Running head: INVESTING IN HUMAN CAPITAL

Investing in Human Capital: Underrepresented Racial Minorities' Intentions to Attend Graduate School in STEM fields

M. Kevin Eagan, Jr.
Christopher B. Newman
University of California, Los Angeles

Contact: M. Kevin Eagan Jr., 405 Hilgard Ave., 3005 Moore Hall, University of California, Los Angeles, CA 90095-1521; Phone: (310) 825-1925.

This study was made possible by the support of the National Institute of General Medical Sciences, NIH Grant Numbers 1 R01 GMO71968-01 and R01 GMO71968-05 as well as the National Science Foundation, NSF Grant Number 0757076. This independent research and the views expressed here do not indicate endorsement by the sponsors.

Abstract

This study draws from Paulsen's (2001) econometric theory of investment in human capital and Carlone and Johnson's (2007) science identity framework to examine the characteristics, college experiences, and postsecondary contexts that predict underrepresented racial minority (URM) science, technology, engineering, and mathematics (STEM) students' intention to enroll in graduate education the semester immediately following the conferral of their bachelor's degree. We use hierarchical generalized linear modeling to analyze a longitudinal dataset collected from survey data, and our findings reveal that URM STEM students with higher debt burdens, as measured by accumulated student loans, have significantly reduced probabilities of reporting plans for immediate graduate or professional school enrollment. In contrast, students with a stronger connection to their STEM major are more likely to want to transition immediately into graduate school. Students who attend private and Historically Black Colleges and Universities are significantly more likely to express an intention to enroll in graduate school immediately after completing their bachelor's degree compared to their peers at public institutions or Predominantly White Institutions, respectively. We discuss ways for faculty, institutional administrators, and policymakers to facilitate stronger connections between students in their STEM majors while also assisting students in overcoming financial obstacles in their path toward graduate or professional school enrollment.

Introduction

The persistent underrepresentation of Black, Latino, and Native American scientists and engineers in the U.S. labor market underscores the need to diversify researchers and professionals in the fields of science, technology, engineering, and mathematics (STEM) so as to increase the possibilities for greater innovation and technological advancement (National Academies of Science, 2007). The recent rise in the production of scientists and engineers in both China and the European Union has prompted the federal government to increase funding of efforts aimed at improving STEM bachelor's degree completion rates and matriculation into STEM graduate and professional programs among underrepresented racial minority (URM) students (Basken, 2010). Many of these initiatives focus on increasing students' connection to the STEM discipline through undergraduate research opportunities or academic bridge programs; however, such policies likely only address a portion of the problem behind lower bachelor's degree completion and graduate matriculation rates among URM STEM students.

In addition to developing a strong connection with the discipline, students need to have confidence in their ability to finance their education. A recent report released by the Higher Education Research Institution (HERI) (2010a) indicated that students who entered college in 2009 were more concerned than their peers who started college a decade ago about their ability to pay for higher education. Such concerns may become compounded when students consider enrolling in graduate and professional school, as they not only take into account their income level but also the total amount of student loans they accumulated during their undergraduate career. This concern is underscored by the fact that students' average debt after completing a bachelor's degree has risen by 17% between the spring of 2001 and the spring of 2007 (Baum & Payea, 2008). Furthermore, research has shown that URM students and individuals from lower

socioeconomic backgrounds tend to suffer from excessive debt burdens at the end of college compared to their peers from economically advantaged backgrounds (Price, 2004). This study examines how URM STEM students' concerns about financing their education, their accumulated debt during their undergraduate career, and their connection to their STEM major intersect to predict their likelihood of reporting plans to enroll in a graduate or professional program in the term immediately following the completion of their bachelor's degree.

Even with an influx of federal dollars to support programs designed to improve bachelor's degree completion rates among STEM majors, students attending U.S. colleges and universities still navigate through porous STEM pathways. A study conducted by the HERI (2010b) found that 33% of White and 42% of Asian American students completed their bachelor's degree in STEM within five years of entering college compared to 18.4% of Black and 22.1% of Latino students. Researchers have emphasized the inextricable link between the STEM workforce and the STEM educational pipeline. Alexander (1996) suggests that education has an "option value," which indicates that access to higher levels of education (i.e., graduate or professional school) is contingent on previous educational attainment. Consistent with Alexander's option value categorization, Black and Latino individuals combine to make up only 9.5% of biological sciences, 6.5% of physical sciences, 6.7% of engineering, and 7% of mathematics graduate students (National Science Foundation [NSF], 2009).

Although a number of scholars have focused on the porous nature of undergraduate STEM pathways (Campbell, Denes, & Morrison, 2000; Chapa & De La Rosa, 2006), relatively few studies have specifically examined factors that predict STEM students' intention to enroll in graduate or professional school. In this study, we draw from previous research and theoretical frameworks connected to human capital and science identity to build a statistical model that

offers insight into the key economic, disciplinary, and contextual factors that encourage URM STEM undergraduates to plan for immediate enrollment in graduate or professional school.

Literature Review

Studies that have examined predictors of enrollment in graduate school have given substantial focus to academic achievement at the student level and a culture of academic success and engagement at the institutional level. For example, Sax (2001) concluded that students who found greater academic success during college had significantly better odds of enrolling in a graduate program compared to their peers who found less academic success. Likewise, students who attend higher-quality or more selective colleges and universities generally enroll in graduate and professional programs at higher rates than their counterparts at less-selective institutions (Ethington & Smart, 1986; Mullen, Goyette, & Soares, 2003; Perna, 2004; Zhang, 2005).

Findings linking academic success or a culture of success to an increased probability of graduate or professional school enrollment are not surprising, as doing well academically is generally a requirement for graduate admissions consideration. Underscoring this point, Mullen et al. (2003) analyzed data from 10,080 students who responded to the Baccalaureate and Beyond Longitudinal Study and found that higher SAT scores and earning higher grades in college significantly improved students' probabilities of enrolling in a master's program or a doctoral program. Using the same dataset as Mullen et al. (2003), Zhang (2005) focused his analysis on higher education institutions stratification and differentiation, rather than on individual student attributes, and its relationship with enrollment in a graduate program. With Barron's selectivity ratings as a benchmark, Zhang found that, compared to graduates from "low-quality" public institutions, college graduates from "high-quality" private and public institutions were respectively 16% and 18% more likely to enroll in graduate school within four to five years

of receiving their bachelor's degree. The studies by Zhang (2005) and Mullen et al. (2003) analyzed a more general sample of college graduates and relied upon less-robust single-level statistical techniques that did not account for the multilevel nature of the data.

Socioeconomic Status and Student Loan Debt

Although academic achievement and institutional quality represent some of the strongest predictors of eventual graduate or professional school enrollment, researchers also have documented how students' socio-economic background and accumulated undergraduate debt burden affect the decision to enroll in graduate school (Heller, 2001). Mullen et al. (2003) found that "students with highly educated parents are more than three times more likely to enroll in first-professional and doctoral programs than are those whose parents have a high school degree or less" (p. 150). Mullen et al.'s findings support Perna's (2004) expansion of traditional econometric models to include indices of social and cultural capital (e.g., McDonough, 1997). Parental education often serves as an indicator for socio-economic status, and a number of scholars tend to combine parents' education with income to create a scale representing an individuals' socioeconomic status (e.g., Hurtado, Han, Saenz, Espinosa, Cabrera, Cerna, 2007; Titus, 2006). Students who have the financial backing from their parents can often make the decision to enroll in graduate school without being forced to consider how they might finance their education. On the other hand, students from lower socio-economic backgrounds often face the burden of funding their higher education through student loans (Millet, 2003), which may require students to carry exorbitant amounts of student loan debt.

Ekstrom, Goertz, Pollack, and Rock (1991) concluded that students' background characteristics significantly predicted graduate school aspirations, decision to apply, and enrollment whereas undergraduate debt had no significant effect on these outcomes. Although

Ekstrom et al. (1991) and Fox (1992) concluded that accumulating debt to finance undergraduate education had no significant effect on students' decision to apply to or enroll in graduate school, they conducted their studies in a very different era of financial aid. As the U.S. transitioned from a system that appreciated the public value of higher education to one that emphasized the private returns to individuals, students pursuing undergraduate studies became forced to rely on personal resources to fund their education or take out student loans. Thus, more recent studies of graduate student enrollment and debt demonstrate the negative impact of student loans on students from lower income families (Millet, 2003; Weiler, 1994).

Weiler (1994) examined students' decision-making process as a series of discrete steps that take place at specific times in the students life (i.e., upon graduation from high school and graduation from college). He accounted factors linked to students' future plans, the cost of a baccalaureate education, the debt incurred during the undergraduate years, and students' expectations for career, salary, and future socioeconomic status. Findings from Weiler's study suggested that the debt burden incurred during the undergraduate years had a significant, negative effect on students' intentions to enroll in graduate school.

In a more recent study, Millett (2003) argued that the high cost of undergraduate debt decreases student access to graduate school, particularly at the doctoral level, as current public policy, which encourages undergraduate students to borrow heavily to finance their education, may lead to negative graduate school enrollment outcomes with more students deciding not to pursue advanced degrees because of their high student loan debt. Millett limited her sample to Baccalaureate and Beyond (B&B) respondents who had graduated from college and indicated an aspiration to earn a doctoral degree, and she analyzed predictors of students' decision to apply to and enroll in graduate school. Millett's (2003) findings indicate that student undergraduate debt

significantly deterred students from applying to graduate school. Specifically, students who had accumulated between $5,000 and $15,000 worth of student loans during their undergraduate career had between 9% and 12% lower probabilities of submitting an application to graduate school compared to their peers who had accumulated no student loan debt. By limiting her sample to college graduates with self-reported ambitions to enroll in graduate or professional school, Millet offers important insight into the role of undergraduate debt, as her sample controls for individuals' motivation and aspiration for advanced learning.

Graduate School Enrollment among STEM Majors

Relatively few studies have specifically examined predictors of graduate school enrollment among students who earned a bachelor's degree in STEM. Sax (2001) used data from the Higher Education Research Institute to examine what background characteristics and college experiences explained the decision to enroll in graduate school among women and men science, math, and engineering (SME) majors. Sax's results suggested that SME students who reported a probable career choice of "scientist" as a freshman, indicated that they wanted to make a theoretical contribution to science in their life, and attended a college or university with a stronger scientific orientation tended to have a higher likelihood of enrolling in graduate school. Additionally, students who more frequently interacted with faculty and earned higher grades in college were significantly more likely to pursue a graduate degree than their peers who interacted less often with faculty or earned lower grades in college. Although Sax's study is one of a few that considers the specific factors related to SME majors' likelihood of enrolling in graduate school, her use of single-level statistical techniques and inclusion of just a handful college experience variables limits the implications of her research.

Other studies have taken more of a micro-focus on the issue of STEM bachelor's degree recipients' pursuit of post-baccalaureate education. Carter, Mandell, and Maton (2009) examined nearly 500 Black students who had participated in the Meyerhoff Scholars program at the University of Maryland, Baltimore County. Using probit analysis, the authors concluded that participation in a year-long undergraduate research opportunity significantly and positively predicted students' enrollment in a STEM Ph.D. program, and these findings support conclusions drawn by other researchers about the benefits of undergraduate research in promoting students' pursuit of post-baccalaureate degrees (Hunter, Laursen, & Seymour, 2007; Lopatto, 2004; MacLachlan, 2006; Russell, Hancock, & McCullough, 2007). Although the study by Carter, Mandell, and Maton underscore the benefits of undergraduate research on post-baccalaureate enrollment, their sample is likely biased, as they limited their study to include only those students who applied to and were selected for inclusion in the Meyerhoff Scholars program; thus, these students may be more highly motivated than their peers who were outside this program.

Although undergraduate research programs help to orient students from all backgrounds toward a commitment to STEM disciplines, URM students continue to face unique sociological and psychological challenges in adjusting to the culture within STEM. Hurtado et al. (2007) supported earlier findings from Seymour and Hewitt (1997) in identifying how campus racial climate, the STEM culture, and competitive environments in STEM fields can serve as obstacles to URM students' ability to identify with their STEM major. Hurtado, Cabrera, Lin, Arellano, and Espinosa (2009) concluded that participation in undergraduate research programs not only provided URM students with the self-confidence necessary to continue their education in STEM beyond the bachelor's degree but engagement with the culture of STEM also provided students with the support networks necessary in navigating around other potential educational barriers.

Theoretical Framework

Carlone and Johnson's (2007) science identity model develops an important theoretical layer when considering how human capital theory relates to aspirations to enroll in STEM graduate school. Carlone and Johnson's conceptual model of science identity includes three overlapping components of performance, recognition, and competence. Additionally, Carlone and Johnson contend that race/ethnicity and gender identities influence a student's science identity. These components of a science identity are important when trying to better understand the non-financial motivations and how students perceive the return on their investment.

The first component, recognition, includes both personal and external recognition of being a "science person" as opposed to just being a "science student." Carlone and Johnson (2007) found that students who identified themselves as scientists tended to have more altruistic desires to help others and their community, which is a clear non-financial return on an individual investment. The benefits of finding a cure for a persistent disease or a solution to a challenge that faces a student's community may out-weigh any monetary benefits. The last two components, competence and performance, characterize students' feelings of proficiency as latent constructs that suggest that students with strong science identities must feel competent and perform well academically on exams and in laboratories. In all, these components of science identity indicate that students who are not recognized for their talents, perceive themselves not to be competent, or do not feel comfortable performing scientific tasks may choose to discontinue investing in their human capital because the benefits are not out-weighing their financial, psychological, and social investment.

Whereas Carlone and Johnson's (2007) science identity model provides for social and psychological considerations in STEM students' decision to pursue graduate or professional

school, traditional econometric models of human capital cast decision-making processes as choices made by rational actors who use perfect information when deciding to invest in his or her human capital (Becker, 1993). A number of higher education scholars have demonstrated that individuals do not always base their decisions under the auspices of rational economic behavior. A clear example of irrational decision making processes are in the differential responses to the price of tuition for students with higher and lower socioeconomic backgrounds (Hearn & Longnecker, 1996; Leslie & Brinkman, 1987; St. John, Paulsen, & Carter, 2005). Researchers have corroborated similar discrepancies in how students finance their education. Although students tend to feel that the benefits of earning a bachelor's degree were worth whatever debt they acquired to finance that degree (Baum & O'Malley, 2003), individuals, particularly those from lower socioeconomic backgrounds, who face a human capital investment decision, tend to express anxiety about relying upon loans to finance additional education (Levhari & Weiss, 1974).

Paulsen (2001) expands on the rational decision-making model to demonstrate how the decision to invest in one's human capital is a very complex process that takes into consideration a barrage of palpable and latent factors. Paulsen defines human capital as "the productive capacities—knowledge, understandings, talents, and skills—possessed by an individual or society; and investment in human capital refers to expenditures on education, health and other activities that augment these productive capacities" (p. 56). The typical cost-benefit considerations of investing in human capital include the direct costs of the education and the foregone earnings and how these impact the increased earning potential for the investor. From a rational actor perspective, if the direct costs and the forgone earnings do not significantly increase the earning potential of the investor, it becomes irrational to invest in the human capital

and the inverse would be true as well. Paulsen notes that the monetary benefits and costs fluctuate due to differences in "socioeconomic status and background, academic ability, access to information about postsecondary opportunities, financial opportunities in the credit markets, employment opportunities in the job markets, discriminatory practices in the credit or job markets or at institutions of higher education, and early home and school environments" (p. 60). Similar to Perna (2004), Paulsen suggests that social capital is an important component in mediating the aforementioned differences in students' resources and knowledge of the benefits and returns on an investment in human capital.

Given the characteristics of science identity development (Carlone and Johnson, 2007) and human capital theory (Paulsen, 2001), we suggest that these theoretical perspectives intersect in a unique way to predict URM STEM students' decision to pursue post-baccalaureate degrees. Students who have experienced recognition and have had the opportunity to "perform" as STEM majors likely have significantly increased odds of pursuing graduate or professional education immediately after completing their bachelor's degrees. However, an individual's financial situation may weigh heavily in the consideration of graduate or professional school, as some students may want to reap the benefits of their investment in their undergraduate education rather than delaying these potential rewards. Similarly, other students may have an aversion to the possibility of adding to any student loan debt they accumulated while earning their bachelor's degree, and human capital theory would suggest that such students would opt not to enroll immediately in a post-baccalaureate degree program. This study seeks to understand whether STEM identity and human capital theories jointly predict immediate enrollment in graduate or professional school or whether one perspective out-weighs the other.

Methods

Research Questions

Drawing from the human capital and science identity frameworks, this study examines the individual and institutional factors that predict students' decision to enroll in a graduate or professional school program immediately following the completion of their bachelor's degree. Specifically, the following research questions guide this study:

1. Controlling for students' background characteristics and pre-college experiences, what effects do URM STEM students' college experiences and accumulated loan debt have on their decision to enroll in graduate or professional school immediately following bachelor's degree completion?
2. Controlling for student characteristics, how do the contextual effects of higher education institutions, such as Carnegie classification, selectivity, and minority-serving status, affect STEM students' decision to enroll in graduate or professional school immediately following the completion of their bachelor's degree?

Data and Sample

We analyzed data from multiple sources to address the above questions. Our student data came from two surveys administered by the Cooperative Institutional Research Program (CIRP) at the Higher Education Research Institute (HERI). Specifically, we drew student data from the 2004 CIRP Freshman Survey and the 2008 CIRP College Senior Survey (CSS). The CIRP Freshman Survey was administered to the entering cohort of 2004 during summer orientation or the first few weeks of the fall term. The survey included questions about students' background, high school experiences, anticipated involvement in college, political and social views and attitudes, and educational and career goals (see Sax, Hurtado, Lindholm, Astin, Korn, & Mahoney, 2004, for more information about this survey). The 2008 CSS followed up with this same cohort of students in the spring and summer of their fourth year in college and asked students about their college experiences, attitudes toward political and social issues, satisfaction

with various facets of campus life, and educational and career goals. We collected institutional data from the Integrated Postsecondary Educational Data System (IPEDS).

Grants from the National Institutes of Health (NIH) and National Science Foundation (NSF) provided funds for a targeted sampling strategy for this study. An NIH grant allowed for the targeted recruitment of minority-serving institutions (MSIs) with strong reputations of graduating undergraduates in the biomedical and behavioral sciences. This grant also provided resources to sample institutions with NIH-funded undergraduate research programs. Additional funding from NSF allowed us to expand our institutional sample to include colleges and universities with strong reputations for producing bachelor's degrees in STEM.

Within each institution, we also had a sampling strategy for students. We targeted equal numbers of URM STEM majors, URM non-STEM majors, and White and Asian American STEM majors. This strategy provided an opportunity to compare URM STEM majors to their same-race, different-major peers and to their same-major, different-race counterparts. Because this study examines the individual and institutional predictors of URM STEM students' intention to enroll in graduate or professional school, we limited the analytic sample for this study to 1,027 URM students who persisted as STEM majors across 176 institutions. The longitudinal response rate for the Freshman Survey and CSS was 23%.

Variables

The dependent variable for the study is a dichotomous item representing whether students indicated on the 2008 CSS that they intended to enroll in a graduate or professional school program in the fall of 2008 immediately following their completion of their undergraduate degree. Given that students completed the CSS in late spring or summer of 2008, many of them likely reported their immediate plans with greater confidence, as admissions decisions from most

graduate and professional programs already had been communicated to students. Although matriculation data would provide a more accurate depiction of whether respondents *actually* enrolled in graduate or professional school in the fall of 2008, this survey item serves as an appropriate proxy. Finally, we chose this measure of intention to immediately enroll rather than other aspirational, time-indefinite survey items to best examine the short-term effects of accumulated undergraduate debt and identification with STEM disciplines on students' post-baccalaureate educational trajectories.

Our primary independent variables of interest stem from the frameworks of human capital and science identity development that guide this study. To examine how measures of human capital affect students' self-reported intentions to enroll in graduate school in the fall of 2008, we included measures of accumulated loan debt, the extent to which students relied upon their own resources to finance their final year of undergraduate study, the extent to which scholarships and grants assisted them in paying for their final year as an undergraduate student, students' concerns about financing college, and socioeconomic status. Accumulated debt burden was an open-ended question where students could write in the estimated amount of debt that had accrued throughout their undergraduate career, and we log-transformed this variable. The two other variables related to financial aid were measured on a scale, and the details of that scale are shown in Table 1. Additionally, we created a scale to represent students' socioeconomic status (SES) from three items from the Freshman Survey: parental income, mother's education, and father's education. The Cronbach's alpha coefficient for this scale was 0.72 Another measure of students' financial situation considered students' self-reported concerns about financing their college education, as reported on the Freshman Survey.

The second set of primary independent variables related to students' STEM identity. We identified a construct representing participants' identity with STEM from four items on the CSS that asked students to rate the personal importance of becoming an authority in their field, being recognized for their contributions to their special field, finding a cure for a health problem, and making a theoretical contribution to science. The Cronbach's alpha coefficient for this construct was 0.71, and the items comprising this construct underscore the central facets of performance, competence, and recognition found in Carlone and Johnson's (2007) science identity model. A second factor we identified and used in the model represented the extent to which students felt support from faculty, which connects to Carlone and Johnson's tenet of recognition. The Cronbach's alpha coefficient for this construct was 0.86, and the following items composed the factor: faculty provided encouragement to pursue graduate or professional study, advice about the educational program; emotion support and encouragement; a letter of recommendation; and help in achieving professional goals.

We also analyzed the predictive power of several college experiences on students' intention to enroll in graduate or professional school. These experiences served as proxy measures for the tenets of performance and competence in developing a stronger science identity. We included a measure that asked students to report the frequency with which they worked with faculty on research, as prior studies have found research experience to be a significant, positive predictor of graduate school enrollment (Canter, Mandell, & Maton, 2009; Hunter, Laursen, & Seymour, 2007; Lopatto, 2004). Additionally, we examined whether participation in an academically related club or organization had a significant relationship with students' intention to enroll in graduate or professional school. Other controls in the model included students'

cumulative GPA and academic major. We included dummy variables to represent general disciplinary areas within STEM, and engineering fields served as the reference group.

In addition to these primary independent variables, the analyses accounted for a range of student background characteristics and pre-college experiences. We controlled for students' race and gender with a set of dichotomous variables. The model also included indicators of students' prior academic achievement as measured by high school grade point average (GPA) and SAT math score. To account for reasons why students decided to pursue a bachelor's degree, we included two items from the Freshman Survey in the model: the extent to which students came to college to get training for a specific career and to be able to make more money. In addition to including measures for general college attendance, we also controlled for one of students' reasons for enrolling in their specific undergraduate institution: the extent to which they felt graduates from this institution gain admission to top graduate and professional schools.

Finally, we included a limited set of variables that measured the institutional context that students encountered during their undergraduate careers. We included three measures of institutional type: HBCU status; control; and doctoral institution. We also accounted for the average socioeconomic status of students within each institution and institutional selectivity, which was measured by average SAT scores of entering students in 2004.

Analyses

Before discussing the multivariate analyses used to predict students' intention to enroll in graduate school, we need to discuss how we handled cases with missing data. We utilized listwise deletion for cases with missing data on the outcome variable, student demographic characteristics, and dichotomous college experiences (e.g., major, participation in an academic club). For the remaining variables in the model, we analyzed the extent to which data were

missing. Examination of missing data patterns suggested that missing data occurred at random, and no variable had more than 8% of cases missing. The SAT math variable had the highest proportion of missing data at 8%.

Given the relatively low proportion of missing data across variables used in the multivariate analyses, we proceeded with the use of the expectation maximization (EM) algorithm to account for missing data. McLachlan and Krishnan (1997) suggest that the EM algorithm provides a more robust method for handling cases with missing data than using listwise deletion or mean replacement. Through the use of maximum likelihood estimates, the EM algorithm imputes values for cases with missing data (Allison, 2002; Dempster, Laird, & Rubin, 1977; McLachlan & Krishnan, 1997).

The primary analytic technique guiding this study was hierarchical generalized linear modeling (HGLM). HGLM represents an appropriate statistical method for studies involving clustered data used to predict a dichotomous outcome (Raudenbush & Bryk, 2002). Our study's data included students nested within colleges and universities, and we had a dichotomous outcome measure: whether students intended to enroll in graduate or professional school in the fall of 2008. HGLM provides a more robust analysis of multilevel data than more traditional single-level statistical techniques such as logistic regression. By accounting for the nested nature of the data, HGLM appropriately partitions variance in the outcome attributable to students and to institutions, which allows analysts to more accurately identify the significant predictors of the outcome variable (Raudenbush & Bryk). In contrast, single-level techniques do not account for the homogeneity of errors within institutions and thus increase the likelihood of making a Type I statistical error (de Leeuw & Meijer, 2008).

Our model building occurred in several stages. We began with a fully unconditional model to confirm that students' average probability of reporting an intention to enroll in graduate school varied across institutions. Equation 1 presents the fully unconditional model.

$$\text{Log}\left[\frac{\Phi_{ij}}{1-\Phi_{ij}}\right] = \beta_{0j} + \mu_j \quad (1)$$

where β_{0j} represents the average probability of reporting graduate or professional school enrollment intentions for students in college *j*, and μ_j represents the between-institution variance component. After confirming that the between-institution variance component significantly varied across colleges and universities, we proceeded with building our level-1 model. We started by including only students' background and pre-college characteristics. Next, we added all of students' college experiences, including measures of science identity and debt burden, to the model. Equation 2 presents the full student-level model.

$$\begin{aligned}\text{Log}\left[\frac{\Phi_{ij}}{1-\Phi_{ij}}\right] = \beta_{0j} + \beta_{1j}\,(\text{BACKGROUND CHARACTERISTICS})_{ij} \quad (2)\\ + \beta_{2j}\,(\text{COLLEGE EXPERIENCES})_{ij}\\ + \beta_{3j}\,(\text{DEBT BURDEN})_{ij} + \beta_{4j}\,(\text{SCIENCE IDENTITY})_{ij}\end{aligned}$$

where background characteristics, college experiences, debt burden, and science identity correspond to the individual or blocks of variables previously described, B_{1j} -B_{4j} represent the individual parameter estimates associated with each variable in the model. Finally, to examine how institutional contexts affect students' average probability of reporting intentions to enroll in graduate or professional school, we included several institutional predictors in the level-2 model, which predicted the intercept from Equation 2. Equation 3 includes the institutional variables included in the model.

$$B_{0j} = \gamma_{00} + \gamma_{01}\,(\text{HBCU})_j + \gamma_{02}\,(\text{AVERAGE SES})_j \quad (3)$$

$$+ \gamma_{03} (\text{CONTROL})_j + \gamma_{04} (\text{SELECTIVITY})_j$$

$$+ \gamma_{05} (\text{DOCTORAL INSTITUTION})_j + \mu_j$$

where HBCU, average SES, control, selectivity, and doctoral institution refer to the variables previously described, μ_j represents the randomly varying level-2 error component. The terms γ_{01} - γ_{05} correspond to the institutional parameter estimates.

When using multi-level modeling, analysts must give consideration to centering effects of variables. Because we were interested in the average effect of each predictor on all students' likelihood to report graduate or professional school enrollment intentions, we chose to grand-mean center all continuous variables. Grand-mean centering subtracts the mean of the variable for the entire sample from each individual observation (Raudenbush & Bryk, 2002). We left all dichotomous variables un-centered.

We report results for significant predictors as delta-p statistics. Delta-p statistics represent the change in probability of reporting intentions for graduate school enrollment, versus not having those intentions, associated with a one-unit change in the predictor variable. We relied upon the formula offered by Petersen (1985) to calculate the delta-p statistics.

Limitations

Before presenting the results from our analyses, it is important that we note the limitations of our study. First, we recognize the low longitudinal response rate (23%) for our survey data. Although this response rate limits the generalizability of our findings to a larger population of URM STEM students, we note that few studies within higher education have analyzed such a relatively large sample of URM STEM students, as studies generally combine URM students with their White and Asian American peers to have a large enough sample for the types of analyses we used in this study. Second, as with any study that utilizes secondary data

analysis, we are limited by the variables and data in the dataset. Third, we recognize that we have a restrictive dependent variable that only examines students' decision to immediately enroll in graduate or professional school following the completion of their undergraduate degree. An outcome measure that examined students' graduate school enrollment intentions and matriculation behavior over a longer period of time likely would capture substantially more students who report, and follow through with, such intentions. Finally, we acknowledge that students do not randomly decide to acquire student loan debt in college, as students' background characteristics, prior academic achievement, and type of undergraduate institution they attend contribute both to their likelihood of taking out student loans as well as the total amount of loan debt accumulated during their undergraduate career. Given the potential endogeneity of some of the variables included in the model, we risk mis-estimating the true effect of undergraduate debt on students' likelihood of immediate plans for graduate or professional school enrollment.

Results

Descriptive Statistics

Table 2 shows the results from the descriptive analyses of the data. Just 27% of URM students who were retained in their STEM majors through four years of college indicated that they had immediate plans to enroll in a graduate or professional program by the fall of 2008. This figure was consistent across the three racial/ethnic groups included in the analyses, as 27.5% of Native American students, 25.4% of Latino students, and 27.6% of Black students reported an intention to enroll in graduate or professional school immediately after completing their undergraduate degree.

On average students reported earning a cumulative GPA in the range of a B to a B+, and this level of achievement was slightly lower than students' self-reported high school GPAs,

which had an average range of B+ to A-. The mean SAT math score for students in this sample fell just below 600. Latino students comprised 48% of the sample, Black students 38%, and Native American students 14%. Women accounted for 61% of the sample. The average amount of loans for all students was slightly more than $1,000; however, considering the average loans for students with positive debt was $13,629. The median student loan burden across all students was $11,047.

Hierarchical Generalized Linear Modeling

Table 3 presents the results from the full model of the HGLM analysis. Considering our primary independent variables of interest, we found that accumulating increased loan debt significantly and negatively predicted students' likelihood of reporting intentions to enroll in graduate or professional school by the fall of 2008. Because we log-transformed this variable prior to its inclusion in the multivariate analyses, it is helpful to examine how discrete values of debt burden affect students' probability of reporting graduate school enrollment intentions. A student who had accumulated an average of $1,000 in student loans was approximately 5.3% less likely to report intentions to enroll in graduate or professional school than a student without any loan debt. Similarly, a student with approximately $22,000 in debt was 7.8% less likely to indicate plans for immediate graduate or professional school enrollment compared to a student without any debt.

Other variables related to students' finances had mixed results. Students who relied more heavily on their personal finances, such as income from work or work study, to pay for their educational expenses during the 2007-2008 academic year had significantly lower probabilities of indicating plans to enroll immediately in graduate or professional school. In contrast, relying more upon grants and scholarships to fund educational expenses during the final year of college

had no significant relationship with students' likelihood to intend to enroll in graduate school immediately after earning their bachelor's degree. Socioeconomic status had a significant, positive association with the outcome, as a one-standard-deviation increase in students' socioeconomic status resulted in a 3.90% increase in their probability of planning to enroll in graduate or professional school in the fall of 2008. In contrast, students' self-reported concerns from the fall of 2004 about their ability to finance their undergraduate education had no statistically significant effect on graduate or professional school enrollment plans.

Two of the variables connected to students' identity with their STEM major significantly and positively predicted their likelihood of planning to enroll immediately in graduate or professional school. Students with a stronger connection to their STEM major had better odds of planning for graduate or professional school enrollment, as a one-standard-deviation increase in the STEM identity factor corresponded to a 6.52% increase in students' probability of intending to enroll in a graduate or professional school program in the fall of 2008. Likewise, respondents who conducted research with faculty more frequently during their undergraduate careers had an increased likelihood of planning for immediate graduate or professional school enrollment, as a one-unit increase in this variable corresponded to a 7.42% increase in the probability of reporting graduate or professional school plans for the fall of 2008. The third variable connected to students' STEM-major identity, whether they joined a club or organization related to their major, had no statistically significant effect on their plans for immediate graduate school enrollment.

In addition to our key independent variables of interest, we found significant effects from several other college experience variables. Students with higher cumulative GPAs had significantly higher probabilities of reporting plans for immediate graduate school enrollment. Specifically, a one-unit increase in the variable measuring students' cumulative GPA

corresponded to an 8.33% increase in their probability of reporting plans to enroll in graduate or professional school in the fall of 2008. We also found mixed results with students' fourth-year major. Students majoring in the life sciences were not statistically different from their peers in engineering and mathematics in their likelihood to report immediate graduate school enrollment intentions. In contrast, students who reported majoring in the physical sciences had a 13.26% higher probability of indicating immediate graduate school enrollment plans compared to their engineering counterparts. Health science majors had a 12.13% lower probability than engineering majors of reporting plans for immediate graduate school enrollment.

Other variables significantly related to students' probability of reporting plans for immediate graduate or professional school enrollment included coming to college to be able to make more money and coming to college to get training for a specific career. Students who indicated on the 2004 Freshman Survey that they came to college to be able to make more money had a significantly lower probability of reporting plans to immediately enroll in graduate or professional school. A one-unit increase in this variable corresponded to a 6.16% decrease in their probability of reporting intentions to enroll in graduate school by the fall of 2008. In contrast, respondents who indicated that they came to college to get training for a specific career appeared significantly more likely to enroll in graduate school immediately after earning their bachelor's degree, as a one-unit increase in this predictor corresponded to an 8.56% increase in students' likelihood of reporting immediate graduate school enrollment plans.

In addition to the student-level variables, we included several measures of the college context. The findings suggest that students who attended HBCUs had significantly higher probabilities of reporting immediate graduate or professional school enrollment plans. Specifically, students who attended an HBCU for their undergraduate degree were 23.38% more

likely to report immediate graduate enrollment plans compared to their URM peers at Hispanic-Serving institutions and predominantly-White institutions. Additionally, respondents who were enrolled in private colleges and universities were 10.18% more likely than their counterparts at public institutions to have immediate graduate school plans. We found no significant effects from the average socioeconomic status of students at the institution, institutional selectivity, or institutional Carnegie classification. The institutional predictors accounted for 62.6% of the between-institution variance in students' average probability of reporting immediate graduate or professional school enrollment plans.

Discussion

In this study, we examined whether URM STEM students' debt burden and their connection to STEM disciplines significantly predicted their likelihood to report plans to enroll in graduate or professional school immediately after earning their bachelor's degree. We relied upon human capital theory and science identity theory to analyze student- and institution-level data to understand how students' finances and disciplinary connections jointly predicted intentions to enroll immediately in graduate or professional school.

We found a negative relationship between URM STEM students' debt burden and their probability of intending to enroll in graduate or professional school immediately following the completion of their bachelor's degree. This finding suggests that URM STEM students who take out student loans to finance their undergraduate education may have an aversion to the possibility of acquiring more debt in the pursuit of a post-baccalaureate degree, which supports the results from previous studies (Millet, 2003; Weiler, 1994). Following from human capital theory (Becker, 1993; Paulsen, 2001), the negative relationship between students' undergraduate debt burden and their probability to indicate plans for immediate enrollment in graduate or

professional school may be explained by a personal assessment that the additional financial costs, both direct costs and opportunity costs, of enrolling in a graduate or professional program may outweigh the perceived personal, academic, and financial benefits from completing such a program. Furthermore, students who utilized more of their own financial resources to pay for their educational expenses during their final year of undergraduate study also had a significantly reduced probability of immediate graduate school enrollment.

The results related to students' financial situation at the end of their undergraduate career may connect to the general life and career goals that students stated at the beginning of their freshman year in 2004. Students who indicated that they came to college with the goal of being able to make more money had significantly reduced likelihoods of planning to enroll in graduate or professional school immediately following the completion of their bachelor's degree. Taking this finding in context with the negative relationship between debt burden and graduate school enrollment intentions, it appears as though URM STEM students in this study who have a short-term focus on financial stability or on reducing their overall debt tend to have a disinclination to delay entering the labor force any longer and seek an immediate return on their investment in their undergraduate education. In other words, these students perceive that the potential benefits of immediately earning a salary, and potentially paying down their undergraduate debt, significantly outweigh the possible costs of financing additional years of education and postponing full-time employment. It is important to note that enrolling in graduate or professional school and maintaining full-time employment do not represent mutually exclusive paths nor can our analyses account for whether any students in the sample decided to pursue both paths simultaneously in the fall of 2008.

In addition to the findings related to students' finances, our results also suggested that students who demonstrated a stronger connection to STEM disciplines had a significantly increased likelihood of deciding to immediately enroll in graduate or professional school. This finding was illustrated by the significant, positive relationship between the STEM identity construct and enrollment in graduate school as well as the significant, positive relationship between involvement in faculty research projects and graduate school enrollment intentions. These findings connect to prior studies that have underscored the value of undergraduate research opportunities in engendering students' connection to their discipline in a way that encourages them to pursue post-baccalaureate study (Carter, Mandell, Maton, 2009; Lopatto, 2004; MacLachlan, 2006; Russell, Hancock, & McCullough, 2007). Working with faculty on research enables students to apply the knowledge and skills learned in the classroom to real experiences where they have the opportunity to experience life as a STEM researcher. Because our study lacked an experimental design, we cannot conclusively state that participation in an undergraduate research program led students to indicate graduate school enrollment intentions, as the survey respondents may have decided to go to graduate school and decided to find research opportunities with faculty to improve their odds of being admitted.

These research opportunities also may have led to a stronger connection between students and their STEM major. Respondents who reported that they wanted to make theoretical contributions to science, find cures for health problems, and be recognized for contributions to their field had significantly higher probabilities of indicating plans for immediate enrollment in graduate and professional school. This factor may encompass a more intrinsic motivation to contribute to the public good and the discipline, and respondents recognize that additional years of education will provide them the skills, knowledge, and credentials necessary to achieve such

advancements and recognition in their disciplines. The fact that having a stronger disciplinary connection significantly and positively predicted plans for immediate graduate school enrollment even after accounting for students' financial situation underscores the importance of developing such ties throughout the undergraduate experience. Although undergraduate research experiences may provide opportunities for strengthening such connections by allowing individuals to "perform" science and develop competence in their discipline (Carlone & Johnson, 2007), students need to have multiple avenues to establish important links to their major.

The connections that students make with their discipline are just as important as the discipline itself, as our results indicate significant differences based on students' general field of study. Students in the physical sciences, including math, physics, and chemistry, among others, had a significantly higher likelihood of planning to transition immediately into a graduate or professional program compared to their peers in engineering and math. This finding may be explained by the limited prospects of employment for physical science students holding a bachelor's degree or that the salaries garnered by these degree holders are not lucrative, which reduces the opportunity costs to immediately enroll in graduate school. Therefore, the investment in human capital beyond the bachelor's degree for physical science students would warrant an earnings differential that out-weighs the direct and opportunity costs. On the other hand, bachelor's degree recipients in engineering may have an immediate and more remunerative path in industry. Engineers may see the forgone earnings as too significant to justify immediately enrolling in graduate school.

In contrast to students in the physical sciences, students pursuing health-science majors tended to be significantly less likely than engineers to report plans for immediate enrollment in graduate or professional school. The fact that our health sciences category included students who

majored in nursing partly explains health-sciences students' reduced likelihood to immediately enroll in graduate or professional school, as nursing degree recipients may prefer to have hands-on experience in the field before pursuing any additional education. Additionally, some students who graduate with a health-science degree may need to take additional courses before they meet the pre-requisites for medical school, which may delay plans for immediate enrollment.

Finally, our results underscore the importance of institutional context in predicting students' likelihood of pursuing a graduate or professional degree immediately following the completion of their bachelor's degree. URM STEM students who earned their bachelor's degree from an HBCU had a significantly higher probability of reporting plans for immediate enrollment in a graduate or professional program compared to their peers at PWIs and HSIs. This positive effect of HBCU attendance supports prior studies that concluded the supportive context of HBCUs offers students encouragement to continue their studies beyond the bachelor's degree (Allen, 1992; Zhang, 2005), and this finding connects to other research that has shown that HBCUs tend to be the top producers of Black baccalaureate recipients who eventually earn a doctoral degree (Solorzano, 1995). The climate within HBCUs provides students with a space to achieve recognition for their academic efforts while developing competence in their fields of study without the more challenging racial contexts found within PWIs (Pascarella & Terenzini, 2005; Wagener & Nettles, 1998).

Attending a private institution, compared to a public college or university, also had a significant, positive effect on students' probability of planning to enroll in graduate or professional school by the fall of 2008, which supports prior research (Eide, Brewer, & Ehrenberg, 1998; Zhang, 2005). Private institutions tend to offer students substantially more programmatic resources to help them to understand the benefits of additional years of education

while also assisting students in navigating the graduate school application process. (Kamens, 1981). The studies Eide et al. (1998) and Zhang (2005) specifically noted the benefits of graduating from *elite* private institutions on students' likelihood of enrolling in graduate school; however, our findings did not indicate a unique effect of institutional selectivity on URM STEM students' probability of immediate enrollment in graduate school.

Conclusions and Implications

The findings from our study underscore an opportunity for administrators and policymakers to implement programs that simultaneously reduce students' reliance on loans to finance education while strengthening their connection with STEM disciplines. Recent legislation and policy proposals from the Obama administration have aimed to address both of these concerns. The signing of the Health Care and Education Reconciliation Act of 2010 removed banks from serving as an intermediary between students and the federal government, and such a move provides federal cost savings that are to be directed toward increasing the maximum Pell Grant. Increasing the maximum Pell Grant will provide additional funds to students from lower socioeconomic backgrounds, particularly URM students, which may reduce students' overall debt burden at the end of college. The Obama administration also has proposed consolidating undergraduate STEM programs designed to increase retention and completion rates among URM students. The benefits of such a strategy include increased funding to these programs and streamlining a fragmented system of programs; however, critics suggest that the proposal may increase competition among existing programs at minority-serving institutions, which may limit access (Dervarics, 2010). Indeed, any potential reduction in funding to minority-serving institutions, especially HBCUs, may restrict their continued level of success in

graduating high numbers of URM students with bachelor's degrees in STEM and in encouraging these students to move immediately into post-baccalaureate degree programs.

Although the federal government has an important role in providing funds to support financial aid and undergraduate research programs, institutions can do more to engage and financially support their students. Importantly, changes in federal aid policy related to student loans and increasing the maximum amount for Pell Grants will have little if any effect on students' educational debt if institutions continue to increase cost of attendance at a rate that far exceeds inflation. Additionally, for institutions that currently lack funded undergraduate research programs, administrators can encourage faculty to engage undergraduates on faculty-led research projects. Such experiences pair students with faculty mentors, which allow them not only to gain valuable research experience but also provide them with an opportunity to learn directly about the benefits and drawbacks of pursuing a career in research. As suggested by Carlone and Johnson (2007), students need space and opportunity to develop competence, apply knowledge, and be recognized for their contributions to the field for them to develop a strong and lasting identity with their STEM discipline. By providing opportunities for research, engagement with faculty, and a supportive climate of academic success as early as possible in students' undergraduate career, U.S. colleges and universities can improve the United States' rate of success at producing baccalaureate and post-baccalaureate degrees in STEM, particularly for URM students.

References

Alexander, K. (1996). The value of an education (1976). In D. W. Breneman, L. L. Leslie, & R. E. Anderson (Eds.), *ASHE reader on finance in higher education*. Needham Heights: Simon & Schuster Custom Publishing.

Allen, W. (1992). The color of success: African-American college student outcomes at predominantly White and historically Black public colleges and universities. *Harvard Education Review, 62*(1), 26-44.

Allison, P. D. (2002). *Missing data*. Thousand Oaks, CA: Sage Publications.

Basken, P. (2010, March). NSF seeks new approach to helping minority students in science. *The Chronicle of Higher Education.* Retrieved March 15, 2010 from http://chronicle.com/article/NSF-Seeks-New-Approach-to/64592.

Baum, S., & O'Malley, M. (2003). College on credit: How borrowers perceive their education debt. *NASFAA Journal of Student Financial Aid, 33*(3), 7-19.

Baum, S., & Payea, K.(2008). Trends in student aid 2008 (Tech. Rep.). New York: College Board.

Becker, G. S. (1993). *Human capital: A theoretical and empirical analysis with special reference to education.* (3rd ed.). Chicago: The University of Chicago Press.

Campbell, G., Jr., Denes, R. & Morrison, C. (Eds.). *Access Denied: Race, Ethnicity, and the Scientific Enterprise.* Oxford: Oxford University Press.

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research In Science Teaching, 44*(8), 1187-1218.

Carter, F. D., Mandell, M., & Maton, K. I. (2009). The influence of on-campus academic year undergraduate research on STEM Ph.D. outcomes: Evidence from the Meyerhoff scholarship program. *Education Evaluation and Policy Analysis, 31*(4), 441-462.

Chapa, J., & De La Rosa, B. (2006). The problematic pipeline: Demographic trends and Latino participation in graduate science, technology, engineering, and mathematics programs. *Journal of Hispanic Higher Education, 5*(3), 203-221.

de Leeuw, J., & Meijer, E. (2008). Introduction. In de Leeuw, J. & Meijer, E. (Eds.), *Handbook of multilevel analysis.* New York, NY: Springer.

Dempster, A. P., Laird, N. M., & Rubin, D. B. (1977). Maximum likelihood from incomplete data via the EM algorithm. *Journal of the Royal Statistical Society, 39*(1), 1-38.

Devarics, C. (2010, March). Obama proposal seeks to consolidate minority undergraduate STEM programs. *Diverse Issues in Higher Education.* Retrieved March 15, 2010 from http://diverseeducation.com/cache/print.php?articleId=13616.

Eide, G., Brewer, D. J., & Ehrenberg, R. G. (1998). Does it pay to attend an elite private college? Evidence on the effects of undergraduate college quality on graduate school attendance. *Economics of Education Review, 17*(4), 371-376.

Ekstrom, R., Goertz, M., Pollack, J., & Rock, D. (1991). Undergraduate debt and participation in graduate education: The relationship between educational debt and graduate school aspirations, applications, and attendance among students with a pattern of full-time, continuous postsecondary education. Princeton, NJ: Educational Testing Service.

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

Fox, M. (1992). Student debt and enrollment in graduate and professional school. *Applied Economics, 24*(7), 669-677.

Hearn, J. C., & Longanecker, D. (1996). Enrollment effects of alternative postsecondary pricing policies. In D. W. Breneman, L. L. Leslie & R. E. Anderson (Eds.), *ASHE Reader on Finance in Higher Education* (pp. 275-289). Needham Heights, MA: Simon & Schuster Custom Publishing.

Heller, D. E. (2001). Debts and decisions: Student loans and their relationship to graduate school and Career Choice. Indianapolis, IN: Lumina Foundation for Education.

Higher Education Research Institute. (2010a). The American freshman: National norms fall 2009. Los Angeles: Higher Education Research Institute.

Higher Education Research Institute. (2010b). Degrees of success: Bachelor's degree completion rates among initial STEM majors. Los Angeles: Higher Education Research Institute.

Hunter, A. B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education, 91*(1), 36-74.

Hurtado, S., Cabrera, N. L., Lin, M. H., Arellano, L., & Espinosa, L. L. (2009). Diversifying science: Underrepresented student experiences in structured research programs. *Research in Higher Education, 50*(2), 189-214.

Hurtado, S., Han, J. C., Saenz, V. B., Espinosa, L. L., Cabrera, N. L., & Cerna, O. S. (2007). Predicting transition and adjustment to college: Biomedical and behavioural science aspirants' and minority students' first year of college. *Research in Higher Education, 48*(7), 841-887.

Kamens, D. H. (1981). Organizational and institutional socialization in education. *Research in*

Sociology of Educational and Socialization, 2, 111-126.

Leslie, L. L., & Brinkman, P. T. (1987). Student price response in higher education: The student demand studies. *The Journal of Higher Education, 58*(2), 181-204.

Levhari, D., & Weiss, Y. (1974). The effect of risk on the investment in human capital. *The American Economic Review, 64*(6), 950-963.

Lopatto, D. (2004). Survey of undergraduate research (SURE): First finginds. *Cell Biology Education, 3*(4), 270-277.

MacLachlan, A. J. (2006). Developing graduate students of color for the professoriate in science, technology, engineering, and mathematics (STEM). *Research and Occasional Paper Series: CSHE.6.06,* Center for Studies in Higher Education, University of California, Berkeley.

McDonough, P. M. (1997). *Choosing colleges: How social class and schools structure opportunity.* Albany: State University of New York Press.

McLachlan, G. J., & Krishnan, T. (1997). *The EM algorithm and extensions*. New York: Wiley.

Millet, C. M. (2003). How undergraduate loan debt affects application and enrollment in graduate or first professional school. *The Journal of Higher Education, 74*(4), 386-427.

Mullen, Ann L., Goyette, K. A., & Soares, J. A. (2003). Who goes to graduate school? Social and academic correlates of educational continuation after college. *Sociology of Education, 76*(2), 143-169.

National Academies of Sciences, National Academy of Engineering, & Institute of Medicine. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future.* Washington, D.C.: The National Academies Press.

National Science Foundation. (2009). Women, minorities, and persons with disabilities in science and engineering. Arlington, VA: National Science Foundation.

Pascarella, E. T. & Terenzini, P. T. (2005). *How college affects students: A third decade of research (Vol. 2).* San Francisco: Jossey-Bass.

Paulsen, M. B. (2001). The economics of human capital and investment in higher education. In M. B. Paulsen & J. C. Smart (Eds.). *The finance of higher education: Theory, research policy, and practice*. New York: Agathon.

Perna, L. W. (2004). Understanding the decision to enroll in graduate school: Sex and racial/ethnic group differences. *The Journal of Higher Education, 75*(5), 487-527.

Petersen, T. (1985). A comment on presenting results from logit and probit models. American Sociological Review, *50*(1), 130-131.

Price, DV. (2004). Educational debt burden among student borrowers: An analysis of the Baccalaureate & Beyond Panel, 1997 follow-up. *Research in Higher Education, 45*(7). 701-737

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods. 2nd Edition.* Thousand Oaks, CA: SAGE.

Russell, S. H. Hancock, M. P., & McCullough, J. (2007). Benefits of undergraduate research experiences. *Science, 316*, 548-549.

Sax, L. J. (2001). Undergraduate science majors: Gender differences in who goes to graduate school. *The Review of Higher Education, 24*(2), 153-172.

Sax, L. J., Hurtado, S., Lindholm, J. A., Astin, A. W., Korn, W. S., Mahoney, K. M. (2004). *The American freshman: National norms for fall 2004.* Los Angeles: Higher Educaiton Research Institute.

Solorzano, D. G. (1995). The doctorate production and baccalaureate origins of African Americans in the sciences and engineering. *Journal of Negro Education, 64*(1), 15–32.

St. John, E. P., Paulsen, M. B., & Carter, D. F. (2005). Diversity, college costs, and postsecondary opportunity: An examination of the financial nexus between college choice and persistence for African Americans and Whites. *The Journal of Higher Education, 76*(5), 545-569.

Titus, M. A. (2006). Understanding the influence of the financial context of institutions on student persistence at four-year colleges and universities. *The Journal of Higher Education, 77(2),* 353-375.

Wagener, U., & Nettles, M. T. (1998). It takes a community to educate students. *Change: The Magazine of Higher Learning, 30*(2), 18-25.

Weiler, W. C. (1994). Expectations, undergraduate debt and the decision to attend graduate school: A simultaneous model of student choice. *Economics of Education Review, 13*(1), 29-41.

Zhang, L. (2005). Advance to graduate education: The effect of college quality and undergraduate majors. *The Review of Higher Education, 28*(3), 313-338.

Table 1
Table of Measures

Variables	Coding
Student Characteristics	
Intended to enroll in graduate or professional school by the fall of 2008	Dichotomous: 1=yes, 0=no
Sex: Female	Dichotomous: 1=yes, 0=no
Race: Native American	Dichotomous: 1=yes, 0=no
Race: Latino	Dichotomous: 1=yes, 0=no
(Black reference group)	
Socioeconomic status	Continuous: Three-item scale composed of parental income, mother's education, father's education
High school GPA	Ordinal: 1=D through 8=A or A+
Came to college to be able to make more money	Ordinal: 1=Not important through 3=Very important
Came to college to get training for a specific career	Ordinal: 1=Not important through 3=Very important
Concerns about financing college education	Ordinal: 1=None through 3=Major
Chose this college because graduates gain admission to top graduate/professional schools	Ordinal: 1=Not important through 3=Very important
SAT math score	Continuous
Time spent working with faculty on research	Ordinal: 1=Not at all through 3=Frequently
Joined a club or organization related to major	Dichotomous: 1=yes, 0=no
Hours per week spent studying	Ordinal: 1=None through 8=20 or more
College GPA	Ordinal: 1=D through 8=A or A+
Science identity	Continuous
Sense of faculty support	Continuous
Total amount of loans accumulated during college (log transformed)	Continuous
Amount of personal funds used to pay for education during last year of college	Ordinal: 1=None through 6=$10,000 or more
Amount of grants and scholarships used to pay for education during last year of college	Ordinal: 1=None through 6=$10,000 or more

Major: Life sciences	Dichotomous: 1=yes, 0=no
Major: Physical sciences	Dichotomous: 1=yes, 0=no
Major: Health sciences	Dichotomous: 1=yes, 0=no
Institutional Characteristics	
HBCU	Dichotomous: 1=yes, 0=no
Average SES of students	Continuous
Control: Private	Dichotomous: 1=yes, 0=no
Selectivity (average SAT scores)	Continuous
Carnegie classification: Doctoral/Research	Dichotomous: 1=yes, 0=no

Table 2
Descriptive Statistics (N=1,027 students, 176 institutions)

	Mean	S.D.	Min.	Max.
Student Characteristics				
Intended to enroll in graduate or professional school by the fall of 2008	0.27	0.44	0.00	1.00
Sex: Female	0.61	0.49	0.00	1.00
Race: Native American	0.14	0.33	0.00	1.00
Race: Latino	0.48	0.50	0.00	1.00
Socioeconomic status	0.00	1.00	-2.26	1.71
High school GPA	6.88	1.25	2.00	8.00
Came to college to be able to make more money	2.64	0.60	1.00	3.00
Came to college to get training for a specific career	2.73	0.53	1.00	3.00
Concerns about financing college education	1.95	0.63	1.00	3.00
Chose this college because graduates gain admission to top graduate/professional schools	2.29	0.75	1.00	3.00
SAT math score	598.13	91.05	210.00	800.00
Time spent working with faculty on research	1.57	0.72	1.00	3.00
Joined a club or organization related to major	0.65	0.48	0.00	1.00
Hours per week spent studying	5.64	1.51	1.00	8.00
College GPA	5.41	1.69	1.00	8.00
Science identity	0.00	1.00	-2.35	1.86
Sense of faculty support	0.00	1.00	-1.99	1.62
Total amount of loans accumulated during college (log transformed)	6.91	4.45	0.00	12.66
Amount of personal funds used to pay for education during last year of college	2.63	1.32	1.00	6.00
Amount of grants and scholarships used to pay for education during last year of college	4.23	1.88	1.00	6.00
Major: Life sciences	0.27	0.34	0.00	1.00
Major: Physical sciences	0.09	0.33	0.00	1.00
Major: Health sciences	0.31	0.34	0.00	1.00
Institutional Characteristics				
HBCU	0.10	0.30	0.00	1.00
Average SES of students	0.00	0.68	-2.08	1.59
Control: Private	0.56	0.50	0.00	1.00
Selectivity (average SAT scores)	1119.85	173.45	490.00	1518.33
Carnegie classification: Doctoral/Research	0.49	0.50	0.00	1.00

Source: Analysis of 2004 Freshman Survey and 2008 College Senior Survey Data.

Table 3
HGLM Results Predicting the Probability of Intending to Enroll in Graduate or Professional School by the Fall of 2008 (N=1,027 students, 176 institutions)

	Log Odds	S.E.	Sig.	Delta-P
Student Characteristics				
Sex: Female	-0.30	0.17		
Race: Native American	-0.29	0.27		
Race: Latino	-0.20	0.19		
Socioeconomic status	0.19	0.09	*	3.90%
High school GPA	0.13	0.08		
Came to college to be able to make more money	-0.34	0.15	*	-6.16%
Came to college to get training for a specific career	0.40	0.20	*	8.56%
Concerns about financing college education	0.29	0.18		
Chose this college because graduates gain admission to top graduate/professional schools	0.16	0.13		
SAT math score	0.26	0.15		
Time spent working with faculty on research	0.35	0.11	***	7.42%
Joined a club or organization related to major	0.22	0.18		
Hours per week spent studying	-0.05	0.05		
College GPA	0.39	0.06	***	8.33%
Science identity	0.31	0.10	**	6.52%
Sense of faculty support	0.08	0.11		
Total amount of loans accumulated during college (log transformed)	-0.04	0.02	*	-0.78%
Amount of personal funds used to pay for education during last year of college	-0.19	0.07	**	-3.58%
Amount of grants and scholarships used to pay for education during last year of college	0.06	0.05		
Major: Life sciences	0.16	0.19		
Major: Physical sciences	0.60	0.27	*	13.26%
Major: Health sciences	-0.75	0.31	*	-12.13%
Institutional Characteristics				
HBCU	1.01	0.49	*	23.38%
Average SES of students	-0.04	0.22		
Control: Private	0.47	0.22	*	10.18%
Selectivity (average SAT scores)	0.17	0.09		
Carnegie classification: Doctoral/Research	0.33	0.25		
Model Statistics				
Variance at level-2	0.27			
Proportion of explained variance at level-2	0.62			
Chi-square statistic	205.02			

Source: HGLM analysis of 2004 Freshman Survey and 2008 College Senior Survey data.