Application				Enrollment			
Predictors	Income		+ High School Contexts		Income		+ High School Contexts	
Student-Level Predictors								
Demographics								
Female	1.18	*	1.18	*	1.01		1.01	
Native Language is English	1.13		1.13		1.08		1.08	
Asian (ref. White)	0.47	*	0.47	*	0.81	~	0.81	~
Black (ref. White)	0.62	*	0.62	*	1.18		1.18	
Latino (ref. White)	0.88		0.88		1.10		1.10	
Other (ref. White)	0.80		0.80		1.18		1.18	
Qualification (ref. nonselective institution)								
Most Selective	123.44	*	121.39	*	11.74	*	11.76	*
Highly Selective	104.46	*	102.99	*	13.20	*	13.33	*
Very Selective	37.69	*	37.34	*	8.11	*	8.11	*
Selective	13.77	*	13.64	*	4.49	*	4.51	*
Human Capital: Academic Preparation								
Highest Math: Alg. I (ref. Calculus)	1.69		1.69		1.33		1.33	
Highest Math: Alg.II/Geo. (ref. Calculus)	1.03		1.02		0.98		0.98	
Highest Math: PreCalc./Trig (ref. Calculus)	1.00		1.00		1.00		1.00	
Number of AP or IB courses	0.81	*	0.81	*	0.92	*	0.92	*
Human Capital								
Income: $0K to $25K (ref. over $100K)	1.23		1.22		1.07		1.07	
Income: $25K to $50K (ref. over $100K)	1.42	*	1.41	*	1.04		1.03	
Income: $50K to $75K (ref. over $100K)	1.19	~	1.19	~	1.08		1.08	
Income: $75K to $100K (ref. over $100K)	1.30	*	1.30	*	1.01		1.01	
Expected Benefits & Costs	1.01		1.01		1.02		1.02	
“Sticker price” tuition for 4-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 4-years	1.54		1.48		0.96		0.97	
“Sticker price” tuition for 2-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 2-year institutions	3.89	*	3.91	*	1.77		1.62	
Social Capital								
Sources of Information about College	0.61	*	0.61	*	0.80	~	0.80	~
Peer Networks	0.68	*	0.68	*	0.77	*	0.77	*
Parent & Family Networks	1.51	*	1.51	*	1.07		1.07	
Cultural Capital								
Parent Ed: High School (ref. Bachelor’s)	1.58	*	1.58	*	1.45	*	1.45	*
Parent Ed: Some College (ref. Bachelor’s)	1.34	*	1.33	*	1.24	~	1.23	~
Parental Ed: Associate’s (ref. Bachelor’s)	1.37	*	1.37	*	1.18		1.18	
Value of College Attainment	0.81	*	0.82	*	1.03		1.03	
Habitus	0.69	*	0.69	*	0.93		0.93	
High School Characteristics								
High School Context (ref. Average)								
Very High Resources & Norms	0.29	*	0.28	*	0.56	*	0.55	*
High Resources & Norms	0.72	*	0.72	*	0.82	~	0.81	~
Low Resources & Norms	1.09		1.09		1.17	~	1.17	~
Very Low Resources & Norms	1.20		1.17		0.77		0.56	
Variance Tests of Random Effects								
Intercept	0.10	*	0.07		0.00		0.00	

Income (ref. over $100K)				
$0K to $25K	0.11	0.14	0.06	0.04
$25K to $50K	0.00	0.00	0.00	0.00
$50K to $75K	0.03	0.03	0.00	0.00
$75K to $100K	0.00	0.00	0.00	0.00
High School Contexts (ref. Average)				
Very High Resources & Norms		0.17		0.07
High Resources & Norms		0.03		0.00
Low Resources & Norms		0.00		0.05
Very Low Resources & Norms		0.74		0.95
-2 Log Likelihood	7442	7439	7013	7011
AIC	7616	7619	7185	7187
% of High school-level variance explained				

Notes: *$p < .05$, ~ $p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius.
Source: Analysis of ELS:2002

Table F5. Odds-ratios for the likelihood of undermatch at the application and enrollment steps by student characteristics as well as high school factors with random effects for parent education

	Application				Enrollment			
Predictors	Parent Education		+ High School Factors		Parent Education		+ High School Factors	
Student-Level Predictors								
Demographics								
Female	1.17	~	1.17	*	1.01		1.01	
Native Language is English	1.13		1.13		1.08		1.08	
Asian (ref. White)	0.46	*	0.46	*	0.81	~	0.81	
Black (ref. White)	0.58	*	0.58	*	1.14		1.14	
Latino (ref. White)	0.82		0.82		1.05		1.06	
Other (ref. White)	0.79	~	0.78	~	1.16		1.16	
Qualification (ref. nonselective institution)								
Most Selective	140.31	*	138.15	*	12.83	*	12.83	*
Highly Selective	117.51	*	115.70	*	14.33	*	14.41	*
Very Selective	42.21	*	41.84	*	8.68	*	8.69	*
Selective	15.03	*	14.93	*	4.73	*	4.74	*
Human Capital: Academic Preparation								
Highest Math: Alg. I (ref. Calculus)	1.70		1.68		1.35		1.35	
Highest Math: Alg.II/Geo. (ref. Calculus)	1.02		1.01		0.97		0.97	
Highest Math: PreCalc./Trig (ref. Calculus)	1.00		1.00		1.00		1.00	
Number of AP or IB courses	0.81	*	0.81	*	0.92	*	0.92	*
Human Capital								
Income: $0K to $25K (ref. over $100K)	1.20		1.20		1.08		1.07	
Income: $25K to $50K (ref. over $100K)	1.40	*	1.39	*	1.04		1.04	
Income: $50K to $75K (ref. over $100K)	1.21	~	1.20	~	1.10		1.09	
Income: $75K to $100K (ref. over $100K)	1.33	*	1.32	*	1.03		1.03	
Expected Benefits & Costs	1.01		1.01		1.02		1.02	
“Sticker price” tuition for 4-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 4-years	1.73		1.65		1.04		1.04	
“Sticker price” tuition for 2-years	1.00	*	1.00		1.00	*	1.00	*
Net tuition for 2-year institutions	4.74	*	4.70	*	1.89		1.83	
Social Capital								
Sources of Information about College	0.60	*	0.60	*	0.79	~	0.79	~
Peer Networks	0.70	*	0.70	*	0.77	*	0.77	*
Parent & Family Networks	1.45	*	1.45	*	1.06		1.06	
Cultural Capital								
Parent Ed: High School (ref. Bachelor’s)	1.47	*	1.47	*	1.39	*	1.39	*
Parent Ed: Some College (ref. Bachelor’s)	1.30	*	1.31	*	1.21	~	1.21	~
Parental Ed: Associate’s (ref. Bachelor’s)	1.37	*	1.37	*	1.18		1.17	
Value of College Attainment	0.80	*	0.81	*	1.02		1.03	
Habitus	0.69	*	0.69	*	0.94		0.94	
High School Characteristics								
School Resources								
Academic Preparation	1.08		1.09		1.01		1.01	
Availability of College Guidance	2.01	*	1.96	*	1.48	*	1.48	
School Norms								
College-Going Culture	0.31	*	0.31	*	0.57	*	0.56	
Parental Involvement/Influence	1.20	~	1.21	~	1.01		1.00	
Variance Tests of Random Effects								

Intercept	0.10	*	0.02		0.00		0.00
Parent Education (ref. Bachelor's)							
High School	0.12		0.14		0.16		0.14
Some College	0.01		0.00		0.07		0.05
Associate's	0.00		0.00		0.00		0.00
High School Factors							
Academic Preparation			0.10	~			0.00
Availability of College Guidance			0.00				0.00
College-Going Culture			0.05				0.00
Parental Involvement/Influence			0.00				0.03
-2 Log Likelihood	7420		7415		7007		7006
AIC	7594		7591		7179		7180
% of High school-level variance explained							

Notes: *$p < .05$, ~$p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius.
Source: Analysis of ELS:2002

Table F6. Odds-ratios for the likelihood of undermatch at the application and enrollment steps by student characteristics as well as high school contexts with random effects for parent education

Predictors	Application				Enrollment			
	Parent Education		+ High School Contexts		Parent Education		+ High School Contexts	
Student-Level Predictors								
Demographics								
Female	1.18	*	1.18	*	1.01		1.01	
Native Language is English	1.13		1.14		1.09		1.09	
Asian (ref. White)	0.47	*	0.47	*	0.81	~	0.81	
Black (ref. White)	0.62	*	0.62	*	1.18		1.19	
Latino (ref. White)	0.87		0.87		1.10		1.10	
Other (ref. White)	0.81		0.81		1.18		1.19	
Qualification (ref. nonselective institution)								
Most Selective	124.84	*	122.49	*	12.04	*	11.98	*
Highly Selective	105.37	*	103.71	*	13.51	*	13.55	*
Very Selective	37.92	*	37.51	*	8.24	*	8.21	*
Selective	13.83	*	13.68	*	4.56	*	4.56	*
Human Capital: Academic Preparation								
Highest Math: Alg. I (ref. Calculus)	1.69		1.69		1.34		1.34	
Highest Math: Alg.II/Geo. (ref. Calculus)	1.03		1.03		0.99		0.99	
Highest Math: PreCalc./Trig (ref. Calculus)	1.00		1.00		1.00		1.00	
Number of AP or IB courses	0.81	*	0.81	*	0.92	*	0.92	*
Human Capital								
Income: $0K to $25K (ref. over $100K)	1.25	~	1.24	~	1.09		1.08	
Income: $25K to $50K (ref. over $100K)	1.42	*	1.42	*	1.04		1.04	
Income: $50K to $75K (ref. over $100K)	1.20	~	1.20	~	1.09		1.08	
Income: $75K to $100K (ref. over $100K)	1.30	*	1.30	*	1.01		1.01	
Expected Benefits & Costs	1.01		1.01		1.02		1.02	
“Sticker price” tuition for 4-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 4-years	1.54		1.49		0.99		0.99	
“Sticker price” tuition for 2-years	1.00	*	1.00	*	1.00	*	1.00	*
Net tuition for 2-year institutions	3.91	*	3.91	*	1.77		1.62	
Social Capital								
Sources of Information about College	0.61	*	0.61	*	0.80	~	0.80	~
Peer Networks	0.68	*	0.68	*	0.76	*	0.76	*
Parent & Family Networks	1.51	*	1.51	*	1.07		1.07	
Cultural Capital								
Parent Ed: High School (ref. Bachelor’s)	1.55	*	1.55	*	1.43	*	1.43	*
Parent Ed: Some College (ref. Bachelor’s)	1.34	*	1.33	*	1.23	~	1.23	~
Parental Ed: Associate’s (ref. Bachelor’s)	1.38	*	1.37	*	1.19		1.18	
Value of College Attainment	0.81	*	0.82	*	1.03		1.03	
Habitus	0.69	*	0.69	*	0.94		0.94	
High School Characteristics								
High School Context (ref. Average)								
Very High Resources & Norms	0.29	*	0.28	*	0.56	*	0.55	*
High Resources & Norms	0.72	*	0.72	*	0.82	~	0.81	~
Low Resources & Norms	1.09		1.09		1.17	~	1.17	~
Very Low Resources & Norms	1.23		1.20		0.76		0.57	
Variance Tests of Random Effects								
Intercept	0.10	*	0.06		0.00		0.00	

Parent Education (ref. Bachelor's)				
High School	0.15	0.16	0.16	0.14
Some College	0.00	0.00	0.07	0.05
Associate's	0.00	0.00	0.00	0.00
High School Contexts (ref. Average)				
Very High Resources & Norms		0.17		0.07
High Resources & Norms		0.03		0.00
Low Resources & Norms		0.00		0.02
Very Low Resources & Norms		0.72		0.89
-2 Log Likelihood	7441	7439	7012	7010
AIC				
% of High school-level variance explained				

Notes: *$p < .05$, ~ $p < .10$ (a) The analytic sample is restricted to students who indicated they planned to go to college, graduated in the spring of 2003, and are not in special education or do not attend a vocational or alternative high school, are in the 10th grade cohort and present in both of the follow-up surveys in the ELS:2002 dataset; (b) Average cost within a 50-mile radius; (c) reference category is "Average high schools resources and norms."
Source: Analysis of ELS:2002

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