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College Graduation Rates for Minority Students in a Selective Technical University: Will Participation in a Summer Bridge Program Contribute to Success?

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Abstract

There are many approaches to solving the problem of underrepresentation of some racial and ethnic groups and women in scientific and technical disciplines. Here, the authors evaluate the association of a summer bridge program with the graduation rate of underrepresented minority (URM) students at a selective technical university. They demonstrate that this 5-week program prior to the fall of the 1st year contains elements reported as vital for successful student retention. Using multivariable survival analysis, they show that for URM students entering as fall-semester freshmen, relative to their nonparticipating peers, participation in this accelerated summer bridge program is associated with higher likelihood of graduation. The longitudinal panel data include more than 2,200 URM students.

Keywords

persistence; retention; underrepresented minority; survival analysis; STEM; bridge program

Scientific and technical careers are among the most demanding of professional paths, but the discipline required for success pays off in a consistently robust job market and high wages. Despite the attractiveness of these careers, there is abundant evidence that minorities in the United States are underrepresented in scientific and technical professions and in the educational trajectories that open up such opportunities. In its 2005 national report, the National Action Council for Minorities in Engineering (NACME) reported that underrepresented minority (URM) persons made up 27% of the overall U.S. population (NACME, 2005). NACME follows National Science Foundation convention in defining URM asAfricanAmerican, Hispanic, NativeAmerican, or of mixed ethnicity (Johnson & Sheppard, 2004). Whereas parity-based representation would suggest that approximately 27% of engineering students be URM, in 2005 only 15.3% of 1st-year students enrolled in engineering programs were members of URM groups. Furthermore, compared with 63% of all students persisting to graduation, only 39% of URM students graduated (NACME, 2005).

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Although the causes of underrepresentation are complex, and there are many points along the educational trajectory at which to intervene, a particularly important leverage point is the transition from high school to college (Reichert & Absher, 1997). Although we are familiar with recent criticism of the pipeline model for increasing diversity in engineering (Watson & Froyd, 2007), we nevertheless follow pipeline reasoning in our theoretical development. To focus on the transition from high school to college, we select students who have been admitted already to a competitive institution of higher education. Research indicates, however, that this transition may be riskier for URM students than others (Bowen & Bok, 1998; Campbell, Denes, & Morrison, 2000; Pearson & Fechter, 1994). As a result, a number of higher educational institutions have experimented with and implemented programs that are specially designed to assist with the transition from high school to college (Anderson-Rowland, Reyes, & McCartney, 1998; Butler & Hicks, 2006; Friedman, 1990; Reyes, Anderson-Rowland, & McCartney, 1998; Weatherby, Shumpert, & Fergus, 1998).

Literature on Student Persistence to Graduation

Although the more philosophical among us may argue for education for education's sake, most observers of higher education would agree that graduation is the key measure of student success. It therefore follows that student retention is the key leverage point for solving the URM conundrum (Tinto, 1975). Student success, however, is not simply a matter of an individual will to succeed. Current approaches to evaluating student retention emphasize the interaction of individual and institutional traits. For example, Tinto's work emphasizes that retention is improved by the integration of students into the institution, a fundamentally interactionist insight (Tinto, 1975). This implies that intra-university factors that improve integration into the institution, such as specially targeted programs, may create varying institutional traits associated with success. In the subsection that immediately follows, we briefly discuss the individual-level factors that are known to affect student persistence to graduation; these constitute important controls in our evaluation of program association. In the second subsection, we report on institutional-level program factors known to improve student graduation rates.

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Individual-level factors known to affect student graduation from college

Although our primary interest is the evaluation of an institutional-level program, student persistence develops one student at a time. Therefore, to evaluate the summer bridge program in robust fashion, it is crucially important to account for influential individual-level factors. These factors include demographic characteristics such as race, gender, residency, and socioeconomic status. Because preparation before college also predicts college persistence, we also adjust for high school grades, advanced placement (AP) credit, and SAT scores. We also briefly review the effect of college athletics on college persistence to graduation.

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Race, gender, residency, and socioeconomic status are all ascribed characteristics; that is to say, these are characteristics about which children and adolescents can do nothing. As people reach adulthood, characteristics such as residency and socioeconomic status become acquired as individuals enact their own preferences. In the college-bound age group, however, most students have as little control over their economic circumstances as they do over their race or gender. In the case of gender, the evidence about persistence to graduation is mixed. Some have found that women are less likely to persist in engineering programs (Takahira, Goodings, & Byrnes, 1998; Zhang, Anderson, Ohland, & Thorndyke, 2004), whereas other research has found that women are more likely to graduate (Chimka, Reed-Rhoads, & Barker, 2008).

With respect to race, differences in persistence to graduation from college are well understood: URMs—and especially African Americans—are less likely to graduate than members of other groups (French, Immekus, & Oakes, 2005; May & Chubin, 2003; Reichert & Absher, 1997). It is important to note, however, that African American women are much more likely to graduate from college than African American men ("Black Student College Graduation Rates," 2007). Recent research indicates that relative to African American men, African American women tend to get more involved in their college institutions and thereby enjoy the same benefits associated with involvement documented for students from other groups (Eagan, 2006).

In addition to considering race in a study of minority students at a large, public university, it is also important to account for the possible effect of being an athlete. This is because prior research indicates that athletes—especially those in high-profile sports such as football and basketball—tend to perform more poorly than do their peers who are not athletes (Adler & Adler, 1985; Purdy, Eitzen, & Hufnagel, 1982). Race also is related to athletic participation: athletes at NCAA Division I Schools are disproportionately African American. Because of the strong association between the two variables (i.e., race and athlete), controlling for only one of them could result in spurious associations.

Students who are from in-state in state-supported schools are less likely to graduate, pre sumably reflecting greater heterogeneity among in-state students (Chimka et al., 2008). Finally, students who come from more affluent, resource-rich environments are more likely to persist to graduation from college (Choy, 2002; Huang, Taddese, & Walter, 2000). Because these factors widely are believed to affect college graduation, they are necessary controls for a thorough evaluation of any institutional-level factor.

Despite the importance of demographic characteristics, it is even more important to consider the effect of high school preparation on college persistence and graduation. Students matriculating to college are a selected group, and those who go on to succeed through graduation are further selected by a process with antecedents in high school. Research has shown the importance of high school performance on college grade point average (GPA; French et al., 2005; Lam, Doverspike, & Mawasha, 1999; Ohland & Zhang, 2002; Takahira et al., 1998) and on student graduation (Zhang et al., 2004). Standardized test scores also help to explain student persistence (Lam et al., 1999; Takahira et al., 1998). Finally, the opportunity to pursue AP courses, and experiencing success in them, has positive effects on college graduation (Dougherty, Mellor, & Jian, 2006). Because demographic and academic variables potentially can interact, it is important to account for both. For example, the socioeconomic and racial status of a child's family has a great effect on a variety of educational indicators, including performance on standardized tests and access to AP courses (Dougherty et al., 2006).

Programs designed to raise graduation rate of underrepresented minority students

When students are admitted to selective colleges and universities, they already meet the qualifications for entry and thereby have shown academic potential for success. It is therefore important to understand whether specific events taking place during time at university play a role in improving the graduation rate of URM students. For example, a wealth of literature documents that to become integrated into science, technology, engineering, and math (STEM) disciplines, women and underrepresented minorities must overcome higher barriers than their majority counterparts. Two key barriers are the university and the professoriate; for example, the counterproductive attitudes of educators themselves have been identified as a major barrier to the full inclusion of minority students in STEM education (Reichert & Absher, 1997). At the same time, the proactive and sincere commitment by universities and their professional staff can be one of the most important facilitators of minority integration and persistence to graduation (May & Chubin, 2003; Reichert & Absher, 1997).

Two important reviews highlight the crucial role that universities can play in reducing barriers to URM students. The first is Reichert and Absher’s 1997 review of retention of African American engineers that uses NACME data to identify and study top university performers in the retention and graduation of African American engineering students (Reichert & Absher, 1997). High performance in the areas of retention and graduation helped Reichert and Absher to identify and study 13 Minority Engineering Programs (MEPs) for best practices. The results indicated that the most important factor of success is a sincere and ongoing commitment on the part of the university to counteract barriers to minority student success. Given this essential feature, programs take a variety of forms, with common elements including academic support, minority engineering societies, scholarships, bridge programs, clustering, and outreach.

In a more recent article on retention of URM students in engineering, May and Chubin (2003) review the literature since 1980. Like Reichert and Absher, they define success as boosting retention and graduation rates of URM students. They conclude that programmatic efforts can improve the preparation, commitment, and engagement of minority students, which in turn enhances retention and graduation. Examples of successful programmatic efforts at the university level include the MEP model. Specifically, they report that summer bridge programs and study centers enhance student preparation, support, and motivation to persist to graduation.

In summary, institutional commitment to retention of minority students is a minimal condition for minority retention programs to succeed (Clewell&Ficklen, 1986;Landis, 1991;Richardson, Simmons, & de los Santos, 1987; Tinto, 1975). Institutions that have been successful in minority retention have nurtured a climate of cultural awareness, diversity, and inclusiveness. They have been characterized by formal tutoring programs, bridge programs, scholarships, and other academic support; in other words, their “sincere commitment” is backed up with real resources (Reichert & Absher, 1997). Successful retention programs for minority students usually emphasize counseling, social support, and community membership (Trippi & Cheatham, 1991). Minority students are more prone to use the services of counselors and advisors of similar racial background (Sanchez & King, 1986). Counseling from members of the same racial group helps assuage the difficulty and isolation faced by minorities attending non-historically Black colleges and universities (HBCUs) as they incorporate themselves into what is essentially a foreign community (Attinasi, 1989; Fleming, 1984). Individuals who are integrated solidly into academic and social networks at their colleges are more likely to persist (Astin, 1985; Pascarella & Terenzini, 1991).

In this research, we evaluate the association between graduation rate of URM students and participation in a summer bridge program designed especially for these students. Our research question asks whether participation in the summer bridge program is associated with higher likelihood of graduation, net of other factors known to be correlated with student persistence to graduation.

Method

Describing a Specific Summer Bridge Program at a Selective Technical University

Georgia Tech is one of the nation’s premier engineering universities, nationally ranked as the fifth best overall engineering program (U.S. News and World Report, August 27, 2007, Volume 143, Issue 6, page 124). Although Georgia Tech is a predominantly White university, it is also a national leader in the cultivation of engineering diversity (Reichert &

Absher, 1997). In 1961, Georgia Tech became the first university in the South to integrate voluntarily; in 1969, it started its first dual-degree programs with the HBCUs of the Atlanta University Center, the most well known being Morehouse and Spelman.

At Georgia Tech, the Office of Minority Educational Development (OMED) was established in 1979 to address the Institute's problem in retaining URM students. OMED is housed in a historic building in the middle of campus, situated between the senior administration building and the main library. The building includes computer labs, small classrooms, meeting space, and offices that are available to students at any time during the day and well into the evening. Ongoing activities sponsored by OMED are numerous, but key features include peer mentoring and regular, free tutoring and study sessions organized to address core elements of the engineering program.

In addition to providing ongoing academic support services of recognized effect (May & Chubin, 2003; Trippi & Cheatham, 1991), OMED has conducted an accelerated bridge academic session, the Challenge Program, since 1981. The first version of the Challenge Program was remedial in nature, focusing on minority students in academic trouble. In the early 1990s, however, the Challenge Program changed its mission from remediation to support and integration, a key feature of other successful MEPs (Anderson-Rowland et al., 1998; Reyes et al., 1998). In turn, OMED started inviting all URM students to participate and modified the curriculum of the Challenge Program to prepare students in core coursework. Although all students are eligible to attend this program, OMED actively promotes attendance by incoming minority students. The program begins in the last week of June and extends through the end of July.

The academic component of the Challenge Program—The Challenge coursework includes short courses in calculus, chemistry, computer science, and English composition. Although these courses do not count for credit, they closely reflect the content and pacing of freshmen coursework at selective technical universities. To encourage the development of time management skills and discipline while respecting newfound student freedoms (e.g., there is no curfew), the academic component of the Challenge Program is highly structured. If a student is late for class or engages in disrespectful behavior, he or she is warned. A second instance results in the student's family being contacted and a final warning. A third "strike" results in expulsion from the program.

Challenge coaches are typically upperclassmen who are acknowledged campus leaders and solid academic performers with in-depth knowledge of the university environment. Complementing their advisory role through the 5 weeks of Challenge, these coaches strive to keep the Challenge-induced momentum moving throughout the 1st academic year by making themselves available to their team members on an as-needed basis. This program element exemplifies findings that peer educators and ongoing support are crucial components of student persistence (Astin, 1985; Pascarella & Terenzini, 1991; Sanchez & King, 1986; Trippi & Cheatham, 1991). Students pay a nominal fee for the program to ensure an appreciation of its value. To provide a more realistic experience of the academic demands placed on freshmen, the grading of the Challenge course work intentionally is not based on curves. Any student completing the trial semester with a perfect 4.0 average receives a complete refund of this tuition; students who earn a 3.0 GPA or higher receive a partial rebate. When asked how many students plan to achieve this goal, a great many hands are raised. However, the data from the past 15 years of Challenge show that only between 2% and 3% of the participants received the full rebate. For example, in the 2005 Challenge Program, only 2 of 70 students achieved a perfect 4.0 GPA, whereas 15 earned a 3.0 or better. Many students, however, earn GPAs below 2.0; at Georgia Tech, this would automatically result in a student being placed on academic probation. It is a sobering wake-up call.

The social component of the Challenge Program—The explicit objective of the Challenge Pro gram is to help minority students navigate the complexities of academic life at a top tier engineering school. An important feature of the pro gram is the inclusion and integration of family members into the students' academic support network. Concerns are typical of parents sending their children off to college: discussion topics include housing arrangements, food plans, and co-ed visitation. Because the majority of minority students participating in Challenge are the first generation of their families to attend college, this process of initiating parents and students to the common pitfalls of the college environment is especially important. In the last week of the program, there is an awards luncheon for students completing Challenge, where the attendance of supportive family members is encouraged.

Data: Underrepresented Minority Students in our Cohort

One of the difficulties of conducting retention and graduation studies is the longitudinal nature of the process and the demands of data collection required to sustain such analyses. Georgia Tech maintains a longitudinal database on the academic performance and programmatic participation of all students. To enhance the intended analysis, the data we use here were limited to all URM students who first matriculated in the fall semesters between 1990 and 2000. URM is defined as those who classify themselves as African American, Hispanic, Native American, or of mixed ethnicity.

The database design was motivated by the following considerations. The period starting in 1990 marks the beginning of a new phase of the Challenge Program: an integration and support model rather than a remediation model. Because only first-time fall matriculates are eligible to participate in the Challenge Program, specifically designed to provide a jump-start to one's college career, we restrict our cohort in like manner. By maintaining data through September 2005, we have a minimum follow-up time of 5 full calendar years for each participant to graduate. Because most engineering students at Georgia Tech participate in the cooperative education program, 5 years is the most common length of time in which students graduate.

The time to graduation in this panel ranges from 3 years to 16 years, representing more than 2,200 URM students who matriculated over this period. The institutional data record is initiated when a student first applies to the university. Demographic variables (gender, race, and state residency) are collected at that time, as are high school GPA and SAT scores. The award of AP credit is established upon matriculation, whereas athlete status is determined upon registration for classes.

Income reporting widely is recognized to be sensitive, resulting in high levels of missing data. Our data are no exception: Family income is missing from 35% of our study population. This third of the sample is not missing at random: It represents those families who did not apply for financial aid (i.e., the families in the upper third of the income distribution of incoming students). We therefore use the student's zip code at the time of application to code the median household income for that neighborhood (see www.census.gov). This geographic measure represents the socioeconomic status of the student's home neighborhood, which in turn reflects local school quality and rates of retention.[1] Although it would be ideal to have a measure of parental education, those data are not collected in the institutional data series.

Description of underrepresented minority students at Georgia Tech—Students choose to participate in the Cha llenge Program; therefore, it is essential to examine the differences between students who participate and those who do not. Table 1 compares characteristics of URM students who participated in the Challenge Program (first column) with URM students who did not (second column). The test statistic for these bivariate tests of difference between the subgroups is a chi-square, Wilcoxon, or *t* test, depending on the nature of the comparison. The chi-square, Wilcoxon, and *t* test correspond to comparisons of proportions, continuous non-normal random variables, and continuous normal random variables, respectively. The two groups are similar in some characteristics theorized to have an effect on college persistence: Approximately one out of seven students is an athlete in each group; the average high school GPA is in the high “B” range for both groups; and the average combined SAT score is nearly 1200 for both groups of students.

There are also significant differences in several of the covariates hypothesized to affect college retention. Students participating in the Challenge Program are half as likely to receive AP credit. Only one of nine Challenge participants, compared with one of five nonparticipants, enters college with this highly informative measure of preparation. Furthermore, as measured by median household income of their parents’ residential zip codes, nonparticipants come from wealthier neighborhoods.

Each of these variables can serve as a proxy indicator for the quality of the students’ high school, as the local financing of schools can create large differences in opportunity structures for otherwise equally able students. Women, African Americans, and state residents are more likely to participate in the Challenge Program. Following Winship and Radbill (1994), we statistically control for each of these differential bases of selection.

Gender and ethnicity among Challenge participants from 1990 to 2000—In the previous subsection, we compared the Challenge participants with their URM peers in the overall student population during the study period. In Table 2, we break down the Challenge participants into subgroups by gender and ethnicity. Not ice that among ethnic groups, African Americans strongly dominate attendance (80.1%), followed by Hispanics (17.4%) and mixed ethnicity (2.5%), and that no Native Americans have participated in Challenge during the study period. By gender, males (62%) clearly outnumber females (38%), with approximately four times as many Hispanic and mixed ethnicity males compared with their female peers. Although the Hispanic population has been growing faster than any other segment of the population, both 76 nationally and regionally, recent demographic shifts are not manifest in our data (1990–2000). Because the Challenge Program historically has seen higher rates of participation by African Americans, we focus on this community in our discussion of results.

Survival Analysis as the Appropriate Statistical Approach

Our primary interest is to evaluate the specific association between participation in the Challenge Program and rate of graduation among eligible URM students. Our central research question can be stated as follows:

> Among underrepresented minority students entering Georgia Tech as incoming freshmen, is participation in the Challenge Program associated with higher likelihood of graduation relative to those not participating?

[1]We ran sensitivity analyses of our final model using family income instead of zip code income as the control. The results were substantively and statistically equivalent. We report the results from the zip code income because this allows us to retain the nonrandom third of the cohort that was missing family income.

We have chosen survival analysis over logistic regression and discriminant analysis for several reasons. First, survival analysis is designed to accommodate censoring. Censoring occurs when participants in a study never experience the event of interest. Graduation from college is the event of interest, and students remain "at risk" (i.e., in the data) until they actually graduate. In our study, some students are censored because they do not graduate within the time frame of the study. Survival analysis discerns between the information available from a person before he or she achieves the event of interest (graduation) and information from the same person at the time of experiencing the event. Survival analysis is a semi-parametric approach and is thereby more robust (i.e., less sensitive) to violations of parametric assumptions concerning the distribution of the outcome. Finally, because the method analyzes a continuous measure (i.e., time to event), survival analysis uses more information than either logistic regression or discriminant analysis; these techniques are best employed in the analysis of dichotomous occurrence of an event. Because dichotomous outcomes provide less information than continuous ones, survival analysis can thereby calculate more precise estimates of association (Cox, 1972).

The Proportional Hazards Cox Model

We use survival analysis to estimate the association of covariates with the likelihood of graduation in each year of observation. Technically, survival analysis relies on the Cox proportional hazards model to calculate the instantaneous change in the value of the hazard function using maximum partial likelihood estimation (Cox, 1972). The value of the hazard function is the risk of graduating given that graduation has not occurred yet. In this study, experiencing the hazard is good, as this indicates that the student has graduated within the study period. Once a student experiences the hazard (i.e., graduates), he or she leaves the risk set and subsequent stages of the estimation procedure consider only those students still eligible for graduation.

The hazard function for an individual i at time t, that is, $h_i(t)$, is the product of two factors: an unspecified baseline hazard function, $\lambda_0(t)$, and a linear function of a group of fixed covariates that is exponentiated, as presented in Equation 1 immediately below:

$$h_i(t)=\lambda_0(t)\exp(\beta_{11}X_1+\boldsymbol{\beta_2 X_2}+\boldsymbol{\beta_3 X_3}), \quad (1)$$

where the bold font of the latter exponentiated terms indicates that they represent vectors of covariates. It is common to write out this same model in the form given by taking the logarithm of both sides, as presented in Equation 2 immediately below:

$$\text{Log}\, h_i(t)=a(t)+\beta_{11}X_1+\boldsymbol{\beta_2 X_2}+\boldsymbol{\beta_3 X_3} \quad (2)$$

where $a(t)$ = logarithm of baseline hazard function,

X_1 = participation in Challenge Program,

X_2 = vector of demographic control covariates, and

X_3 = vector of academic control covariates.

Controlling for vectors of demographic and academic covariates known to be associated with college graduation rates increases the plausibility of our inference. We control for high school characteristics such as AP credit, standardized test performance (total SAT scores), and high school GPA, which are all positive predictors of college graduation.

We also control for ascribed characteristics: Higher socioeconomic status is associated with higher likelihood of graduation, and being African American with lower likelihood. We also control for gender, whether or not a student comes from Georgia (an important stratifying factor in this public university), and whether a student is an athlete.

Please note that we did not apply an automatic model selection approach. Because we felt that adjustment for certain adjustment variables was mandatory for a plausible evaluation, we chose these variables a priori and kept them in the model regardless of statistical significance. An automatic selection approach chooses the variables according to a statistical strategy of maximizing model fit without providing a conceptual rationale for its choice of adjustment. Because graduation time is measured in integer values corresponding to years, the exact method was used to handle tied values of time to graduation. Model fit was checked by confirming the validity of the proportional hazards assumption for the main predictor (i.e., participation in the Challenge Program) and by an examination of the model's deviance residuals. All statistical tests were two-tailed, and p values $\leq .05$ indicated statistical significance. All analyses were performed using SAS statistical software (SAS Institute, 2009).

How to Interpret Hazard Ratios

The coefficients of the Cox proportional model are reported as hazard ratios that represent the ratio of the estimated hazard for individuals with a value of 1 for a particular covariate over that of individuals with a value of 0 for the same covariate. For example, the covariate representing participation in Challenge takes on the value of 1 for participants and 0 for nonparticipants. Because our primary question is whether participation in the Challenge Program is associated with higher likelihood of graduation, we hypothesize a hazard ratio greater than 1, corresponding with an association with a higher likelihood of graduating. In contrast, a hazard ratio between 0 and 1 signifies that the characteristic is associated with a lower likelihood of graduating.

Note that for the adjustment variables in the model (i.e., the demographic and academic measures), whenever possible we use the continuous scale of these variables. By drawing on the finer resolution information available from their continuous scales, these variables provide more powerful adjustment of the main effect. The hazard ratios for all non-Challenge variables represent the multiplicative increase or decrease in yearly risk corresponding to each incremental increase in the value of the predictor. Note that although the hazard ratios for the adjustment variables may be large or small depending on the scale of the variable, their major purpose is to control for competing associations between participation in Challenge and likelihood of graduation.

Results

The main result shown in Table 3 indicates that after controlling for important demographic and academic characteristics, participation by URM students in the Challenge Program is associated with a higher likelihood of graduation than that of nonparticipants. All demographic characteristics have statistically significant associations. Women have a higher likelihood of graduation, as do students coming from residential zip codes of higher median income. By contrast, African American students and Georgia residents are less likely to graduate than are their peers from other states or countries.

Most of the socioeconomic variables also are associated positively with likelihood of graduation. Higher GPAs in high school and receipt of AP credit prior to entering Georgia Tech are associated positively with likelihood of graduation. These two academic effects are direct and additive: Students benefit from both higher GPA and AP credit. SAT scores, however, are not associated, likely due to the fact that students admitted to Georgia Tech have average scores around 1200, suggesting that among this cohort, differences in SAT scores are not informative with regard to likelihood of graduation. Finally, although its positive tendency is not in agreement with some studies, being an athlete shows no significant association with graduation in this cohort (Adler & Adler, 1985).

Discussion

Interpretation of Results

This quantitative analysis of the Challenge Program suggests a plausible relation with higher likelihood of graduation. Although the lack of a randomized design precludes any causal claim, this analysis of a large, well-monitored sample does indicate that participation in Challenge may be helping URM students to navigate successfully the Georgia Tech system. We believe that elements of the Challenge Program provide a reasonable explanation for this.

First, Challenge is a bridge program that assists students in preparing for the transition from high school to a competitive college. It helps to develop a student's realistic academic expectations for success through actual classes, examinations, and study experiences that replicate what the first semester will be like. Because so many participants perform less well than expected, the Challenge Program gives them the opportunity to understand fully the qualitatively different nature of the experience at a selective university. In addition to its contribution to developing realistic expectations about the level of difficulty likely to be encountered, the Challenge Program provides academic tools that will assist students during their transition: Students learn time management and study skills and about the myriad resources available to assist them during their academic career.

Just as important as the academic goals of the Challenge Program is the comprehensive nature of its design. It explicitly recognizes that individual academic challenges are not the only ones likely to create barriers in the transition to college. By keeping parents apprised of potential problems as they unfold, the Challenge Program seeks to transform parents into full academic partners from the kickoff weekend through the celebratory conclusion. We believe that this is a particularly important feature for many of our students, the majority of whom are the first members of their families to attend college.

In addition to fostering parental partners, the Challenge Program facilitates the development of academically oriented social networks that will help students succeed at Georgia Tech. Not only do these students get to know one another, they also are mentored by a more advanced peer, who remains available to them after the Challenge summer program ends. OMED and its Challenge Program provide an alternative networking framework where URM students can cultivate such academically oriented social resources. These programmatic elements implement the seminal findings of Tinto (1975), wherein the Challenge Program serves as a means of integrating URM students into the university in a way that may enhance their odds of graduating.

Finally, the Challenge Program explicitly recognizes the purely social challenges to academic success that face students in their transition to college. The Challenge Program creates opportunities for participants to gain greater awareness and understanding of issues such as drug use and respectful interaction with the opposite sex and helps participants think through how they will deal with these situations in the college setting.

Our analysis shows that some individual-level factors persist in importance, as predicted by an extensive literature: High school preparation and socioeconomic status are powerful predictors of graduation (Choy, 2002; French et al., 2005; Huang et al., 2000; Lam et al., 1999; Ohland & Zhang, 2002; Takahira et al., 1998). We added student athlete and in-state residency to our covariates because we know that they are important in this context. Despite findings in the literature that student athletes are at academic risk, the URM student athletes in this Georgia Tech data set did not exhibit the same negative association with graduation (Adler & Adler, 1985; Purdy et al., 1982). We believe that this is due to the strong academic support provided to student athletes at Georgia Tech through the athletic department. The finding related to Georgia residency makes sense: Students coming from other states and countries experience stronger selection effects than those attending from in-state (Chimka et al., 2008). Coming from geographically distant sites, they are likely to be more motivated and to have better academic preparation than students who are residents of Georgia.

Strengths of This Study

This study possesses several desirable characteristics that support the positive association identified between participation in the Challenge Program and higher likelihood of graduation. First, it is based on a diligently maintained database of considerable size at an institution with a successful track record for graduating URM students. Second, it employs survival analysis with appropriate adjustment for the most important demographic and socioeconomic variables that were available. Last, it includes elements described in the literature as necessary for successful retention of university students from minority backgrounds (Astin, 1985; Fleming, 1984; Pascarella & Terenzini, 1991; Sanchez & King, 1986; Trippi & Cheatham, 1991).

Limitations of This Study

The study also possesses several limitations that merit comment. First, the analysis is based on an observational study, meaning that one can never completely rule out bias that may come from unobserved variables that have not been measured. An observational study does not enjoy the theoretical properties of a randomized, controlled trial, where random assignment of participants to treatment (Challenge participant) and control arms (nonparticipant) allows for a theoretical balancing of all unmeasured variables. We can therefore make no claim of causality and are restricted to viewing our result as a significant association that may be due to other factors beyond our control.

Second, due to limited access to the family income of 35% of the cohort, we used a zip code–level measure of median family income. Rather than represent the students' specific financial resources, this measure provides information on the median salary of their parents' residential areas. This is clearly not ideal, as for nearly all cases, median income is either higher or lower than the economic circumstances of any particular family. However, the risk of bias from deleting 35% of the participants who were missing family-specific income data was deemed greater than potential bias induced from using this aggregate measure of income, which was available for nearly all participants. We note that a supplementary analysis on the subset of participants for whom family income was available did not reduce noticeably the significance or magnitude of the positive association between participation in Challenge and likelihood of graduation reported in Table 3.

Last, the reported association between participation in the Challenge Program and likelihood of graduation is a somewhat coarse measure in that it does not identify specifically which of the many characteristics of the program might be responsible for its potential efficacy. A randomized, factorial design would be a better choice to identify specifically whether the academic or social components of the Challenge Program contribute most to the reported association. Although such a study is beyond the scope of this article, the results of this analysis may prove to be very informative in designing one.

Concluding Remarks

In addition to finding a positive association between participation in the summer bridge program and likelihood of graduation for URM students, our analysis also reveals dynamics related to covariates whose mechanisms continue to be poorly understood. Specifically, the findings of improved female graduation and decreased African American retention are cause for concern and continued research. Women's stronger academic performance and concurrently lower representation in the science and engineering labor force continue to be the subject of intense policy scrutiny. In the past 2 years, the National Academy of Sciences (NAS) has completed three major studies that may inform this dynamic; a fourth NAS study on the topic is expected this year (NAS, 2006, 2007; National Research Council, 2006).

The finding of lower African American graduation rates is consistent with prior literature but is nevertheless disappointing (French et al., 2005; May & Chubin, 2003; Reichert & Absher, 1997). Some scholars suggest that cultural pressures in the African American community are especially negative, particularly for African American men. It is difficult to know how institutions can develop programs to counteract stereotypes that include a perceived lack of negative social consequences for failure. Some political commentators have suggested recently that Barack Obama's election to the presidency signifies attainment of a "post-race" society. We suspect that if American society were in fact postrace, rates of graduation by well-qualified African American students at select technical universities would not differ from those of their peers.

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TABLE 1

Comparing Important Covariates by Participation in the Challenge Program

Covariates by class	Proportion/mean/median (standard deviation) of underrepresented minority students participating in Challenge Program	Proportion/mean/median (standard deviation) of underrepresented minority students not participating in Challenge Program	Statistic used to compare for equality	*p* value of comparison for equality
Demographic characteristics				
Female	0.38 (0.49)	0.31 (0.46)	chi-square	**0.0013**
African American	0.80 (0.40)	0.56 (0.50)	chi-square	**< 0.0001**
Resident of Georgia	0.61 (0.49)	0.52 (0.50)	chi-square	**< 0.0001**
Median household income of zip code tabulation area of student's home in dollars[a]	46,646[b] (18,197)	49,450[b] (19,367)	Wilcoxon	**0.0003**
Academic characteristics				
Mean high school GPA	3.51 (0.38)	3.48 (0.50)	*t* test	0.19
Advanced placement credit	0.11 (0.31)	0.22 (0.42)	chi-square	**< 0.0001**
Mean total SAT score	1175 (130)	1182 (186)	*t* test	0.29
Athlete	0.14 (0.34)	0.16 (0.36)	chi-square	0.21

Note. Number of subjects in database = 2,222. Number of Challenge participants = 770. Number of nonparticipants = 1,452.

Bold font indicates statistically significant difference between comparison groups.

[a]U.S. Census 2000.

[b]Missing 346 values.

TABLE 2

Makeup of Challenge Participants From 1990 to 2000 by Gender and Ethnicity

Gender	Counts by ethnicity[a] (% of row subtotal) (% of column subtotal)			Row subtotals (% of all Challenge participants from 1990 to 2000 in each row)
	African American (AfrA)	**Hispanic (HIS)**	**Mixed**	
Female	257 (89% of females) (42% of AfrA)	28 (10% of females) (21% of HIS)	4 (1% of females) (21% of mixed)	289 (38% of total are female)
Male	360 (75% of males) (58% of AfrA)	106 (22% of males) (79% of HIS)	15 (3% of males) (79% of mixed)	481 (62% of total are male)
Column subtotals (% of all Challenge participants from 1990 to 2000 in each column)	617 (80.1% of total are AfrA)	134 (17.4% of total are HIS)	19 (2.5% of total are mixed)	total = 770 (100%)

[a]No Native Americans participated in Challenge Program from 1990 to 2000.

TABLE 3

Survival Analysis of Challenge Program Participation on Graduation of Underrepresented Minority Students Entering Georgia Tech as Freshmen Between Fall 1990 and Fall 2000

	Hazard ratio (95% confidence interval)	***p* value**
Participation in Challenge Program	1.19 (1.05, 1.35)	**0.006**
Demographic characteristics		
Female (binary)	1.43 (1.27, 1.62)	**0.0001**
African American (binary)	0.80 (0.70, 0.92)	**0.0001**
Resident of Georgia (binary)	0.78 (0.69, 0.88)	**0.0001**
Median income (continuous)	1.08 (1.05, 1.11)	**0.0001**
Academic characteristics		
High school GPA (continuous)	2.38 (2.00, 2.84)	**0.0001**
Total SAT score (continuous)	1.02 (0.97, 1.07)	0.53
Advanced placement credit (binary)	1.37 (1.18, 1.58)	**0.0001**
Athlete (binary)	1.19 (0.99, 1.44)	0.07

Note. Bold font indicates statistically significant association.