

**Degree Attainment for Black Students at HBCUs and PWIs:
A Propensity Score Matching Approach**

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Abstract

HBCUs are crucially important for providing Black students with access to postsecondary opportunities. This study examines how attending an HBCU impacts chances to persist and graduate when compared to PWIs. To account for endogeneity bias and the nested data structure, we employ a propensity score matching, multilevel modeling approach. Across all dependent variables (six-year, four-year degree attainment; 1st-year persistence), we find significant positive effects. More specifically, we estimate the average treatment effect (ATE) of attending an HBCU to be within 6.0% and 16.1%, indicating significantly higher chances of success for Black students at these institutions. Results for the average treatment effect on the treated (ATET) are similar, ranging from 7.6% to 14.5%.

Keywords: Historically Black Colleges and Universities (HBCUs), retention, degree completion, student outcomes, propensity score matching

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Introduction

Historically Black Colleges and Universities (HBCUs) have attracted considerable media attention in the early weeks of the Trump Administration (i.e. Aderoju, 2017; Chiles, 2017). These institutions are a unique part of the American higher education fabric and for more than 150 years have provided crucially important access to education for students of color. HBCUs provide more supportive learning environments as well as greater access to supportive peers, faculty and staff (Allen, 1992; Arroyo & Gasman, 2014; M. M. Kim & Conrad, 2006; Palmer, Davis, & Maramba, 2010). Today, HBCUs enroll approximately 15% of all Black degree-seeking undergraduates and about 20% of all full-time, first-time Black students at four-year institutions (Nichols & Evans-Bell, 2017). HBCUs also play a critical role in access to graduate education. Data show that among doctoral degree recipients in science and engineering, for instance, 8 of 10 PhD-bound bachelor's degree recipients earned their undergraduate degree from an HBCU (Richards & Awokoya, 2012), underscoring their crucial role for the black community, the economy, and the country at large. In addition, there are beneficial long-term labor market outcomes for Black student graduates of HBCUs versus those who attend non-HBCUs (Price, Spriggs, & Swinton, 2011).

Despite their historical role and importance for U.S. higher education as well as the documented benefits of attendance, HBCUs are frequently regarded as

low-performing institutions, which in large part has been attributed to lower graduation rates when compared to other institutions (Arroyo & Gasman, 2014; M. M. Kim & Conrad, 2006). According to a recent report (Nichols & Evans-Bell, 2017), the average six-year degree completion rate for Black students at HBCUs is 32.1%, noticeably lower than the average rate of 45.4% among public and private non-HBCUs in the sample. These aggregate numbers, however, do not adequately take into account systematic differences in student factors, such as socioeconomic status and academic preparation, or institutional disparities in revenues and wealth.

Given the fact that HBCUs disproportionately enroll economically and educationally disadvantaged students, scholars and policy makers in recent years have used various approaches to more adequately compare their performance to other institutions (i.e. Nichols & Evans-Bell, 2017; Richards & Awokoya, 2012). For instance, the Education Trust compared HBCU and non-HBCU institutions within tiers of PELL grant recipient enrollment patterns and found that they outperform non-HBCUs for institutional graduate rates among Black students by 3.1% to 9.7% (Nichols & Evans-Bell, 2017). Richards and Awokoya (2012) used IPEDS data to simulate student outcomes and found that if non-HBCUs were to enroll students with the same characteristics, HBCUs would outperform them by 14 percentage points in graduation rates. These studies, however, are limited in their institutional scope and rely on institutional aggregates and simulations, thus fail to account for individual factors that contribute to student success. With this study, we seek to

contribute to this pivotal and understudied area of study, and examine how attending an HBCU affects chances to persist and complete a degree for Black students. To minimize selection bias and systemic differences in student and institutional characteristics, we rely on a quasi-experimental estimation technique and multilevel modeling. In particular, we use a nationally representative data set and carry out a propensity score matching approach to more reliably estimate effects on degree completion and student persistence.

Review of the Literature

Research on student success at HBCUs and how they compare, for instance, to PWIs is limited and shows somewhat mixed results (M. M. Kim & Conrad, 2006). Descriptive reports typically point to comparatively low persistence and graduation rates at HBCUs. For instance, Richards and Awokoya (2012) find that graduation rates for African-American students attending HBCUs are substantially lower than for African-American students attending other institutions, 31% to 41%, respectively, for six-year attainment rates. The disparity is even greater for males, 24% versus 38% (Richards & Awokoya, 2012). However, a systematic issue with this and similar reports is that these are unable to account for the differences between African-American students at historically black institutions and their peers attending predominantly white institutions, particularly in terms of academic preparation and family income. African-American students attending HBCUs are often less academically prepared and come from lower socioeconomic status families than their African American peers at white colleges (Allen, 1992).

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Not surprisingly then, after Richards and Awokoya (2012) controlled for SAT scores and Pell Grant funding, students attending HBCUs were actually more likely to graduate. Similarly, when Nichols and Evans-Bell (2017) limited their analysis to colleges where Pell receipt was between 40% and 75% (similar to those at HBCUs), the graduation rate for African-Americans at HBCUs was nearly 6 percentage points higher than that African-Americans at other institutions (37.8% versus 32%).

To examine differences in learning between African-American students attending HBCU and PWIs, Bohr et al. (1995) used data from the National Study of Student Learning to compare student improvement on the Collegiate Assessment of Academic Proficiency test by the end of the first year of college. Their study was based on 243 students at HBCUs and 162 attending other institutions and they found no significant difference in gains in reading comprehension, mathematics, or critical thinking between HBCUs and PWIs.

One significant limitation of most studies of the effect of HBCUs on learning, retention, and degree completion, is that they do not adequately model the impact of institutional characteristics (Kim & Conrad, 2006). Using Cooperative Institutional Research Program (CIRP) data to follow 941 African-American students nine years after their first year in college and a multilevel modeling approach, Kim and Conrad found that attending an HBCU did not have a significant impact on the probability of degree completion or on GPA. This showed, that once student and institutional characteristics are taken into account, differences in

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success rates between HBCUs and PWIs are equalized. The authors also found that participating in faculty research projects in senior seminars had a positive effect on degree attainment, and that students at HBCUs were more likely to participate in faculty research projects.

Qualitative researchers have also taken a closer look at factors that potentially contribute to improving retention and graduation rates at HBCUs. Palmer et al. (2010) interviewed 11 black males at an HBCU who eventually graduated from that institution despite being academically unprepared for college level courses. The researchers reported that students believed that the school's racial homogeneity, peer groups, and its remedial program contributed to the students' motivation to achieve academically and their integration into the college community. On the other hand, students discussed financing college, being unwilling to seek academic help when needed, and problems at home as important potential impediments to graduating.

Perna et al. (2009) study gives us a better sense of how institutional policies and practices impact persistence to graduation in STEM fields at Spelman College, an historically black women's college. Spelman was selected because of its track record of strong student persistence, particularly in STEM fields. The researchers conducted focus groups with students, faculty, and administrators. Among their findings was that Spelman's cooperative, as opposed to competitive, culture, the availability of academic supports, the active engagement of faculty, and

undergraduate research opportunities improved the likelihood of students persisting in STEM to graduation.

Conceptual Framework

This study is informed by Arroyo and Gasman's (2014) framework for Black student success and Nora, Barlow, Crisp's (2005) student/institution engagement model. Primarily in model building we draw from Nora, Barlow & Crisp's (2005) student/institution engagement model. Drawing off of work that Nora (2004) began by expanding frames used to study college choice to the study of first-year retention, the student/institution engagement model pushes these frames to study retention across the undergraduate life course – year-to-year and even term-to-term from initial entry till degree completion. The model emphasizes the unique interaction between students and the institution where they enroll and how that interaction is influenced by elements both within and outside of the college setting. The interaction leads to a connection between the student and the institution that in turn fosters persistence or attrition. The model incorporates the distinct precollege characteristics a student bring with them to college, including their collective high school experiences, past academic achievement, financial circumstances, specific psychosocial characteristics, and factors and circumstances that might pull them away from college. The retention model also incorporates student's initial commitments to earn a degree and to their institution, the academic and social experience a student has at their institution, the cognitive and

non-cognitive outcomes from those experiences, and later or final commitments to the institution and to earning a degree. In moving beyond the early theory on retention, notably Tinto (1993), this model was consciously designed to address retention and degree attainment for students from minoritized populations.

We use Arroyo & Gasman's HBCU centric model to frame how institutional environments specifically support success for Black students. The focus on institutional responsibility for fostering success for Black students is at the center of the framework and represents a movement away from theory and models where the onus for student success implicitly is placed on students. This framing is said to interrupt "institutional neglect" (Harper, 2009) which is propagated when institutional policies and institutional agents come from a deficit perspective (Bensimon, 2005) in addressing Black students. We bring the foundation of the framework providing a supportive environment for Black students into our modeling. The grounding aspect of providing a supportive environment is extent to which the environment is accessible and affordable for Black students coming from a range of backgrounds and experiences. Arroyo & Gasman note that one of the defining features of HBCUs in the aggregate is that they provide an example of educating students from a wealth of different backgrounds and experiences successfully alongside one another. The level to which an institution provides accessibility and affordability for Black students contributes to the extent to which students develop health identities, and cultivate values consistent supporting their communities and social justice. An environment that provides these opportunities

is theorized then to contribute through a reciprocal process to student achievement and success during the college experience. These three reciprocal processes, identity formation, values cultivation, and academic achievement and success then contribute together to degree completion and student outcomes beyond college.

Methods

To better estimate the role of HBCUs in educating and graduating Black students, this study uses a nationally representative dataset and a combination of advanced methodological approaches, namely multilevel modeling and propensity score matching to reduce influences of selection bias. In particular, we seek to analyze how attending an HBCU influences students' chances to persist or complete a degree compared to attending a PWI. Thus, we examine effects on first-year persistence and degree completion measures (four-year and six-year).

Data Source and Sample

The data for this study is drawn from three sources, the 2004 CIRP Freshman Survey (TFS), National Student Clearinghouse (NSC), and the Integrated Postsecondary Education Data System (IPEDS). The TFS is a comprehensive national dataset containing information on student background, high school experience, grades and test scores, financial resources, and expectations for college, along with other data about incoming college students. Data on retention and degree completion comes from the NSC, which tracks enrollment and degree

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completion for participating institutions in the U.S. Additionally, we include institutional context and financial characteristics from IPEDS. Through merging these data sources, CIRP created a unique dataset that allows us to explore aspects of student access and success across the higher education sector in the U.S. Initially, the 2004 TFS/NSC dataset included 210,056 students from 471 colleges and universities.

The sample for this study is restricted to first-time, full-time Black students who attended bachelor's degree granting programs either at an HBCU or PWI in 2003-04. In order to identify HBCUs, we relied on IPEDS classification data (n=19); to categorize PWIs we built on existing definitions in the literature (Brown II & Dancy II, 2010) and flagged postsecondary institutions in which Whites account for 50% or greater of the undergraduate enrollment (n=411). The final sample contains N=16,737 students attending n=430 four-year colleges and universities in the U.S (N=5,877 at HBCUs and N=10,860 at PWIs, respectively). The dependent variables are degree attainment status six and four years after initial enrollment and first-to-second year persistence (all dichotomous).

Analytic Approach - Propensity Score Matching and HGLM

To estimate effects on the specified outcome measures and minimize endogeneity, we rely on a combination of two statistical approaches. First, we use propensity score matching to reduce endogeneity bias in the estimation of HBCU attendance (Rosenbaum & Rubin, 1985; Rubin, 2006), building in similar studies that examined the impact of institutional type on student success (Heil, Reisel, &

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Attewell, 2014). Second, we use hierarchical generalized linear modeling (HGLM) to examine factors impacting degree completion at the student and institutional level and better account for the nested data structure (Raudenbush, Bryk, Cheong, & Congdon, 2004). Integrating these two advanced estimation techniques is a recent phenomenon and a field of increasing scholarly attention (J. Kim & Seltzer, 2007; Rickles, 2012).

Propensity score techniques rely upon the counterfactual framework (Rubin, 1978, 1979) and build on the premise that selection bias in observational data can be sufficiently reduced, or even removed, by eliminating differences between the groups that received and did not receive a treatment (Graham & Kurlaender, 2011). For this, a propensity score will be estimated and evaluated as the first step of the analysis. For the dichotomous treatment variable (1=attending an HBCU; 0=PWI), we use logistic regression.

To estimate influential factors on degree attainment, the main analyses will be carried out using an HGLM approach (doubly robust estimation). Separate HGLM analyses will be run for the three defined outcome measures. For ease of interpretation, final results will be reported as delta-P statistics (d-P), which, in this study, represents the change in probability of an individual to obtain a degree within six years when attending an HBCU (Cruce, 2009; Petersen, 1985).

Conceptual Model and Independent Variable Blocks

The background literature on student retention and degree attainment with particular focus in HBCUs (M. M. Kim & Conrad, 2006; Perna et al., 2009), as well as

Arroyo & Gasman's (2014) and Nora's (2005) frameworks guided the independent variable selection at the student-level for the analytical model. We include four blocks of variables in our model to represent influential factors: student background characteristics (age, gender, income parental education), academic preparation (HS GPA and SAT), financial resources (\$\$ grants, loans, family resources), initial student commitments (i.e. choice, reasons to attend, degree aspirations, distance to home), and planned academic and social experiences (i.e. living plans, planned activities). On the institutional-level, we build on Titus's (2004) and Oseguera & Rhee's (2009) work and incorporate structural-demographic characteristics, such as control, size, selectivity, and a regional control measure.

Results

In this section, we will briefly discuss descriptive statistics for the dependent variables chosen in this analysis, followed by a presentation of the results for naïve (unmatched) estimations using logistic regression with clustered standard errors (Table 3) and an HGLM model that includes full covariate controls at the student and institutional level (Table 4). We discuss these to show full model controls and also to provide a baseline for the propensity score matching results that will be discussed thereafter (see Table 5).

Descriptive Statistics

Examining descriptive results for degree completion within six years (see Table 2), our data show similar patterns found elsewhere in the literature (Nichols & Evans-Bell, 2017; Richards & Awokoya, 2012) in that Black students at PWIs graduate at higher rates. Specifically, six-year degree attainment rates (DV 1) at PWIs are 49.2%, compared to 41.4% at HBCUs – a difference of 7.8 percentage points. When assessing rates for students that either graduated in six years or are still enrolled (DV 2), the gap is marginally reduced to 6.3 percentage points. However, PWIs still show higher rates of attainment and persistence with 53.8%, compared to 47.5% for HBCUs, respectively.

A similar descriptive pattern is also found in regard to four-year attainment rates and first-year persistence, albeit with smaller institutional differences. Whereas 27.7% of Black students graduate in four years (DV 3) from a PWI, 23.7% of their peers do so from an HBCU, a 4.0 percentage point difference. When considering students that either finished in four years or are still enrolled at their initial institution (DV 4), the share at PWIs is 56.3% and 54.3% at HBCUs, respectively. Regarding first-year persistence (DV 5), our data show that about 3 out of 4 Black students at HBCUs (74.4%) return to their second year, a rate that is 4.4 percentage points lower than the persistence rate at PWIs (78.9%).

Naïve Estimations – Six-Year Degree Completion (DV 1)

Generally, results for both naïve estimations show comparable results for the impact of HBCU attendance on degree completion; however, in the opposite direction of the descriptive results. After including full covariate controls at the student and institutional level, estimators for the logistic regression (Table 3) show Black students attending HBCUs have 49.2% higher odds to graduate within six years ($b=.400$, $p<.01$; Odds ratio [OR] = 1.492). Thus, using marginal effect calculations in STATA, students attending HBCUs are 9.95% more likely to obtain a degree in this timeframe. Results for the HGLM show a similar effect for the HBCU estimator (albeit somewhat larger), with students attending these institutions having 67.4% higher odds of completing a degree ($b=.515$, $p<.01$; OR=1.674). Calculating marginal effects for the naïve multilevel model (not shown in tables), Black students are 11.9% more likely to complete a bachelor's degree in six years at an HBCU when compared to PWIs. Though these rates are not based on a matched sample of students, the magnitude of the effect at HBCUs is sizable and reflects findings recently reported elsewhere in the literature (Richards & Awokoya, 2012).

Examining selected results for student-level covariates in the HGLM model (Table 4), data show that, similar to previous studies on degree attainment (DeAngelo, Franke, Hurtado, Pryor, & Tran, 2011), women are significantly more likely to graduate than men ($b=.324$, $p<.001$) whereas older students are less likely to graduate ($b= -.071$, $p<.05$). Regarding factors related to SES, low-income

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students are significantly less likely to obtain a degree ($b = -.201, p < .05$) when compared to their high-income peers. Students in the middle-income brackets show no significant difference. Both mother and father educational level are also found to positively affect degree attainment ($b = .087, p < .001$ and $b = .056, p < .01$, respectively). Also little surprising, both high school GPA and SAT score positively predict degree completion in six years, with $b = .238 (p < .001)$ and $b = .006 (p < .001)$, respectively. Interestingly, however, most of the financial aid related measures show no significant influence on the likelihood to obtain a degree in six years.

Results Propensity Score Matching (PSM)

Propensity score estimations rely on ten separate analyses of the average treatment effect (ATE) and the average treatment effect of the treated (ATET) for the five outcome variables, using an inverse probability weighted regression adjustment (IPWRA) approach. When examining results for the propensity score estimations (see Table 5), data confirm a significant positive effect for Black students attending HBCUs over PWIs. More specifically, results for the ATE show that, after controlling for individual and institutional level factors, students at HBCUs have a 15.8% ($p < .001$) higher likelihood to graduate in six years (DV 1)¹. Thus, both the naïve logistic and HGLM analyses appear to underestimate the true effect of HBCU attendance on degree attainment. Results for the ATET are

¹ Given the dichotomous nature of the treatment variable (attending an HBCU) and also dichotomous outcome (here degree completion), results of the PSM estimation can be interpreted as the change in probability resulting from the treatment.

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marginally lower; however, still show a sizable positive effect for attending an HBCU with an increase in the likelihood to obtain a degree of 9.0% ($p < .001$).

Results for other outcome measures in four years and for first-year persistence are similar in pattern and show significant positive effects for Black students attending HBCUs, once student- and other institutional-level factors are controlled. More specifically, the ATE for four-year degree completion (DV 3) shows that students at HBCUs are 10.8% ($p < .001$) more likely to graduate; using the ATET that shows the effects for Black students that actually attended such an institution, the effect is somewhat smaller, but still points to a large, significant effect (7.6%; $p < .001$). Assessing results for students that either graduated in four years or are still enrolled (DV 4), the ATE shows Black students at HBCUs being 9.7% more likely. Interestingly, for this dependent variable the ATET is larger in effect size and estimated to be 14.5% for individuals attending HBCUs over PWIs.

The smallest effect size is found for the probability to reenroll in the 2nd year of college (DV 5). Our estimation shows that Black students attending an HBCU are 6.0% ($p < .001$) more likely to persist when compared to peers attending PWIs (ATE). The ATET is marginally higher, with students at HBCUs having a 7.0% ($p < .001$) greater chance of returning to their sophomore year compared to their peers attending PWIs.

Conclusion

HBCUs are crucially important for providing Black students with access to postsecondary opportunities. Results reported here provide further evidence that

these institutions outperform other colleges and universities in persistence and degree completion for these students, once systemic differences are taken into account. While, descriptive statistics for the national data analyzed here also show that HBCUs have lower persistence and degree attainment rates when compared to PWIs, our analyses show significant effects across all measured student outcomes, once student and institutional characteristics are taken into consideration. Naïve estimations, using logistic and multilevel approaches, examining six-year degree completion already show significant positive effects. Based on our results, student attending an HBCU are between 9.9% and 11.9% more likely to obtain a bachelor's degree in six years when compared to their Black peers attending predominantly white institutions.

These results are confirmed, using a more rigorous, doubly robust estimation approach that matches students on their individual characteristics. Across all dependent variables (6-year, 4-year, 1st-year), we find the average treatment effect of attending an HBCU to be within 6.0% and 16.1%, indicating significantly higher chances of success for Black students at these institutions. Results for the average treatment effect on the treated are similar, ranging from 7.6% to 14.5%, also underscoring the large, positive effects found here.

Our results are comparable to other, recent findings in the literature on the impact of HBCUs and their role in U.S. higher education (Nichols & Evans-Bell, 2017; Richards & Awokoya, 2012), although we report even more sizable positive effects. Based on the improving understanding of the importance of these

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institutions, we need to engage in broader discussions on adequate financial and policy support for HBCUs and similar institutions that serve marginalized populations in higher education.

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Table 1 Descriptive Statistics

Variable	Descriptives				
	N	Mean	S.D.	Min	Max
Sex (female)	16,708	1.610	0.488	1	2
Age	16,583	3.243	0.600	1	10
Income					
Quarter 1	14,792	1.485	0.500	1	2
Quarter 2	14,792	1.292	0.457	1	2
Quarter 3	14,792	1.172	0.377	1	2
Quarter 4	14,792	1.051	0.221	1	2
Father's Education	15,251	2.055	1.080	1	4
Mother's Education	16,296	2.272	1.058	1	4
High School GPA	16,473	5.474	1.658	1	8
SAT (rescaled)	14,708	97.415	15.886	42	160
No Family Resources	14,473	1.194	0.395	1	2
Less than \$2,999	14,473	1.459	0.498	1	2
\$3,000-\$5,999	14,473	1.137	0.344	1	2
\$6,000-\$9,999	14,473	1.084	0.277	1	2
\$10,000+	14,473	1.126	0.332	1	2
No Grant Aid	14,484	1.104	0.306	1	2
Less than \$2,999	14,484	1.267	0.442	1	2
\$3,000-\$5,999	14,484	1.215	0.410	1	2
\$6,000-\$9,999	14,484	1.139	0.346	1	2
\$10,000+	14,484	1.276	0.447	1	2
No Loans	13,955	1.263	0.440	1	2
Less than \$2,999	13,955	1.316	0.465	1	2
\$3,000-\$5,999	13,955	1.182	0.386	1	2
\$6,000-\$9,999	13,955	1.111	0.315	1	2
\$10,000+	13,955	1.127	0.333	1	2
HPW studying	16,067	2.940	1.232	1	5
HPW working for pay	15,979	3.115	1.987	1	6
HPW for household duties	15,933	3.205	1.521	1	6
Institutions is 1st choice	16,580	1.547	0.498	1	2
Institutions is 2nd choice	16,580	1.296	0.456	1	2
Distance Home-College	16,166	3.222	1.313	1	5
<i>Choose Instituion</i>					
My Relatives Wanted Me to Come Here	15,846	1.578	0.716	1	3
College Has Very Good Academic Reputation	15,819	2.516	0.649	1	3
The Cost of Attending this College	15,747	2.112	0.816	1	3
I Wanted to Live Near Home	15,737	1.653	0.784	1	3
Religious Affiliation/Orientation	15,572	1.404	0.627	1	3
Highest Degree Aspirations	16,054	3.084	0.843	1	4
Rate-Academic Ability	16,393	3.742	0.698	1	5
Rate-Spirituality	16,307	3.551	0.995	1	5
Liveplan	16,636	1.924	0.382	1	3

Variable	Descriptives				
	N	Mean	S.D.	Min	Max
<i>Planned Activities in College</i>					
Work Full-time while Attending College	15,417	2.049	0.939	1	4
Transfer to Another College	15,367	2.070	0.947	1	4
Communicate Regularly with Professors	15,319	3.226	0.757	1	4
<i>Inst. Level</i>					
Selectivity	16,737	103.654	14.517	80	151
Inst. Control (Private)	16,737	1.424	0.494	1	2
UG Enrollment (log)	16,737	8.467	0.875	5.771	10.314
OBE Region	16,737	3.957	1.566	1	8
% Share Faculty of Color	10,191	35.150	28.543	0	88.842

Note: Descriptive statistics based on original, unimputed dataset. Dataset imputed (n=5) using multivariate normal approach (MVN). See DeAngelo et al. (2011) for details.

Table 2 Descriptive Statistics - Dependent Variables Student Success, HBCUs and PWIs

Dependent Variables	HBCUs	PWIs	Diff.
	(%)	(%)	(pp)
DV 1: Six-Year Degree Completed	41.4	49.2	-7.8
DV 2: Six-Year Degree Completed or Still Enrolled	47.5	53.8	-6.2
DV 3: Four-Year Degree Completed	23.7	27.7	-4.0
DV 4: Four-Year Degree Completed or Still Enrolled	54.3	56.3	-2.1
DV 5: Persisted into 2nd Year	74.4	78.9	-4.4

Note: Descriptive statistics based on original, unimputed dataset. Dataset imputed (n=5) using multivariate normal approach (MVN). See DeAngelo et al. (2011) for details.

Table 3 Naïve Estimation -- Logistic Regression Results Six-Year Degree Completion (clustered SE's)

Variable	Logistic Regression Results (N=16,134)				
	Coeff.	Clust. S.E.	p	95% C.I.	
HBCU	0.400	0.118	0.001 **	0.168	0.632
Sex (female)	0.309	0.057	0.000 ***	0.196	0.421
Age	-0.065	0.032	0.045 *	-0.128	-0.002
Income (4th Quartile)					
1st Quartile (low)	-0.225	0.105	0.032 *	-0.432	-0.019
2nd Quartile (low-mid)	-0.094	0.108	0.383	-0.305	0.117
3rd Quartile (up-mid)	0.015	0.103	0.886	-0.186	0.216
Father's Education	0.091	0.022	0.000 ***	0.049	0.134
Mother's Education	0.047	0.023	0.037 *	0.003	0.091
High School GPA	0.232	0.013	0.000 ***	0.206	0.259
SAT (rescaled)	0.007	0.002	0.000 ***	0.004	0.011
Family Resources (No Family Resources)					
Less than \$2,999	-0.010	0.049	0.843	-0.105	0.086
\$3,000-\$5,999	0.036	0.069	0.605	-0.100	0.172
\$6,000-\$9,999	0.080	0.076	0.291	-0.068	0.228
\$10,000+	0.146	0.081	0.071	-0.013	0.306
Grant Aid (No Grant Aid)					
Less than \$2,999	0.060	0.067	0.369	-0.071	0.192
\$3,000-\$5,999	0.029	0.070	0.683	-0.108	0.166
\$6,000-\$9,999	0.074	0.087	0.394	-0.096	0.243
\$10,000+	0.105	0.074	0.157	-0.040	0.250
Loans (No Loans)					
Less than \$2,999	-0.035	0.044	0.419	-0.121	0.050
\$3,000-\$5,999	-0.089	0.056	0.108	-0.198	0.020
\$6,000-\$9,999	-0.023	0.067	0.733	-0.155	0.109
\$10,000+	0.003	0.066	0.960	-0.127	0.134
Distance Home-College	0.003	0.019	0.880	-0.035	0.040
Institutions is 1st choice (3rd or less)	-0.053	0.059	0.371	-0.169	0.063
Institutions is 2nd choice (3rd or less)	-0.120	0.057	0.034 *	-0.231	-0.009
<i>Choose Institution</i>					
My Relatives Wanted Me to Come Here	0.026	0.024	0.280	-0.021	0.074
College Has Very Good Academic Reputation	0.013	0.039	0.742	-0.063	0.089
The Cost of Attending this College	0.088	0.026	0.001 **	0.037	0.138
I Wanted to Live Near Home	0.008	0.025	0.748	-0.041	0.058
Religious Affiliation/Orientation	0.009	0.033	0.790	-0.056	0.074
Highest Degree Aspirations					
Bachelors degree	0.117	0.110	0.284	-0.097	0.332
Masters degree	0.232	0.106	0.029 *	0.024	0.439
Doctorate degree	0.116	0.111	0.297	-0.102	0.335
Liveplan (with family)					
Live on campus	0.408	0.100	0.000 ***	0.213	0.604
Other living arrangement	-0.188	0.128	0.142	-0.439	0.063

Logistic Regression Results (N=16,134)						
Variable	Coeff.	Clust. S.E.	p	95% C.I.		
Planned Activities in College						
Work Full-time while Attending College	-0.122	0.027	0.000 ***	-0.175	-0.070	
Transfer to Another College	-0.144	0.022	0.000 ***	-0.187	-0.101	
Communicate Regularly with Professors	0.072	0.030	0.017 *	0.013	0.132	
Selectivity	0.038	0.005	0.000 ***	0.028	0.048	
Inst. Control (Private)	-0.304	0.199	0.128	-0.694	0.087	
UG Enrollment (<i>log</i>)	0.006	0.068	0.935	-0.127	0.138	
OBE Region						
New England	0.356	0.162	0.028 *	0.038	0.673	
Mid East	0.205	0.120	0.089	-0.031	0.441	
Great Lakes	-0.341	0.109	0.002 **	-0.554	-0.127	
Plains	-0.267	0.140	0.056	-0.542	0.007	
Southwest	-0.302	0.149	0.043 *	-0.595	-0.010	
Rocky Mountains	-0.897	0.316	0.005 **	-1.517	-0.278	
Far West	0.422	0.142	0.003 **	0.145	0.700	
Constant	-6.669	0.955	0.000 ***	-8.540	-4.798	

Note: Reference categories are displayed in parenthesis.

* p<0.05; ** p<0.01; *** p<0.000

Table 4 Naïve Estimation -- HGLM Results Six-Year Degree Completion (DV1)

Variable	HGLM results (N=16,134; n=428)				
	Coeff.	S.E.	p	95% C.I.	
HBCU	0.515	0.167	0.002 **	0.187	0.843
<i>Student Level</i>					
Sex (female)	0.324	0.041	0.000 ***	0.243	0.403
Age	-0.071	0.033	0.033 *	-0.137	-0.006
Income (4th Quartile)					
1st Quartile (low)	-0.201	0.096	0.037 *	-0.390	-0.013
2nd Quartile (low-mid)	-0.073	0.093	0.435	-0.256	0.110
3rd Quartile (up-mid)	0.063	0.095	0.507	-0.123	0.250
Father's Education	0.087	0.021	0.000 ***	0.047	0.128
Mother's Education	0.056	0.021	0.007 **	0.015	0.097
High School GPA	0.238	0.013	0.000 ***	0.212	0.264
SAT (rescaled)	0.006	0.002	0.000 ***	0.003	0.009
Family Resources (No Family Resources)					
Less than \$2,999	0.007	0.051	0.897	-0.093	0.106
\$3,000-\$5,999	0.035	0.066	0.593	-0.094	0.164
\$6,000-\$9,999	0.066	0.079	0.402	-0.088	0.220
\$10,000+	0.109	0.078	0.165	-0.045	0.262
Grant Aid (No Grant Aid)					
Less than \$2,999	0.130	0.066	0.049 *	0.000	0.260
\$3,000-\$5,999	0.098	0.07	0.163	-0.040	0.235
\$6,000-\$9,999	0.120	0.077	0.118	-0.030	0.270
\$10,000+	0.111	0.074	0.135	-0.035	0.256
Loans (No Loans)					
Less than \$2,999	-0.060	0.049	0.226	-0.157	0.037
\$3,000-\$5,999	-0.118	0.058	0.040 *	-0.231	-0.005
\$6,000-\$9,999	-0.024	0.067	0.721	-0.154	0.107
\$10,000+	-0.052	0.068	0.439	-0.185	0.080
Distance Home-College	0.011	0.018	0.540	-0.024	0.046
Institutions is 1st choice (3rd or less)	-0.080	0.056	0.153	-0.189	0.030
Institutions is 2nd choice (3rd or less)	-0.116	0.057	0.043 *	-0.228	-0.004
<i>Choose Institution</i>					
My Relatives Wanted Me to Come Here	0.022	0.026	0.406	-0.030	0.074
College Has Very Good Academic Reputation	0.012	0.032	0.708	-0.050	0.074
The Cost of Attending this College	0.090	0.024	0.000 ***	0.043	0.138
I Wanted to Live Near Home	0.014	0.026	0.588	-0.038	0.066
Religious Affiliation/Orientation	0.021	0.031	0.493	-0.040	0.083
Highest Degree Aspirations					
Bachelors degree	0.108	0.118	0.361	-0.123	0.339
Masters degree	0.230	0.116	0.048 *	0.002	0.457

Variable	HGLM results (N=16,134; n=428)				
	Coeff.	S.E.	p	95% C.I.	
Doctorate degree	0.099	0.117	0.397	-0.130	0.329
Liveplan (with family)					
Live on campus	0.346	0.068	0.000 ***	0.213	0.479
Other living arrangement	-0.246	0.118	0.037 *	-0.477	-0.015
Planned Activities in College					
Work Full-time while Attending College	-0.132	0.02	0.000 ***	-0.172	-0.092
Transfer to Another College	-0.148	0.021	0.000 ***	-0.189	-0.108
Communicate Regularly with Professors	0.091	0.026	0.000 ***	0.041	0.141
<i>Institutional Level</i>					
Selectivity	0.044	0.004	0.000 ***	0.036	0.052
Inst. Control (Private)	-0.077	0.133	0.563	-0.337	0.183
UG Enrollment (<i>log</i>)	0.041	0.068	0.545	-0.092	0.174
OBE Region					
New England	0.499	0.177	0.005 **	0.152	0.840
Mid East	0.280	0.11	0.011 *	0.064	0.496
Great Lakes	-0.227	0.136	0.095	-0.493	0.040
Plains	-0.179	0.166	0.281	-0.504	0.146
Southwest	-0.265	0.189	0.161	-0.634	0.105
Rocky Mountains	-0.929	0.461	0.044 *	-1.833	-0.024
Far West	0.405	0.193	0.035 *	0.028	0.783
Constant	-8.093	0.879	0.000 ***	-9.816	-6.369

Note: Reference categories are displayed in parenthesis.

* p<0.05; ** p<0.01; *** p<0.000

Table 5 Estimated Treatment Effects -- HBCU Attendance on Student Outcomes (N=16,134)

Inverse Probability Weighted Regression Adjustment (IPWRA)	Coef.	Robust S.E.	z-value	p
DV 1: Six-Year Degree Completed				
ATE	0.158	0.012	13.12	0.000***
ATET	0.090	0.013	7.21	0.000***
DV 2: Six-Year Degree Completed or Still Enrolled				
ATE	0.161	0.012	13.58	0.000***
ATET	0.106	0.013	7.91	0.000***
DV 3: Four-Year Degree Completed				
ATE	0.108	0.017	6.32	0.000***
ATET	0.076	0.009	8.73	0.000***
DV 4: Four-Year Degree Completed or Still Enrolled				
ATE	0.097	0.017	5.63	0.000***
ATET	0.145	0.014	10.53	0.000***
DV 5: Persisted into 2nd Year				
ATE	0.060	0.009	6.35	0.000***
ATET	0.070	0.015	4.65	0.000***

Note: All estimations performed in STATA 15; N=16,188. IPWRA is a doubly robust estimator that includes full covariate controls (see HGLM Model) on the student and institutional level.

* = $p < .05$, ** = $p < .01$, *** = $p < .000$

Figure 1: Overlap Chart for Common Support Examination, by HBCU Status (Treatment)

