Published in final edited form as:

J Higher Educ. 2017 ; 88(4): 561–592. doi:10.1080/00221546.2016.1272332.

Institutional and ethnic variations in postgraduate enrollment and completion

Marta Tienda and
Princeton University

Linda Zhao
Harvard University

Abstract

Using the B&B:93/03 longitudinal cohort survey, we investigate (1) whether and how much variations in the timing of enrollment, the type of undergraduate institution attended, and type of graduate program pursued contribute to observed racial and ethnic differentials in post-baccalaureate enrollment, and (2) whether the observed enrollment differentials carry over to degree attainment. Dynamic event history methods that account both for the timing of matriculation and the hazard of enrolling reveal that compared to whites underrepresented minorities enroll earlier and also are more likely to enroll in doctoral and advanced professional degree programs relative to nonenrollment. Our results reveal sizable differences in the cumulative probability of advanced degree attainment according to undergraduate institutional mission, with graduates from research institutions enjoying a decided advantage over liberal arts college graduates. The conclusion discusses limitations of the analysis, directions for further research, and implications for strengthening the minority pipeline to graduate school.

Mirroring national demographic trends, both undergraduate and graduate school enrollment has become more diverse. In 1980, for example, Blacks, Hispanics, Native Americans and Asians combined accounted for 17 percent of undergraduate enrollment; by 2010, their combined shares approached 40 percent (Tienda, 2013). Partly due to the changing ethno-racial composition of BA recipients and partly the result of deliberate institutional strategies to recruit members of underrepresented groups, post-baccalaureate enrollment of minorities nearly doubled since the mid-1970s (Aud et al., 2012: Table A-11-1). Approximately 90 percent of all graduate students were non-Hispanic white in 1976, but this share fell to 70 percent in 2010.

The social and economic implications of these trends are not well understood. In explaining wage polarization between college- and high-school educated workers since 1980, for example, Autor et al. (2008) not only signal the growing importance of jobs that reward abstract reasoning skills, but also call attention to widening gaps at the upper tail of the wage distribution. Their findings are consistent with new evidence about growing wage disparities

within the college-educated workforce. In fact, Valletta (2015) reports that wage gaps between BA and advanced degree recipients rose from 11 to 30 percent between 1970 and 2013, with the largest growth after 2000. Lindley and Manchin (2016) suggest that the relative growth in jobs requiring non-routine cognitive skills, such as management, medicine, law, and engineering, drove the higher wage gains of advanced degree holders, but they do not consider racial and ethnic variations among the college-educated. Whether and how the burgeoning minority population will contribute to wage differences among the college-educated depends on their transition to and completion of advanced degrees. By comparison to research about racial and ethnic disparities in college attendance and completion (Perna, 2000; Brown & Hirschman, 2006; Alon & Tienda, 2007), empirical studies about underrepresented groups' transition to and completion of graduate school are relatively scarce (Clune et al., 2001; Perna, 2004; 2007).

An early report based on the Baccalaureate and Beyond Survey of 1992/93 (B&B:93/03) revealed that minority BA recipients enjoyed a slight post-graduate enrollment advantage over whites in the early 1990s: nearly one in three minority college graduates had enrolled in a post-baccalaureate program by 1997 compared with 29.5 percent of nonHispanic white graduates (McCormick et al., 1999:12). Subsequent studies differ in the magnitude of the advantage for specific groups, however. We investigate the veracity of the minority enrollment advantage by asking whether and to what extent variations in the *timing* of enrollment, the *type of undergraduate institution* attended, and the *types of graduate degrees* pursued contribute to the observed racial and ethnic enrollment differentials, and, importantly, whether the higher minority enrollment rates carry over to completion (CGS, 2009).

Section II presents a brief overview of prior scholarship about post-baccalaureate attendance, focusing on evidence about racial and ethnic disparities. Following a discussion of the data and empirical approach in Section III, we present descriptive and multivariate results in Sections IV and V, respectively. Three novel contributions of our approach are the explicit consideration of undergraduate institutional mission and institutional selectivity as correlates of graduate school attendance and completion; the dynamic estimation of enrollment and completion behavior; and the consideration of type of degrees sought. The conclusion (Section VI) summarizes key findings, identifies study limitations, and suggests future research directions.

Background

Mirroring the literature about college attendance, scholarship about post-baccalaureate enrollment shows that decisions about whether to pursue graduate study depend on demographic characteristics (e.g., race, age and sex), social background, and collegiate experiences, especially academic performance, major field of study, and time to degree completion (Sax, 2001; Perna, 2004; Liang Zhang, 2005; Mullen et al., 2003; Stolzenberg, 1994). Other studies identify factors that are unique to post-baccalaureate enrollment decisions, such as the quality, mission and control of undergraduate institutions (Andrieu & St. John, 1993; Liang Zhang, 2005; Lei Zhang, 2013) and accumulated debt (Lei Zhang, 2013; Malcolm & Dowd, 2012; Millett, 2003; Weiler, 1994).

Minority Group Status

Although McCormick and associates (1999) revealed a minority advantage in graduate school attendance rates (McCormick et al. 1999), subsequent studies report inconsistent differentials, most likely due to variations in sample restrictions and handling of missing data. Perna (2004) shows higher post-baccalaureate enrollment for Hispanics compared with whites (Table 1, p.500), particularly for men. Using the same data, Hilmer and Hilmer (2012) indicate higher post-graduate enrollment rates for blacks compared with whites, but not Hispanics (Table 1, p. 69). Several plausible explanations could explain the modest minority post-baccalaureate enrollment advantage, including positive selection and race preferences in admission (Perna, 2007). For example, minority college graduates may be selected on unobserved traits, such as motivation and determination to succeed, as well as observable characteristics, such as standardized test scores and high school grades.

Targeted campus recruitment, particularly at research institutions with established links to graduate programs, also might facilitate minority students' pursuit of advanced degrees (Sax, 2001; Millet & Nettles, 2009). Focusing on science majors, for example, Sax (2001) explains that college graduates are more likely to pursue advanced degrees if trained in environments that practice science than if their learning experiences are restricted classrooms and libraries. By expanding opportunities to participate in research, providing information about post-graduate degree options, and stimulating the desire to pursue an advanced degree, institutional and major-specific pipeline programs designed to promote graduate school enrollment of underrepresented groups also likely contribute to the modest post-baccalaureate enrollment advantage of black and Hispanic students vis-à-vis whites (Millet & Nettles, 2009; Strayhorn, 2010; Millett, 2009; CGS, 2009; Perna, 2007).

Social Background and Student Collegiate Experiences

A sizable social science literature established an association between the educational attainment of parents and their offspring, yet analysts disagree whether the intergenerational link fades after college (Mare, 1980; Stolzenberg, 1994). Mullen et al. (2003) suggest that family socioeconomic status influences graduate school enrollment through student sorting across institutions that differ in their selectivity and research mission because these factors also predict educational continuation after college. College choices of students from different SES backgrounds differ both because family resources constrain options and because of variations in the quality of college guidance services (Perna, 2007). For example, Niu and Tienda (2008) show that graduates from under-resourced high schools have smaller college choice sets comprised of less selective institutions compared with graduates from high schools with strong college going traditions. The influence of social origins on graduate school enrollment also depends on undergraduate major and the type of advanced degree sought (Sax, 2001; Eide et al., 1998). Mullen et al. (2003) find that parental education is unrelated to pursuit of MBA programs, which often require work experience and are sometimes subsidized by employers; however, family background is associated with the pursuit of professional or doctoral degrees.

There is no consensus about whether student debt undermines graduate school enrollment. Millet (2003) concludes that recent BA recipients who owe \$5000 or more are less likely to

seek advanced degrees compared with their debt-free counterparts. The generalizability of her results is unclear because she restricts the analysis of application and enrollment decisions to students who reported that they *expected* to earn a doctoral degree within a year of receiving a BA rather than actual enrollees. Millet also does not address endogeneity biases that arise because accumulated debt is associated with unobserved attributes associated with post-graduate enrollment decisions. Using an instrumental variable approach to estimate the effects of college debt on post-baccalaureate enrollment, Lei Zhang (2013) concludes that the impact of college debt on graduate school enrollment depends on whether students attended public or private undergraduate institutions; that the largest negative effects of debt on post-baccalaureate enrollment are associated with pursuit of (expensive) doctoral, professional and MBA degrees; and that the enrollment dampening effects of indebtedness occur during the first two years after college graduation, but appear to fade thereafter. The debt literature underscores the need to consider both *type of degree sought* and variations in the *timing* of post-baccalaureate enrollment (Mullen et al., 2003). Niu and Tienda (2013), for example, showed that college enrollment delays were associated both with attendance at two-versus four-year institutions and eventual degree attainment.

Baccalaureate Institutional Attributes

Several studies of advanced degree pursuit identify systematic variations in graduate school attendance according to undergraduate institutional attributes, notably admission selectivity; research vs. teaching mission; and public vs. private control, which is highly correlated with cost (Lei Zhang, 2013; Liang Zhang, 2005; Perna, 2004; Millett, 2003; Mullen et al., 2003). Based on two nationally representative surveys conducted in 1972 and 1980, Eide et al. (1998) find that graduation from elite, private institutions increases the likelihood of graduate school attendance. Liang Zhang (2005) shows that college quality is associated with post-baccalaureate enrollment behavior, but that public/private institutional control is not. Research by Mullen et al. (2003), Lei Zhang (2013), and Liang Zhang (2005) demonstrates the importance of baccalaureate institutional mission for predicting the transition to graduate programs, but these authors do not consider racial differences in sorting across types of undergraduate institutions. This is important because, compared with research institutions, there are fewer research opportunities at liberal arts colleges and comprehensive universities, where teaching missions dominate faculty time and guidance about post-graduate opportunities is more limited (Nettles et al., 1999; Perna, 2007).

Research Questions

The available research suggests possible reasons for the minority post-graduate enrollment advantage, including enrollment timing; type of undergraduate institution attended; and type of degree pursued; however, supporting empirical evidence is limited. Accordingly we address (1) whether and how the *timing* of advanced degree enrollment varies along racial and ethnic lines; (2) whether variation in undergraduate *institutional mission* and in the *type of advanced degree* sought explains the observed minority post-baccalaureate enrollment advantage; and (3) whether the minority enrollment advantage carries over to *completion of* advanced degrees.

Data and Methods

We use the Baccalaureate and Beyond Survey (B&B: 93/03), a 10-year cohort panel study conducted by the National Center for Education Statistics (NCES) that targeted students who received baccalaureate degrees between July 1, 1992 and June 30, 1993. The B&B:93 base year cohort included 11,192 respondents who were re-interviewed in 1994, 1997 and 2003. Nonrespondent recapture rates varied across surveys: cohort attrition reduced the sample size to 10,080 for the 1994 follow-up, 10,093 for the 1997 follow-up, and 10,440 for the 2003 follow-up survey.

To construct the analytic sample, we begin with the 11,192 base year respondents. We drop 500 cases that were not re-interviewed in any follow-up survey, an additional 111 cases that were missing interviews in both 1994 and 1997,¹ 79 cases lacking valid postgraduate enrollment data, and 82 cases involving institutions in outlying regions. These exclusions reduced the final analytic sample to 10,420 observations, which includes all cases containing valid enrollment data in any of the follow up interviews, even if censored. We apply the 2003 longitudinal weights to the descriptive tabulations to approximate the population of 1992–93 bachelor's degree recipients after losses to sample attrition. Weights are not applied to multivariate analyses; however, as discussed in the online appendix, multivariate results are robust to application of weights.

Missing data

To reduce loss of observations to item nonresponse, we use multiple imputation methods (MI) to derive values for missing data. Missing data for any single item does not exceed 10 percent, but the potential loss of observations due to the aggregation of nonresponse items is much greater. MI is superior to alternative strategies to deal with missing data, such as listwise or pairwise deletion, substitution with constants, or other forms of single imputation (Little & Rubin 1987; Allison, 2001). In addition to the variables used in the multivariate analyses, the imputation model includes household size, veteran status, tuition, financial aid, graduation rate at undergraduate institution, and several additional indicators associated with pre- and post-graduate experiences. Using the multivariate normal imputation algorithm in Stata, we created ten imputation datasets, which is reasonable when the fractions of missing data for any specific predictor variable are low. A graphical check of convergence using the values of the worst linear function provides confidence that ten imputations are sufficient for the desired precision (the online appendix provides further details).

We use event history methods to assess variations in the timing of post-baccalaureate enrollment decisions. The survey records the month and year of BA completion, but the start dates of first enrollment are less precisely measured and there are some instances of dual enrollment in BA and post-baccalaureate programs. Exact enrollment dates are only available for respondents whose matriculation in graduate school occurs after 1997; for pre-1997 matriculants, graduate school enrollment was matched to a separate month-by-month enrollment status variable. The match is clear for the vast majority of cases, hence we

¹Although the 2003 survey recaptured 111 cases that were missing interviews in 1997 and 1994, information about graduate school matriculation is unavailable.

designate the first day of the relevant month as the start date of post-graduate enrollment; however, for 27 observations involving dual enrollment, the timing of post-graduate matriculation was ambiguous. For these we imputed start dates using average enrollment durations conditional on program completion (or noncompletion) and on typical enrollment sequencing in dual matriculation cases.² Given the small number of observations with ambiguous start dates, results are not sensitive to imputations for these cases.

Longitudinal data incur two forms of right censoring: sample attrition (including missing information on the outcomes of interest) and the inability to observe outcomes for students who might enroll after 2003. Censoring is not a problem for respondents who do not participate in the 1994 survey but do so in 1997 because the later interview recaptures most enrollment behavior and dates retrospectively. Unfortunately the 2003 questionnaire did not retrieve missing information about changes in enrollment status for recaptured respondents. Because it is not possible to determine the timing of first enrollment for baseline respondents that did not participate in either the 1994 or 1997 surveys, these cases were dropped from the analysis. The 2003 survey also did not retrospectively recover information about employment spells, changes in marital status, and births for recaptured respondents; therefore, it is not possible to model family and employment effects on post-graduate enrollment behavior for the entire 10-year period. As a robustness check on possible omitted variable bias, we model enrollment decisions up to 1997 including and excluding time-varying family formation and employment behavior and obtain very similar results (available on request). Analyses of post-baccalaureate degree completion use the 2003 longitudinal file; for these estimates the analysis sample is restricted to respondents who had ever enrolled in a post-graduate program before the 2003 interview.

Time measurement

Graduate school enrollment occurs over semester or trimester periods rather than on a continuous monthly basis; therefore, to approximate semesters since receipt of the baccalaureate degree, all time-related variables, including censoring times, are measured in half-year intervals. For the enrollment analyses we set the observation window at approximately 10 years since the BA, or 20 periods of 6-months each. Of the 10,420 cases in the analytic sample, 6,300 are censored through the 2003 interview. For each enrollment, the file includes information about the type of graduate degree sought: MA; first professional (medical or legal); or doctorate (PhD or EdD).

For the completion analyses, which are restricted to first advanced degree pursued, we define the time until graduation as the number of semesters between the date of first enrollment in a specific graduate program and the date of degree attainment in that program. Both dual enrollment and discontinuous enrollment posed challenges for ascertaining completion dates. For a handful of cases where respondents first attempted but did not complete a master's (MA) program, we ascertained enrollment in a doctorate program before or within a year of stopping MA enrollment. Such dual-enrollment cases were

²For example we know from the data that conditional on completion, enrollment durations (in months) for a Master's program are approximately Normal $\sim(25, 10)$; therefore, in cases where the end date of enrollment for a Master's program is clear but the start date is not, we impute the start date using the corresponding distribution.

reassigned to the higher degree program using the earliest enrollment date to designate the start of the degree.³ To designate interim episodes of nonenrollment as temporary or permanent withdrawal, prior to 1997 we verified future enrollment statuses. Instances where enrollment in the same type of graduate program is resumed within a year of a hiatus are treated as the same enrollment episode.

Although post 1997 enrollment data contained completion and final matriculation dates, the information was insufficiently detailed to capture breaks in enrollment; therefore, our measure of degree completion does not consider instances of discontinuous enrollment in the same program after this date. This data limitation renders our estimates of program completion conservative because the observed length of enrollment is greater than or equal to the actual time spent in the program for these cases.

Predictor Variables

The B&B lacks detailed information about college experiences (Millett, 2003), but does include measures about respondents' baccalaureate institutions, including their regional location. Carnegie classification codes designate institutional mission (major research institution, doctorate granting university, comprehensive university and liberal arts college) and public/private institutional control.⁴ In addition, we classify undergraduate institutions on a selectivity scale using Barron's taxonomy, which groups colleges and universities into six categories (ranging from 0 to 5) based on achievement characteristics of enrollees (class rank, GPA and standardized test scores) as well as yield rates (Liang Zhang, 2005; Alon & Tienda, 2007).

The multivariate analyses control for an array of student ascribed and achieved attributes that are associated with variation in post-baccalaureate enrollment (Perna, 2004). These include students' demographic characteristics (age, race, sex, birthplace), measures of academic achievement (college SAT scores and undergraduate GPA), and parents' education. Controls for gender and parents' education are warranted because of the sharp rise in female college attendance and graduation (Flashman, 2013) and evidence that the influence of students' socioeconomic background for advanced degree achievement differs according to type of degree attained. Other aspects of college experiences associated with post-baccalaureate enrollment behavior include the number of years to attain the BA degree, college debt and major choice (Sax, 2001; Mullen et al., 2003; Lei Zhang, 2013).⁵

Estimation

The dependent variable to portray the *timing* of graduate school attendance is the number of semesters elapsed until the first enrollment. To estimate the probability of enrollment in a given semester, we model the hazard of first postgraduate enrollment and designate

³This decision assumes both that dual enrollment was continuous and that completion of the doctoral degree may have generated an MA degree along the way rather than that the respondents were unsuccessful in the MA program and subsequently enrolled in a doctoral program.

⁴Less than 2 percent of the institutions are classified as for-profit, virtually all of them private, therefore it is not possible to differentiate these in the multivariate analyses.

⁵The analyses control for college debt, but none of the differences are statistically significant, possibly because, according to Zhang (2013) the effects are limited to the two years immediately following college graduation.

censoring dates. For uncensored observations, the dependent variable is set to zero until enrollment occurs, which is set to one for the three types of graduate programs: doctorate, first professional or master's degree.⁶ For the 27 cases involving a dual degree graduate program, we designate the higher of the two with the following priority (doctorate, first professional, masters). Using a censored normal regression where the censoring value may change across observations, the number of semesters (half-year periods) elapsed between receipt of the BA and first enrollment in graduate school is modeled as

$$Y_i^* = X_i \hat{\beta} + \varepsilon_i,$$

where Y_i^* is the latent variable assuming normal distribution of true enrollment times given the censored values of Y_i , which is equal to the observed enrollment date or censoring date (McDonald & Moffitt, 1980). X_i is the vector of random variables that represent race, undergraduate GPA, type of BA institution, and amount of college debt; $\hat{\beta}$ is the matrix of coefficient estimates on the independent variables, and $\varepsilon_i \sim N(0, \sigma)$ are the errors. Unlike the standard tobit model, the censored normal regression allows for censoring points that vary both across observations and over time. Analyses of the timing of enrollment use the full-10 year cohort experience, which includes information about the dates of enrollment through 2003.

Subsequently we model the hazard function for first enrollment to graduate school to derive the probability that enrollment occurs in a given semester after completing the baccalaureate degree, given that postgraduate enrollment has not occurred. Because the likelihood of postgraduate enrollment differs by type of program—professional, MA, or doctorate—to estimate the hazard rates we use a dynamic, discrete choice proportional hazards model with flexible duration dependence and competing risks. This model uses semesters as the time unit.

Let the hazard of each enrollment outcome r , which varies as a function of time t for individual i , be denoted by $h_{ir}(t)$. In this specification the hazard is defined as the probability that individual i experiences enrollment outcome r during time t , given no prior enrollment. Using a competing risks model of the hazard with duration dependency, this formulation assumes that the log-odds of the hazard of each enrollment decision follow a linear model. Given no prior enrollment before time t , this is equivalent to

$$P(Y_{it}=r|X_{it})=h_{ir}(t)=\frac{e^{\beta^{(r)}X_{it}+\alpha^{(r)}D_t}}{1+\sum_{k=1}^3\left[e^{\beta^{(k)}X_{it}+\alpha^{(k)}D_t}\right]}\text{ for }r>0, \text{ and}$$

$$P(Y_{it}=r|X_{it})=h_{ir}(t)=\frac{1}{1+\sum_{k=1}^3\left[e^{\beta^{(k)}X_{it}+\alpha^{(k)}D_t}\right]}\text{ for }r=0$$

⁶Some studies include post-master's certificates as a category of graduate enrollment, but owing to the vast heterogeneity of these programs, which vary from short "in-service" training modules to specialized technical skills, we exclude certificate programs.

In this specification Y_{it} is the enrollment outcome for individual i at time t given that she is still in the risk set at time t . The first enrollment outcome, r , can take on the values 0, 1, 2, and 3, which indicate, respectively, no enrollment (the base case), or the first enrollment in a master's, professional or doctoral program, respectively. X_{it} is the vector values of the fixed and time-varying covariates for individual i at time t ; D_t is the vector of dummy variables indicating approximate years elapsed since BA completion. $\beta^{(r)}$ is the vector of coefficients on the independent variables for each possible outcome, and $\alpha^{(r)}(t)$ is the vector of coefficients for duration (in years) since receipt of the BA degree. Modeling time as a categorical variable yields a flexible baseline hazard. The proportional hazards specification assumes that the effects of the covariates do not change over time.

Maximizing the log-likelihood with respect to $\beta^{(r)}$ and $\alpha^{(r)}$ yields parameter estimates $\widehat{\beta^{(r)}}$ and $\widehat{\alpha^{(r)}}$, which are the estimated marginal effects on the log-odds of the hazard of each enrollment outcome. We specify the model for completion outcomes in like fashion, with separate models for masters program and first professional or doctorate program enrollees; in these models the duration variables indicate the number of years elapsed since enrollment in a postgraduate program. The models for degree completion are simpler because there are only two outcomes by the end of the observation period. We report marginal effects in order to facilitate interpretation of the enrollment and completion hazards.⁷ For enrollment the marginal effects represent the *change* in the probability of matriculating in one of three post-baccalaureate programs given no prior enrollment, per unit increases of the continuous variables, or the differences in the probabilities of enrollment given a particular category of the independent variable relative to the reference category. The marginal effects associated with the time intervals are the duration dependence of the hazard, which represent changes (decreases) in probability of enrolling in (or completing) graduate school over time.

It bears emphasizing that the marginal effects represent the hazard of enrollment (completion) rather than the simple probability of enrollment (completion). The key difference is that the hazard is conditioned by prior nonenrollment (enrollment). Marginal effects on the individual covariates represent average differences that do not account for duration, whereas the cumulative probability of ever-enrollment accounts for duration effects. Thus, small but significant differences in marginal effects yield much larger differences in the predicted *cumulative* probability of ever-enrollment. To illustrate the *cumulative* magnitude of differences in hazards, we also report the predicted lifetime distribution function, which is the complement of the survival function.

$$\hat{F}_{ir}(k) = 1 - \hat{S}_{ir}(k) = 1 - \prod_{k=1}^T (1 - \hat{h}_{ir}(k))$$

Specifically, we report predicted $\hat{F}_{it}(10)$, which is the maximum number of years observed in the data. This is the probability that individual i ever enrolls in (completes) a postgraduate program within 10 years of BA receipt, with independent variables set to values that

⁷We do not report censored normal regressions for completion because results show that the timing of enrollment is the only significant predictor of time to degree completion, which suggests that covariates of interest operate via the timing of enrollment.

correspond with high academic achievement or the mean or modal categories otherwise. The dependence of $\hat{h}_{ir}(K)$ on k derives from the contribution of the duration or time interval to the hazard.

Descriptive Results

Table 1 presents descriptive statistics for the key covariates of interest. Racial and ethnic variation in collegiate academic achievement and institutional mission provide clues about the minority graduate school enrollment advantage. Selection on achievement is not a likely explanation because black and Hispanic baccalaureate recipients do not hail from the higher end of the achievement distribution. Over half of white and Asian college graduates achieved a cumulative grade point average (GPA) of 3.0 or higher, compared with 46 and 30 percent, respectively, of Hispanic and black BA recipients. Also, about one in five white and Asian students scored in the top quartile of the SAT distribution compared with 10 percent of Hispanics and less than five percent of African Americans. If, as Perna (2007) and Mullen et al (2003) contend, the influence of family background extends to post-baccalaureate behavior, both blacks and Hispanics are at a decided disadvantage. Among 1992–1993 college graduates, over 20 percent of black and Hispanic parents did not complete high school compared with, respectively, 3 and 6 percent of white and Asian parents.

There are sizable group differences in attendance rates according to institution type. Nearly half of Asian college graduates attended research institutions, compared with 32 percent of Hispanics and about 18 percent of African Americans. That black college graduates are overrepresented at comprehensive and liberal arts institutions partly reflects their attendance at historically black colleges and universities (HBCUs), which account for about one-quarter of post-secondary enrollment of African Americans (Nettles et al., 1999).⁸ Over half of Asian college graduates attended the most or very competitive colleges and universities compared with 38 to 40 percent of Hispanics and whites, but only 27 percent of blacks. Howard and Xavier Universities, along with Spellman and Morehouse Colleges, rank among the top 10 institutions whose graduates received doctoral degrees in science, technology, engineering and mathematics; however, other HBCU institutions are less successful in graduating students that pursue advanced degrees (Nettles et al., 1999).

Table 2 presents group-specific post-baccalaureate enrollment rates by undergraduate institutional characteristics as well as college GPA and SAT quartiles. The bottom row shows that Hispanics and blacks enroll in graduate programs at higher rates than whites, and that the highest rates correspond to Asians. Claims about the importance of institutional mission for advanced degree pursuit find support in the average enrollment rates: nationally, 42 percent of all college graduates from research institutions enrolled in a post-baccalaureate program within a decade of receiving a BA degree compared with 33 percent of graduates from comprehensive institutions and about 38 percent of graduates from liberal arts and doctorate-granting institutions.

⁸Supplementary tabulations confirm that 44 percent of African American graduates from liberal arts colleges and comprehensive universities attended an HBCU.

The sample enrollment averages conceal sizable variation in enrollment rates by undergraduate institution mission. Post-baccalaureate enrollment rates of black graduates from research institutions exceed those of whites by over 12 percentage points, but only five points for Hispanics. For graduates from doctoral, comprehensive and liberal arts institutions, the racial and ethnic enrollment differentials are less systematic. Group-specific matriculation rates also differ by institutional control, but not uniformly between majority and minority students. Nationally, enrollment rates are slightly higher for graduates from private institutions, but this differential does not obtain either for blacks or Hispanics.

Predictably, enrollment rates vary monotonically according to SAT quartiles, with over half of BA recipients scoring in the top quartile ever enrolling in an advanced degree program. Only 9 percent of African American BA recipients were in the top quartile of the GPA distribution (Table 1), yet 63 percent of these high-achievers enrolled in graduate school—a rate considerably higher than the average GPA-specific rate. At the other extreme, over one-in-four Hispanic and black college graduates with a cumulative GPA in the lowest quartile enrolled in a graduate program compared with 18–19 percent of Asians and whites. An enrollment advantage at the low end of the achievement distribution may result from aggressive recruitment and could potentially result in low completion rates.

The descriptive tabulations provide insight into potential explanations for the apparent minority graduate school enrollment advantage, but can not address whether it reflects creaming of minorities who persist through a pipeline that sorts on achievement; whether and how it varies with years elapsed since BA degree completion; or whether the enrollment advantage carries over to completion rates. We address these questions next.

Multivariate Analyses

The multivariate analysis proceeds in three parts. After describing survival curves portraying the *timing* of graduate enrollment, we estimate the *probability of enrollment* in each year and conclude with estimates of *degree completion*, conditional on enrollment. The analyses assess how minority group status and type of undergraduate institution attended are associated with the risk of enrolling in a particular type of graduate program, and whether these associations are moderated by other circumstances such as college major, accumulated debt, institutional selectivity, baccalaureate attainments or family background. Our focus on temporal variations in graduate school enrollment and completion extends prior work that largely addresses whether respondents *ever* enrolled at each of the survey waves because, as we demonstrate, the significance of postponement differs by type of degree sought and for some types of programs, enrollment delays incur completion penalties.

Results: Timing of Enrollment

Figure 1, which displays racial and ethnic differences in the cumulative percent ever enrolled in a post-baccalaureate degree program, shows that within two years of graduating from college, 26 percent of Hispanics and 23 percent of blacks enroll in an advanced degree compared with 21 percent of white college graduates. These enrollment advantages persist over a 10-year period, when 45 to 46 percent of black and Hispanic college graduates pursue advanced degrees compared with only 40 percent of whites.

On average, minority college graduates also tend to enroll earlier than whites following college graduation.. Hispanics and Asians enroll soonest followed by African Americans and whites. Furthermore, as shown in Figure 2, graduates from research institutions had consistently higher post-baccalaureate enrollment rates in each year following receipt of their BA degree compared with graduates from non-research institutions. It is unlikely that sorting across institutions with varied instructional and research mission is responsible for black and Hispanic students' higher and earlier enrollment rates because both groups are overrepresented among BA graduates from comprehensive institutions. Reflecting their attendance at HBCUs, African Americans (but not Hispanics) are underrepresented among college graduates from research institutions and overrepresented among liberal arts graduates.

Table 3 reports results from a censored normal regression that approximates semesters using 6-month time intervals. Baseline estimates (model 1) indicate that Asian BA recipients enroll in graduate school approximately three semesters earlier than white college graduates, and black college graduates enroll about a year before white graduates, on average. After accounting for group variation in academic performance, loan debt, demographic characteristics (age, sex and nativity), parental education and college experiences (years to complete BA and college major), the minority enrollment advantage widens (model 2). Conditional on graduating from college, Hispanics and Blacks enroll in graduate school 1.5 to 2.5 semesters sooner than statistically comparable white BA recipients; however, the point estimate for Hispanics is not precisely estimated by conventional levels of significance. Furthermore, the Asian enrollment advantage is reduced by a full semester relative to white college graduates with comparable achievements and socioeconomic background.

Model 3, which includes covariates for institutional selectivity, control and mission reveals that uneven sorting across institutions mutes the minority enrollment advantage: the transition to post-graduate enrollment is even faster among underrepresented groups that receive BA degrees from institutions comparable to those of whites. Hispanics and blacks, respectively, enroll in graduate school 3 and 6 semesters earlier than their white counterparts who graduate from similar baccalaureate institutions, but the Asian enrollment advantage is imprecisely estimated. Moreover, taking into account differences in college GPA does not diminish the black and Hispanic postgraduate enrollment advantages (model 4).

Predictably, collegiate academic performance is one of the strongest predictors of post-baccalaureate enrollment. College graduates from the lowest quartile of the GPA distribution witnessed the longest hiatus between BA receipt and pursuit of an advanced degree—approximately three and a half years longer than their counterparts who graduated in the top quartile of the GPA distribution. Compared with top-performing students, college graduates with grade point averages in the B to B+ range delayed the transition to graduate school roughly 1.5 years (3+ semesters), but those with GPAs in the B- to C+ range postponed enrollment in advanced degree programs by over 3 years. Graduates with grade point averages below a C+ delayed enrollment by over 5 years. Enrollment delay, as we demonstrate below, is consequential for program completion, albeit not uniformly by program types.

Graduates from research and doctorate-granting institutions make a faster transition to postgraduate studies relative to their statistical counterparts that attended liberal arts colleges and comprehensive universities. Compared with graduates from research universities, degree recipients from liberal arts colleges delayed post-baccalaureate enrollment by approximately two semesters and graduates from comprehensive institutions postponed advance degree pursuit by about one semester. Like Zhang (2005), we find a clear gradient in the association between institutional selectivity and matriculation in an advanced degree program: graduates from the least competitive undergraduate institutions delay post-baccalaureate enrollment by 2.5 semesters, on average, and those with BA degrees from competitive institutions delay by one year relative to graduates from the most selective institutions. Collectively, results support claims that the minority enrollment advantage is particularly high for graduates from selective research universities.

Results: Probability of Enrollment by Program Type

It is conceivable that the minority enrollment advantage reflects differences in type of advanced degree pursued. For example, some MA programs (e.g., MBA or MPA) typically require work experience, which manifests as delayed enrollment. Furthermore, unlike most PhD programs, which generally involve partial or full financial aid, MA programs generally require out-of-pocket costs, which also can delay enrollment. Figure 3 indicates that college graduates seeking doctoral or professional degrees enroll earlier, on average, than their MA-seeking counterparts.

To evaluate whether the minority graduate enrollment advantage persists across program type, we model the probability of enrolling in an MA, professional or doctoral program as of 2003 using the multinomial specification described above. Table 4 reports the marginal effects on the probability of each graduate enrollment outcome net of duration relative to no enrollment over approximately 20 semesters (~10 years) since receipt of the baccalaureate degree. The empirical specifications also control for undergraduate major, which is associated with pursuit of advanced degrees (Sax, 2001). P-values associated with the Wald statistic adjust for clustered standard errors.⁹

These results confirm that the association between race and postgraduate enrollment persists even after taking into account variations in social background and collegiate academic performance. Furthermore, the minority enrollment advantage is particularly evident for the higher-level professional and doctoral programs; however, by 2003 only African Americans are significantly more likely than whites to enroll in a MA program relative to no enrollment. That all minority groups are more likely than whites to enroll in a professional degree program relative to nonenrollment within the 10 years of their baccalaureate degree reinforces the robustness of the minority enrollment advantage. Importantly, both Blacks and Hispanics are more likely than whites to pursue doctoral degrees (Asians are indistinguishable in this regard). In fact, many of the point estimates are comparable in magnitude to those for college GPA, which is among the strongest predictors of post-baccalaureate enrollment.

⁹Observations are not independently distributed in the expanded panel data. Clustering standard errors by individual ID adjusts for the person-specific inter-temporal correlations, but results in more conservative, significance levels.

Graduates from research institutions are most likely to pursue advanced degrees, but some of the point estimates for institution type are statistically insignificant. Compared with graduates from research universities, grads from comprehensive universities, liberal arts and specialized colleges (e.g., religious or medical and health sciences) have a lower probability of pursuing advanced professional or doctoral degrees relative to nonenrollment. Graduates from doctorate-granting institutions are more likely than their statistical counterparts who attended research universities to pursue MA degrees. Otherwise, type of BA institution attended is inconsequential for enrollment in MA programs, likely due either to lower entry requirements or employment experience as a requirement for enrollment (e.g., MBA or public policy programs).¹⁰ The association between college selectivity and type of graduate degree sought is generally weak, but consistent with expectations: graduates from the most selective institutions have the highest likelihood of pursuing an advanced degree.

The coefficients for years since BA completion are consistently negative and increase in magnitude for longer durations, indicating that the probability of enrollment declines each year since degree receipt. College graduates have a three percent lower probability of enrolling in an MA program four to five years after college graduation compared with the first year after BA receipt. The probability of pursuing professional and doctoral degrees also falls over time, but more gradually relative to the first year after college graduation.

Variation in marginal effects implies large differences in the cumulative probability of ever-enrollment when duration is taken into account. In Table 5 we report the predicted *cumulative* probabilities of ever-enrollment at 1, 5 and 10 years post-BA receipt. These estimates vary group membership and undergraduate institutional mission, fixing other covariates at levels corresponding with the highest academic achievement category or at category means or modes.¹¹ Two findings stand out. First, black and Hispanic enrollment rates are systematically higher than those of similarly situated whites, although the magnitude of the differential depends on time elapsed since BA receipt and type of degree sought. Blacks (Hispanics) are over 12 (2) percentage points *more likely* than whites to enroll in a masters program within a decade of BA completion. Specifically, black and Hispanic graduates from research institutions are, respectively, 9 and 4 percentage points more likely than whites to enroll in a first professional program within a year of college completion; moreover, their respective enrollment advantage widens to 22 and 9 percentage points over the next decade. Although minority graduates from liberal arts institutions also are more likely than whites to pursue professional degrees, the differential is smaller. Ten years after receiving a BA from a research institution, blacks (Hispanics) are over 9 (13) percentage points more likely to enroll in a doctorate program than statistically similar whites.

Second, for all groups, BA institutional mission appears to be especially consequential for the likelihood of pursuing a medical or law degree, but not MA degrees. Enrollment probabilities reported in Table 4 indicate that graduates of comprehensive, liberal arts and

¹⁰The interaction between race and institutional mission on graduate program enrollment was not statistically significant, possibly due to small group-by-institution cell sizes.

¹¹The statistical significance of the predicted probabilities in Table 5 corresponds to the marginal effects in Table 4, not all of which are statistically significant.

specialized colleges are significantly less likely to pursue advanced professional or doctoral degrees relative to nonenrollment as compared with graduates from research universities; however, the *cumulative* enrollment probabilities between graduates of research universities and graduates of liberal arts colleges qualify this inference. For all demographic groups, but especially underrepresented minorities, graduation from a research institution significantly boosts the likelihood of pursuing a professional but not an MA degree. Whites, Hispanics and Blacks who graduated from research universities are, respectively, over 19, 13 and 9 percentage points more likely than graduates from liberal arts colleges to enroll in a first professional program within 10 years of BA receipt. Variation in the cumulative probability of enrollment in doctorate programs according to BA institution type exceeds two percentage points for minorities and one point for whites.

Results: Degree completion

The social and economic significance of the minority post-baccalaureate enrollment advantage largely depends on completion rates, which have received scant attention from researchers. Table 6 shows the proportions completing advanced degrees, conditional on having ever enrolled, by type of degree sought. For this analysis we combine first professional and PhD programs to avoid tiny cell sizes. The lower panel of Table 6 indicates that 10 to 14 percent of respondents pursuing professional/PhD or MA programs were still enrolled (censored) as of 2003. Among college graduates ever enrolled in a PhD or professional degree program, 58 percent of Hispanics and Asians and 35 percent of African Americans completed degrees as of 2003; the sample completion rate of 47 percent is similar to that of whites. On average, the lower MA and PhD/professional degree completion rates of African Americans are only marginally different from those of whites.

Differences in advanced degree completion rates according to undergraduate institutional mission are less consistent than those observed for enrollment; moreover, group differences associated with attendance at a research institution are less pronounced. Partly this reflects selection into advanced degree programs, especially those with high admission bars, and partly this reflects heterogeneity in program rigor and duration. Unlike doctorates in education (EdD), for example, a PhD in a lab-based discipline cannot be pursued part-time.

On balance Table 7 shows little evidence that the minority enrollment advantage results in higher failure rates. That graduate admission regimes directly involve faculty in screening of applicants may provide insurance that admitted students have a high likelihood of success, particularly if the screen on grades is matched by unobservable attributes such as motivation and recommendation letters. Not surprisingly, conditional on enrollment, college GPA is strongly associated with attainment of an advanced degree. Active recruitment might drive the enrollment advantage for African American students, but this is less likely to be the case for Hispanics, whose average professional or doctorate completion rates are similar to those of whites. Hispanic MA completion rates are modestly lower than those of whites, consistent with averages reported in Table 6.

The average marginal effects on the probability of completing the first advanced degree reported in Table 7 indicate that undergraduate institution type is less consequential for degree completion compared with enrollment. In contrast to completion rates based on

cross-sectional assessments (e.g., Bradburn et al., 2006), estimates that take into account variation in the *timing* of enrollment by degree type indicate that the likelihood of PhD or professional degree attainment for minorities does not differ statistically from that of similarly situated white students. Rather, the lower PhD and professional degree completion rates for black enrollees reported in Table 6 largely reflect group differences in college GPA, type of undergraduate institution attended, family background, or undergraduate field of study compared with white students who enroll in similar programs. Students in the lowest GPA quartile, for example, are 4.1 percentage points less likely to complete a master's degree than their counterparts in the highest quartile of the grade distribution.

By comparison to enrollment outcomes, which is where the critical sorting into advanced degree programs occurs, the marginal effects of undergraduate institution mission on post-baccalaureate degree attainment are statistically trivial for MA programs and muted for professional and PhD programs. Conditional on enrollment in a professional or PhD program and at an average duration since enrollment, graduates from liberal arts colleges incur a completion penalty of 3.3 percentage points compared with comparable graduates from research universities. The marginal effects provide little evidence that graduates from selective institutions are more likely to complete a PhD or professional degree than their counterparts who attended less selective institutions; however, conditional on enrollment, graduates from the most selective colleges are about two percent more likely to complete an MA degree.

Table 8 reports the predicted *cumulative* probabilities of degree attainment at 5 and 10 years post-BA receipt, taking enrollment duration into account. These estimates vary group membership, undergraduate institutional mission and whether the transition to advanced degree programs was continuous or discontinuous. To evaluate the completion implications of an enrollment hiatus between BA receipt and pursuit of an advanced degree, we use three- and four-year nonenrollment periods for professional and PhD programs, respectively.¹² Other covariates are fixed at levels corresponding with the highest achievement category or at category means (modes).

Given differences in program requirements, the cumulative completion probabilities at both five and ten years post-BA are systematically higher for MA compared with PhD degrees, which, depending on field, average between five and seven years. This result is consistent with the shorter average duration of MA programs and the work experience requirements of many degrees, such as MBA's and public affairs degrees. Discontinuous enrollment lowers the probability of program completion by five to seven percent, with limited variation among demographic groups. The connection between discontinuous enrollment and program completion implies that covariates of interest, such as racial and ethnic status, institution type, control and selectivity influence degree completion via the timing of enrollment, as shown previously. It is notable that institutional type remains statistically significant to completion outside of its contribution to delayed enrollment. In fact, the small average marginal effects associated with undergraduate institutional mission imply rather sizable

¹²To derive these calculations, we re-estimated the regressions reported in Table 7 and added a covariate representing the number of years between baccalaureate receipt and graduate enrollment.

differences in cumulative probability of attaining advanced degrees. Graduates of research institutions have a decided advantage in doctorate and first professional degree attainment over graduates of liberal arts institutions. The lower panel of Table 8 reveals completion probabilities 15 to 17 points higher for graduates of research institutions versus liberal arts graduates. The completion differentials according to undergraduate institution mission are relatively stable at five and ten years post BA receipt, which further attests to the long shadow of undergraduate institutional mission for advanced degree attainment.

Conclusions

Using dynamic event history methods that account for both the *timing* of matriculation and the hazard of enrolling and completing MA, professional and doctoral degree programs, we confirm that black and Hispanic enrollment rates are systematically higher than those of whites; as expected, however, the magnitude of the enrollment advantage depends on time elapsed since BA receipt, type of degree sought, and importantly, the research mission of baccalaureate institutions. Receipt of a bachelor's degree from a research institution significantly boosts the likelihood that Black and Hispanic students will pursue a professional or doctoral degree, but less so for MA degrees. This implies that the initial sorting across institutions of higher education is consequential for minority college graduates' pursuit of advanced degrees. The sizable differences in the cumulative probability of degree attainment according to undergraduate institutional mission further support this claim. Lower advanced degree enrollment and completion rates among college graduates from institutions with limited research traditions coupled with high representation of Black and Hispanic students at these institutions suggest a need to strengthen institutional bridges in ways that broaden the pipelines of underrepresented students to post-baccalaureate degrees.

We find no statistical interaction between type of undergraduate institution and minority group status on the probability of post-baccalaureate enrollment; however, this likely reflects insufficient power due to sample size constraints. Therefore, we urge replication with more recent data to further scrutinize the association between undergraduate institutional mission and pursuit of advanced degrees; to determine whether incentives to pursue post-graduate training can boost enrollment and completion; and to better understand the welfare implications of the rising wage gaps among college graduates (Lindley & Machin, 2016; Valletta, 2015). Results showing higher advanced degree enrollment and completion rates among college graduates from institutions with limited research traditions coupled with relatively higher representation of black and Hispanic students at these institutions compared with research universities suggest a need to strengthen institutional bridges in ways that broaden the pipelines of underrepresented students to post-baccalaureate degrees.

Valetta (2015) notes that wage disparities between college graduates and advanced degree holders have widened since 2000, underscoring the need to replicate our analyses with more recent B&B data. Participants in the B&B:08/12 study of college graduates have been followed only four years since receiving a baccalaureate degree, which is too soon to evaluate their completion prospects; however, it is possible to verify whether the minority enrollment advantage persists among more recent graduates. Cataldi et al. (2011: Table 5)

reveal a clear postgraduate enrollment advantage for Asian and Black students in the first year post BA, although the latter is buoyed by pursuit of MA degrees. Four years after college graduation, less than 20 percent of the B&B:08/12 cohort was pursuing an advanced degree, but only one-third of these were enrolled full time and not working (Cataldi et al. 2014:Table 2). There is suggestive evidence that minority students are more likely than white students to pursue graduate studies exclusively, but more rigorous analysis is required to determine whether our findings are replicated with more recent data.

Our approach improves on prior work by using dynamic methods that take into account both the timing, continuity and duration of postgraduate enrollment, but the empirical specifications assume that type of undergraduate institution is exogenous. This assumption may not be warranted because the student sorting across institutions is determined *both* by geographic and socioeconomic constraints. This limitation underscores the need for future research to assess whether and how sorting student sorting across institutions with different teaching and research missions alters postgraduate degree pursuit (Mullen et al., 2003). Furthermore, owing to data constraints, we were unable to evaluate whether and how family events (marriage and births) and employment status figure into decisions to pursue and complete graduate studies. As a robustness check, we re-estimated enrollment models through 1997—the period for which B&B provides information to date family and work events. Enrollment results are substantively similar—at least through the period for which family data is available—but the data do not permit replication for the completion analyses. Therefore, we could not consider whether, in what ways, and for which groups family events influence completion of advanced degrees.

Labor market analysts show that college degrees remain a sound investment for lifetime earnings, but also acknowledge that the rising wage gap among college graduates warrants further attention to evaluate the social and economic implications of recent trends (Autor et al., 2008). Recent evidence indicates that post-graduate degree holders face more favorable market conditions as the demand for jobs that require high skills of a nonroutine cognitive nature rises (Valletta, 2015). That advanced degree holders are concentrated in high-level managerial jobs, as well as positions in medicine, law, engineering and design work, explains much of their relative wage gains in recent years. Although our analyses model undergraduate fields of study, we do not directly examine variations in advanced degree seeking by college major. Unfortunately the B&B data are not well suited to examine earnings disparities among respondents who pursue different types of advanced degrees versus nonenrollment because of right censoring for those who delay enrollment and truncation of lifetime earnings for those who complete PhDs (especially if followed by postdoctoral positions). Nevertheless, an examination of racial and ethnic differences among advanced degree holders is warranted both because of the changing demographics of college graduates and because the growing wage dispersion among recipients of advanced degrees.

That diversity has become a goal of graduate school administrators (Einaudi, 2011) probably contributes to the minority enrollment advantage, but the lack of racial and ethnic degree attainment gaps also reflects faculty participation in review of applicant files because they are best equipped to evaluate transcripts from different institutions (Flashman, 2013). In the contemporary legal environment, it behooves graduate school administrators and recruitment

officers to demonstrate the efficiency of their admission policies and to justify the modest enrollment advantages accorded to underrepresented groups.

Acknowledgments

This research benefitted from institutional funding from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, Grant #R24HD047879. We are indebted to Dawn Koffman for her guidance and advice in file construction and missing data imputation and to Florencia Torche for constructive comments on an earlier draft. We are grateful to Liang Zhang for kindly providing the code to assign Barron's selectivity scores to higher education institutions identified in the B&B longitudinal file, and to anonymous reviewers for constructive suggestions that improved the manuscript.

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Institutional and Ethnic Variations in Postgraduate Enrollment and Completion: Missing Data Imputation Appendix

This appendix summarizes the multiple imputation procedures used to handle missing data, and provides summary statistics comparing the means for the key covariates before and after imputation.

MI covariates

The imputation model includes the following key analytical variables: Institutional Type, BA Private/Public, BA GPA, BA Region, BA enrollment length, Age, Debt category, Race, Parent's education, Foreign, Gender, SAT/ACT quartile, graduate enrollment type and timing of graduate enrollment. The imputation model also includes the variables listed in Table 1, which collectively make the missing at random assumption reasonable. Graduate enrollment type and timing of graduate enrollment also are included in the imputation because they are potentially associated with missingness; however, imputed values for outcome variables (graduate enrollment type and timing of graduate enrollment) are later excluded from the analysis.

MI convergence

MI involves producing several imputed datasets drawing from the posterior predictive distribution of the missing data given the observed data. Parameter estimates are averaged across datasets and standard error estimates combine variability within and across datasets. A simplified rule of thumb for the number of imputations necessary for convergence of estimates, in particular the standard error estimate, is that the number of imputations should be similar to the percentage of cases that are incomplete (Bodner, 2008; White, Royston & Wood 2011). Because the maximum amount of missing data for any given variable in our sample less than 7%, shown in Table 2, we judged 10 imputation sets more than sufficient for convergence. Further evidence of convergence can be determined by examining the worst linear function (WLF), a constructed statistic that converges more slowly than all other parameters in the model (Dong & Peng, 2013). Figure 1 shows no trend in the WLF, indicating that all the parameters have converged in the model. Table 2 shows that the means of the key covariates are very similar before and after imputation.

Sample weights

Sample weights are not necessary in imputation analysis if missingness is already well predicted by the other MI covariates. We confirm this in a robustness check where we re-estimated the models with and without the sample weights; point estimates were virtually identical.

Appendix Figure 1.

Worst Linear Function Statistic for Multiple Imputations

Appendix Table 1

Additional B&B Variables used in Multiple Imputation

Variable Name	Variable Description
rategrad	If consider graduation rate in deciding to attend BA?
unsafe	If consider campus safety in deciding to attend BA?
instneed	If recipient of a need-based grant or scholarship
RESSAME7	Same Residence 1993/1997
stuparst	Same State of Legal Residence as parents in 1993
pmarital	Parent's marital status
emphoop	If worked for pay since graduation
msatba	If married at BA
budgetar	Student budget BA
hholdsiz	Number of relatives in family
ingrtamt	If recipient of BA institution-sponsored grant
inathamt	If recipient of athletic scholarship
B2PB2YR	Attended a 2-year school post BA
B2ATT2YR	Attended a 2-year school pre BA
B2VOLFRQ	If participate in volunteer work
tuition	BA tuition
evervote	If ever voted
veteran	If veteran

Variable Name	Variable Description
foodstmp	If student ever received food stamps
house	If respondent owns a house/condo
samereg	If student attended a BA institution in state of legal residence
rateplac	If considered job placement rate in decision to attend BA
ratecrim	If consider campus crime rate in decision to attend BA
stgtamt	If recipient of state-sponsored grant
B2CAR	If own a car
pellamt	If recipient of Pell Grant

Appendix Table 2

Means of Key Covariates Before and After Multiple Imputations

(N)	Before Imputation (10,420)	After Imputation (10,420)
Race		
Asians	0.045	0.047
Blacks	0.059	0.060
Hispanics	0.045	0.046
Whites	0.834	0.847
Missing	0.016	---
Female	0.548	0.546
Missing	0.004	---
Foreign	0.067	0.071
Missing	0.059	---
Age	25.159	25.223
(s.d.)	(6.880)	(6.759)
Missing	0.003	---
Parent's Education		
Less than HS	0.042	0.044
High School	0.433	0.462
BA Recipient	0.224	0.240
Greater than BA	0.241	0.254
Missing	0.061	---
SAT Quartiles		
No SAT	0.209	0.209
4th Quartile	0.189	0.189
3rd Quartile	0.203	0.203
2nd Quartile	0.214	0.214
1st Quartile	0.186	0.186
College GPA		
2.5	0.145	0.152
2.5–2.99	0.279	0.288
3.0–3.49	0.320	0.337

(N)	Before Imputation (10,420)	After Imputation (10,420)
3,5	0.216	0.223
Missing	0.039	---
BA Institution Type		
Research	0.307	0.310
Doctoral	0.139	0.140
Comprehensive	0.356	0.358
Liberal Arts	0.149	0.152
Other Institution	0.040	0.040
Missing	0.008	---
BA Private Institution		
Missing	0.002	---
Duration of BA Enrollment		
BA < 4 years	0.323	0.343
BA 4–5 years	0.266	0.282
BA 5–6 years	0.104	0.110
BA > 6 years	0.250	0.265
Missing	0.058	---
BA Selectivity		
Least/Noncompetitive	0.172	0.172
Competitive	0.361	0.361
Very Competitive	0.257	0.257
Most/ Highly Competitive	0.143	0.143
Missing	0.067	0.067
College Major		
Business	0.221	0.221
Education	0.126	0.126
Engineer	0.061	0.061
Health	0.075	0.075
Math and Science	0.100	0.100
Social Sciences	0.165	0.165
Humanities	0.111	0.111

Source: B&B: 93/03 Longitudinal file

Notes: Proportions weighted by Panel weights; N's are unweighted and rounded to nearest 10

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Figure 1.
Enrollement in Graduate School by Race

Figure 2.
Enrollement in Graduate School by BA Institution Type

Figure 3.
Enrollement in Graduate Degree Program

Table 1

Variable Description for Analytic Sample: Means or Proportions (standard deviation)

(N)	White (8,850)	Black (630)	Hispanic (480)	Asian (460)	Total (10,420)
Female	0.540	0.670	0.604	0.447	0.546
Foreign-born	0.029	0.093	0.269	0.601	0.071
Age (s.d.)	25.173 (6.751)	26.259 (7.915)	26.084 (6.818)	23.951 (4.654)	25.223 (6.759)
Parent's Education					
Less than HS	0.028	0.219	0.213	0.061	0.044
High School	0.462	0.536	0.429	0.404	0.462
BA Recipient	0.246	0.161	0.193	0.275	0.240
Greater than BA	0.264	0.174	0.165	0.261	0.254
SAT Quartiles					
No SAT	0.197	0.244	0.292	0.294	0.209
4th Quartile	0.167	0.449	0.303	0.138	0.189
3rd Quartile	0.216	0.079	0.127	0.195	0.203
2nd Quartile	0.221	0.183	0.175	0.150	0.214
1st Quartile	0.198	0.045	0.103	0.223	0.186
College GPA					
2.5	0.135	0.321	0.213	0.168	0.152
2.5–2.99	0.280	0.377	0.328	0.293	0.288
3.0–3.49	0.345	0.211	0.304	0.369	0.337
3.5	0.239	0.091	0.154	0.170	0.223
BA Institution Type					
Research	0.310	0.183	0.319	0.455	0.310
Doctoral	0.143	0.127	0.120	0.121	0.140
Comprehensive	0.355	0.458	0.428	0.220	0.358
Liberal Arts	0.156	0.204	0.094	0.083	0.152
Other Institution	0.037	0.027	0.038	0.120	0.040
BA Private Institution	0.328	0.390	0.295	0.340	0.331
Duration of BA Enrollment					
BA < 4 years	0.355	0.239	0.246	0.332	0.343

(N)	White (8,850)	Black (630)	Hispanic (480)	Asian (460)	Total (10,420)
BA 4–5 years	0.279	0.286	0.293	0.338	0.282
BA 5–6 years	0.107	0.142	0.100	0.137	0.110
BA > 6 years	0.259	0.332	0.361	0.193	0.265
BA Selectivity					
Missing	0.061	0.060	0.095	0.142	0.067
Least/Noncompetitive	0.167	0.287	0.173	0.090	0.172
Competitive	0.367	0.380	0.352	0.240	0.361
Very Competitive	0.263	0.186	0.255	0.253	0.257
Most/Highly Competitive	0.140	0.087	0.125	0.275	0.143
College Major					
Business	0.220	0.269	0.196	0.213	0.221
Education	0.135	0.077	0.096	0.050	0.126
Engineer	0.059	0.042	0.049	0.127	0.061
Health	0.074	0.074	0.082	0.077	0.075
Math and Science	0.094	0.107	0.093	0.199	0.100
Social Sciences	0.163	0.211	0.214	0.110	0.165
Humanities	0.113	0.082	0.126	0.112	0.111

Source: B&B: 93/03 Longitudinal file

Notes: Proportions weighted by Panel weights; N's are unweighted and rounded to nearest 10

Table 2

Proportions Ever Enrolled in Graduate School

	White	Black	Hispanic	Asian	Total Sample
BA Institution Type					
Research	0.411	0.539	0.463	0.446	0.421
Doctoral	0.373	0.343	0.419	0.445	0.376
Comprehensive	0.321	0.379	0.378	0.240	0.326
Liberal Arts	0.390	0.344	0.297	0.470	0.386
Other ^a	0.292	0.246	0.374	0.058	0.261
BA Institution Control					
Public	0.348	0.410	0.408	0.317	0.353
Private	0.404	0.366	0.389	0.431	0.402
College GPA					
2.5	0.186	0.258	0.279	0.178	0.201
2.5–2.99	0.315	0.402	0.427	0.267	0.326
3.0–3.49	0.393	0.478	0.397	0.397	0.397
3.5	0.489	0.632	0.533	0.594	0.497
SAT ACT Quartile					
No test	0.168	0.333	0.342	0.168	0.301
4th Quartile	0.251	0.337	0.366	0.251	0.258
3rd Quartile	0.301	0.517	0.525	0.301	0.313
2nd Quartile	0.442	0.556	0.353	0.441	0.420
1st Quartile	0.629	0.492	0.534	0.629	0.522
BA Selectivity					
Least/Noncompetitive	0.289	0.319	0.316	0.233	0.292
Competitive	0.332	0.420	0.312	0.276	0.335
Very Competitive	0.385	0.324	0.514	0.367	0.387
Most/Highly Competitive	0.522	0.677	0.590	0.589	0.536
Missing	0.348	0.374	0.346	0.096	0.324
Average (N)	0.366 (8,850)	0.393 (630)	0.402 (480)	0.430 (460)	0.395 (10,420)

Source: B&B: 93/03 Longitudinal file

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Notes: Proportions weighted by Panel A weights; N's are unweighted and rounded to nearest 10
Sample sizes for Asians, Blacks, and Hispanics enrolled in "other" types of institutions range from 16 to 21.

Table 3

Censored Normal Regression Estimates of Timing to Graduate Enrollment (Time metric ~ semesters; Standard errors in parentheses)

	Coefficients (1) ^a	Coefficients (2) ^b	Coefficients (3) ^c	Coefficients (4) ^d
Race/Ethnicity				
Asian	-3.267 *** (0.852)	-1.963 ** (0.978)	-1.737 * (0.926)	-1.552 * (0.915)
Black	-2.050 *** (0.732)	-2.638 *** (0.752)	-5.964 *** (0.741)	-6.050 *** (0.735)
Hispanic	-1.013 (0.887)	-1.530 * (0.914)	-2.942 *** (0.890)	-2.945 *** (0.882)
White	---	---	---	---
College GPA				
2.5	---	---	---	11.513 *** (0.695)
2.5–2.99	---	---	---	6.989 *** (0.5)
3.0–3.49	---	---	---	3.393 *** (0.442)
3.5	---	---	---	---
BA Institution Type				
Research	---	---	---	---
Doctoral	---	---	-1.071 * (0.607)	-1.151 * (0.596)
Comprehensive	---	---	0.651 (0.527)	0.920 * (0.521)
Liberal Arts	---	---	1.935 (0.614)	1.746 *** (0.608)
Other	---	---	4.028 *** (1.491)	2.715 * (1.478)
BA Institution Control				
Private	---	---	-0.957 ** (0.464)	-0.522 ** (0.466)
BA Selectivity				
Least/Noncompetitive	---	---	3.685 *** (0.743)	2.529 *** (0.737)
Competitive	---	---	2.796 *** (0.625)	1.976 *** w (0.619)
Very Competitive	---	---	1.891 *** (0.579)	1.284 ** (0.571)
Most/Highly Competitive	---	---	---	---
Missing	---	---	2.306 ** (1.112)	0.971 (1.095)
Observations	10420	10420	10420	10420

Source: B&B: 93/03 longitudinal file

Note: 4120 Uncensored Observations, 6300 Right-Censored Observations

^a Estimates of base-line model with only race;

^b Include additional controls for nativity, age, sex, parents' education, duration of BA enrollment, region of BA, and BA debt;

^c Account for BA institutional characteristics by including Institutional Type, Control, and Selectivity;

^d Full model which also accounts for "achievement" by including SAT/ACT Quartile, BA GPA, length of enrollment in BA, and BA major.

* 0.10,

** 0.05,

0.01

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Average Marginal Effects (AME) on Hazard of First Graduate Program Enrollment: Base Case = No Enrollment (SE = Standard Errors)

Table 4

	Masters		First Professional		Doctorate	
	AME	SE	AME	SE	AME	SE
Race						
Asian	-0.0002	0.0026	0.0032	0.0007***	-0.0005	0.0006
Black	0.0115	0.0018***	0.0037	0.0008***	0.0016	0.0006***
Hispanic	0.0033	0.0022	0.0019	0.0008**	0.0020	0.0005***
White	---	---	---	---	---	---
College GPA						
GPA < 2.5	-0.0210	0.0018***	-0.0070	0.0009***	-0.0045	0.0007***
GPA 2.5-2.99	-0.0119	0.0013***	-0.0041	0.0005***	-0.0028	0.0004***
GPA 3.0-3.49	-0.0055	0.0011***	-0.0022	0.0004***	-0.0020	0.0003***
GPA > 3.5	---	---	---	---	---	---
BA Institution Type						
Research	---	---	---	---	---	---
Doctoral	0.0039	0.0014***	-0.0009	0.0005*	-0.0005	0.0004
Comprehensive	0.0006	0.0013	-0.0027	0.0005***	-0.0010	0.0004**
Liberal Arts	-0.0005	0.0015	-0.0031	0.0006***	-0.0003	0.0004
Other	-0.0045	0.0035	-0.0049	0.0020**	-0.0009	0.0016
BA Institution Control						
Private	0.0008	0.0011	0.0005	0.0004	-0.0006	0.0004*
Public	---	---	---	---	---	---
BA Selectivity						
Least/Non	-0.0044	0.0018**	0.0000	0.0007	-0.0009	0.0006
Competitive	-0.0024	0.0015	-0.0007	0.0006	-0.0013	0.0004***
Very Competitive	-0.0016	0.0015	-0.0004	0.0005	-0.0004	0.0004
Highly/Most	---	---	---	---	---	---
Missing	-0.0016	0.0026	-0.0007	0.0012	-0.0028	0.0014*

Years Since BA	Masters		First Professional		Doctorate	
	AME	SE	AME	SE	AME	SE
1 year	---	---	---	---	---	---
2 year	-0.0145	0.0012 ***	-0.0029	0.0004 ***	-0.0025	0.0004
3 year	-0.0239	0.0015 ***	-0.0052	0.0006 ***	-0.0040	0.0006 ***
4 year	-0.0273	0.0016 ***	-0.0068	0.0008 ***	-0.0044	0.0007 ***
5 year	-0.0282	0.0017 ***	-0.0071	0.0009 ***	-0.0036	0.0006 ***
6 year	-0.0293	0.0018 ***	-0.0079	0.0010 ***	-0.0037	0.0007 ***
7 year	-0.0347	0.0021 ***	-0.0085	0.0012 ***	-0.0039	0.0007 ***
8 year	-0.0414	0.0024 ***	-0.0082	0.0012 ***	-0.0047	0.0009 ***
9 year	-0.0391	0.0024 ***	-0.0089	0.0013 ***	-0.0043	0.0008 ***
10 year	-0.0430	0.0022 ***	-0.0110	0.0015 ***	-0.0071	0.0014 ***

Source: B&B: 93/03 Longitudinal file. N = 137,450 (semester-years)

Notes: Estimates net of controls for nativity, age, sex, parents' education, SAT/ACT scores, duration of BA enrollment, region of BA institution, BA Debt and BA major. Clustering standard errors by individual ID adjusts for the person-specific inter-temporal correlations, but results in more conservative significance levels.

*** 0.10,

** 0.05,

* 0.01

Table 5

Group-Specific Predicted Probability of Ever Enrollment in Graduate School by Program Type and Institutional Mission

	Time Since BA		
	1 Year	5 Year	10 Years
Masters			
Blacks, Research	0.1345	0.3469	0.4664
Blacks, Liberal Arts	0.1474	0.3583	0.4741
Hispanics, Research	0.1044	0.2698	0.3673
Hispanics, Liberal Arts	0.1105	0.2740	0.3692
Whites, Research	0.1026	0.2510	0.3390
Whites, Liberal Arts	0.1050	0.2510	0.3369
First Professional			
Blacks, Research	0.1681	0.3271	0.3902
Blacks, Liberal Arts	0.0805	0.1615	0.1960
Hispanics, Research	0.1087	0.2157	0.2601
Hispanics, Liberal Arts	0.0503	0.1013	0.1233
Whites, Research	0.0724	0.1410	0.1698
Whites, Liberal Arts	0.0324	0.0636	0.0771
Doctorate			
Blacks, Research	0.0780	0.1336	0.1732
Blacks, Liberal Arts	0.0731	0.1215	0.1553
Hispanics, Research	0.1004	0.1661	0.2111
Hispanics, Liberal Arts	0.0909	0.1476	0.1862
Whites, Research	0.0395	0.0649	0.0827
Whites, Liberal Arts	0.0345	0.0560	0.0709

Source: B&B: 93/03 Longitudinal file. N = 137,450 (semester-years)

Notes: Predicted probabilities of enrollment estimated from marginal effects given in Table 4, some of which are not statistically significant.

Controls at: highest levels of achievement or modal/mean/reference categories otherwise (specifically: age = mean, female, native, no debt, New England, social science major, Public BA, BA length of enrollment less than 4 years, highest GPA, first quartile, most selective BA)

Table 6

Proportions Completing First Advanced Degree Enrollment as of 2003

(Unweighted N)	Masters (3,300)	First Professional/PhD (800)
Race/Ethnicity		
White	0.551 ^{ref}	0.461 ^{ref}
Black	0.487*	0.353*
Hispanic	0.473	0.575
Asian	0.584	0.584
College GPA		
GPA < 2.5	0.414	0.590
GPA 2.5–2.99	0.525	0.434
GPA 3.0–3.49	0.568	0.493
GPA >3.5	0.573 ^{ref}	0.460 ^{ref}
BA Institution Type		
Research	0.592 ^{ref}	0.467 ^{ref}
Doctoral	0.546	0.507
Comprehensive	0.514***	0.473
Liberal Arts	0.529	0.486
Other	0.473	0.112
BA Institution Control		
Public	0.533	0.451
Private	0.563 ^{ref}	0.507 ^{ref}
BA Selectivity		
Least/Non Competitive	0.451***	0.474
Competitive	0.521***	0.506
Very Competitive	0.553***	0.455
Highly/Most Competitive	0.669 ^{ref}	0.480 ^{ref}
Missing	0.510***	0.274
Average Completed	0.544	0.472
% Completed	54.4	47.2
% Still Enrolled	14.4	9.9
% Stopped	31.2	42.8

Source: B&B 93/03 Longitudinal file, N=4,090

Note: Proportions weighted by Panel AW weights

A two-sample t-statistics between this group and the reference category rejects that proportions are equal by * 10% level, ** 5% level, or ***1% level

Table 7

Average Marginal Effects (AME) on Completion of First Advanced Degree by Program Type (SE = Standard Errors)

	Masters		PhD/1st Professional	
	AME	SE	AME	SE
Race				
Asian	−0.0091	0.0148	−0.0143	0.0167
Black	−0.0023	0.0117	−0.0001	0.0192
Hispanic	−0.0225	0.0117*	−0.0138	0.0226
White	---	---	---	---
College GPA				
GPA < 2.5	−0.0556	0.0105***	0.0146	0.0165
GPA 2.5–2.99	−0.0258	0.0071***	−0.0016	0.0110
GPA 3.0–3.49	−0.0140	0.0060**	0.0070	0.0086
GPA >3.5	---	---	---	---
BA Institution Type				
Research	---	---	---	---
Doctoral	−0.0107	0.0085	0.0033	0.0019
Comprehensive	−0.0075	0.0059	0.0056	0.0112
Liberal Arts	−0.0117	0.0071	−0.0328	0.0106***
Other	−0.0251	0.0085	−0.1086	0.0581*
BA Institution Control				
Private	−0.0036	0.0063	−0.0046	0.0095
BA Selectivity				
Least/Noncompetitive	−0.0256	0.0102**	0.0262	0.0189
Competitive	−0.0226	0.0085***	0.0169	0.0121
Very Competitive	−0.0207	0.0079***	0.0185	0.0111*
Most/Highly Competitive	---	---	---	---
Missing	0.0253	0.0150*	0.0032	0.0216
Years Since Enrollment				
1 year	---	---	---	---
2 years	0.2122	0.0087***	0.0924	0.0269***
3 years	0.2540	0.0092***	0.2434	0.0237***
4 years	0.2319	0.0109***	0.2746	0.0244***
5 years	0.1611	0.0153***	0.2421	0.0271***
6 years	0.1373	0.0190***	0.1917	0.0338***
7 years	0.1063	0.0245***	0.2771	0.0294***
8 years	0.0869	0.0420**	0.2491	0.0382***
9 years	0.0565	0.0393	0.2234	0.0516***
10 years	0.0935	0.0472**	0.2224	0.0557***

Source: B&B: 93/03 Longitudinal file. N=15,310 for Masters (person-semester), N= 4370 for First Professional/Doctorate (person-semester)

Notes: Base Case = Still enrolled. Coefficients for the hazard of dropping out not reported.

Estimates net of controls for nativity, age, sex, parents' education, SAT/ACT scores, duration of BA enrollment, debt, region of BA institution, and BA major. Clustering standard errors by individual ID adjusts for the person-specific inter-temporal correlations, but results in more conservative significance levels.

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Table 8

Group – Specific Predicted Probability of Advanced Degree Completion by Program Type, Institutional Mission and Enrollment Delay Status

	Years Since Enrollment	
	5 Year	10 Years
Masters		
Blacks, Research, No Delay	0.8002	0.8709
Blacks, Liberal Arts, No Delay	0.7689	0.8439
Blacks, Research, Delay	0.7398	0.8165
Blacks, Liberal Arts, Delay	0.7056	0.7849
Hispanics, Research, No Delay	0.7353	0.8139
Hispanics, Liberal Arts, No Delay	0.7002	0.7815
Hispanics, Research, Delay	0.6699	0.7509
Hispanics, Liberal Arts, Delay	0.6336	0.7154
Whites, Research, No Delay	0.8089	0.8786
Whites, Liberal Arts, No Delay	0.7780	0.8523
Whites, Research, Delay	0.7509	0.8267
Whites, Liberal Arts, Delay	0.7172	0.7958
Professional Degree/PhD		
Blacks, Research, No Delay	0.5803	0.8355
Blacks, Liberal Arts, No Delay	0.4199	0.6759
Blacks, Research, Delay	0.5192	0.7764
Blacks, Liberal Arts, Delay	0.3660	0.6049
Hispanics, Research, No Delay	0.5085	0.7701
Hispanics, Liberal Arts, No Delay	0.3568	0.5975
Hispanics, Research, Delay	0.4480	0.7026
Hispanics, Liberal Arts, Delay	0.3070	0.5257
Whites, Research, No Delay	0.5818	0.8356
Whites, Liberal Arts, No Delay	0.4213	0.6761
Whites, Research, Delay	0.5175	0.7746
Whites, Liberal Arts, Delay	0.3646	0.6027

Source: B&B: 93/03 Longitudinal file. N = 137,450 (semester-years)

Notes: Predicted probabilities of completion are estimated from marginal effects given in Table 7, some of which are not statistically significant.

Controls at: highest levels of achievement or modal/mean/reference categories otherwise (specifically: age = mean, female, native, no debt, New England, social science major, Public BA, BA length of enrollment less than 4 years, highest GPA, first quartile, most selective BA)

Delay indicates a hiatus of 4 years between BA receipt and enrollment in a masters program or a hiatus of 3 years between BA receipt and enrollment in a doctorate or professional program