



PROJECT MUSE®

The Effect of State Appropriations on College Graduation
Rates of Diverse Students

Aaron S. Horn, Olena G. Horner, David A. Tandberg, Robert K.
Toutkoushian, Shaun N. Williams-Wyche



Journal of Education Finance, Volume 49, Number 1, Summer 2023, pp.
26-64 (Article)

Published by University of Illinois Press

➔ For additional information about this article

<https://muse.jhu.edu/article/908610>

The Effect of State Appropriations on College Graduation Rates of Diverse Students

Aaron S. Horn, Olena G. Horner, David A. Tandberg, Robert K. Toutkoushian, and Shaun N. Williams-Wyche

ABSTRACT

This study estimates the effect of state appropriations on the graduation rates of freshman cohorts by race/ethnicity. Data were obtained for public four-year institutions ($n = 415$) representing six freshman cohorts between 2007 and 2012. Hybrid regression models indicated that a ten percent increase in appropriations would yield a percentage point increase in graduation rates of .59 for all students, .99 for Black students, .84 for Latinx students, and .59 for White students. However, the effect of state appropriations on graduation rates varied across institutions (-1.03 to 2.99 percentage point change) and was frequently larger at institutions with medium or high subsidy reliance (.70 to 1.39 percentage point change). Also, the effect of state appropriations on Black student graduation rates was 2.48 times larger at HBCUs. This study suggests that state appropriations can be an effective instrument for raising the graduation rates of diverse students to help meet state attainment goals.

THE EFFECT OF STATE APPROPRIATIONS ON COLLEGE GRADUATION RATES OF DIVERSE STUDENTS

Relatively low graduation rates among students of underrepresented racial and ethnic backgrounds have long plagued higher education in the United States (Bowen, Chingos, and McPherson 2009). The percentage of students starting at a public four-year institution who ultimately complete a bachelor's degree within six years is much lower among Black (48 percent) and Latinx (57 percent) students

Author Note: An earlier version of this paper was presented at the annual meeting of the Association for the Study of Higher Education in San Juan, PR, in November, 2021.

Acknowledgments: The authors gratefully acknowledge the financial support of the Joyce Foundation and encouragement of Sameer Gadkaree.

Aaron S. Horn, Midwestern Higher Education Compact; Olena G. Horner, University of Minnesota; David A. Tandberg, Adams State University; Robert K. Toutkoushian, University of Georgia; Shaun N. Williams-Wyche, Midwestern Higher Education Compact

than among Asian (79 percent) and White (71 percent) students (National Student Clearinghouse 2022).¹ Consequently, underrepresented students are arguably less likely to reap the full benefits of a college education, such as higher income, better health, and greater intergenerational mobility (McMahon 2009; Mayhew et al. 2016; Torche 2011). Low completion rates can also fail to maximize the myriad social and economic benefits of higher education for local communities, states, and the nation, including greater employment growth (Shapiro 2006), lower crime rates (Lochner 2004), higher levels of civic engagement (Verba et al. 1995), public welfare savings (Landon 2006), and higher tax revenues (Trostel 2010). The potential economic and social consequences of failing to raise college completion rates among underrepresented groups may increase if left unchecked, as population projections through 2060 indicate that the White population will shrink by ten percent, compared to an increase in the Black and Latinx populations by 41 percent and 94 percent, respectively (Johnson 2020).

As college completion has become more consequential for individual well-being, social development, and economic growth, however, public investments in colleges and universities have declined. In the wake of the 2001 and 2008 recessions, competing budgetary priorities, and limited increases in tax revenue, state and local support of \$10,207 per FTE student in 2000 fell to \$8,508 by 2020 in constant dollars (SHEEO 2021). Concomitantly, the real cost of higher education—along with costs in other personal service industries—has risen significantly over the past few decades (Archibald and Feldman 2018). The financial milieu in higher education was further altered through the proliferation of state performance-based funding models (Dougherty et al. 2016), which were frequently used to incentivize institutions to increase degree completions but had the unintended consequence of penalizing institutions with fewer resources and larger proportions of minority students (Hagood 2019; Horn and Lee 2019; Ortagus et al. 2020).

Since public colleges depend heavily on state funding for educational operations (NCES 2021), the confluence of recent trends raises the urgent question of whether changes in state funding for higher education affect the ability of institutions to improve graduation rates, particularly among underrepresented racial and ethnic groups. The current study begins to address this question through an analysis of state appropriations and the six-year graduation rates of all students as well as the graduation rates of three subgroups, including Black, Latinx, and White students. Using a six-year panel dataset of entering freshman cohorts at public four-year institutions, the analyses show how graduation rates

1. Estimates are based on the authors' analysis of students in the 2015 cohort who started at a public four-year institution and completed a credential at any four-year institution within six years.

can be expected to change as a function of varying levels of state appropriations revenue within institutions. Moreover, as institutions may differ in how they respond to changes in state funding and utilize resources to improve educational conditions, variance in the effect of state appropriations is also estimated, and interactions with institutional type are tested for Carnegie Classification, minority-serving status, and subsidy reliance.

BACKGROUND: STATE APPROPRIATIONS, TUITION, AND EDUCATIONAL EXPENDITURES

State appropriations refer to funding allocated by state governments for an institution's current operating expenses, excluding funding for particular projects and programs as well as funding earmarked for purchasing, developing, or improving capital (NCES 2022). State appropriations are used for two broad purposes: (1) to offset some portion of tuition and fees for resident students and (2) to cover some share of the cost of educating students. State appropriations have constituted a substantial though declining proportion of revenue for public colleges and universities. As the Great Recession approached, for instance, state appropriations amounted to 23.8 percent of total revenue for all public four-year institutions in 2007-08, compared to tuition and fees amounting to 17.9 percent (NCES 2021). Over the following decade, the share of state appropriations revenue had declined to 16.6 percent of total revenue by 2017-18, whereas the share of revenue from tuition and fees had increased to 20.5 percent (NCES 2021).

The growth in tuition amidst declines in state appropriations is consistent with resource dependency theory, which maintains that organizations attempt to diversify revenue streams to reduce reliance on an unstable source that could threaten organizational survival (Pfeffer and Salancik 2003; Slaughter and Leslie 1997). Indeed, researchers have consistently documented a negative relationship between state appropriations and tuition rates as public four-year institutions often resort to tuition increases in response to reductions in state funding (Bound et al. 2019; Koshal and Koshal 2000; Mumper and Freeman 2005; Webber 2017; Zhao 2018). The degree of tuition increase, however, does not fully compensate for lost revenue from state appropriations on average (Zhao 2018). Using a very conservative approach, Webber (2017) estimated a pass-through rate from cuts in state appropriations to increases in tuition and fee revenue of between 25 and 30 percent, and thus for every \$1,000 per student cut in state appropriations, the average student would pay \$257 more in tuition and fees. Bound et al. (2019) further elaborated that the pass-through rate varies by institutional type: a ten percent reduction in state appropriations would result in a tuition increase of

\$340 at non-research universities and \$840 at research universities.

In conjunction, while holding tuition constant, changes in state appropriations can have significant effects on educational expenditures (Bound et al. 2019; Deming and Walters 2018; Leslie, Slaughter, Taylor, and Zhang 2012; Zhao 2018). Zhao's (2018) analysis of public doctoral institutions indicated that a \$1 reduction in state appropriations was associated with a decline of \$0.50 in education and related expenditures, which predominantly affected instructional expenditures. Moreover, institutions that rely significantly on appropriations for educational expenditures may be particularly sensitive to changes in state funding (Taylor and Cantwell 2019). High subsidy-reliant institutions may not only have a limited ability to compensate for appropriation reductions by raising tuition rates but also to benefit from appropriation increases by sustaining tuition revenue (thereby growing total revenue). Accordingly, changes in state appropriations have been more strongly correlated with instructional expenditures at non-research universities than at flagship research universities, which are better able to compensate for state funding losses by increasing tuition rates and expanding non-resident student enrollment (Bound et al. 2019; see also Jaquette and Curs 2015).

LINKING STATE APPROPRIATIONS AND GRADUATION RATES

State appropriations can be conceptually linked to graduation rates within Astin's (1993) input-environment-output (I-E-O) model, wherein colleges admit students with particular attributes as inputs into learning environments with varying levels of quality to convert them into, ideally, well-educated graduates. Following the I-E-O model, an institution can improve graduation rates by increasing the proportion of admitted students with a high likelihood of success (e.g., raising admissions selectivity) or, key to the current study, improving the quality of the learning environment with respect to the human and physical capital, programs, practices, and policies conducive to degree completion (see Horn and Tandberg 2018). As state appropriations and tuition are the main sources of educational expenditures (Leslie, Slaughter, Taylor, and Zhang 2012), changes in appropriations while holding tuition constant can affect the quality of the learning environment in such critical areas as instruction (e.g., full-time faculty, number of course offerings), academic support (e.g., academic administration, curricular development), and student services (e.g., admissions, counseling, student activities). Indeed, educational expenditures in these areas have been positively, though not uniformly, associated with graduation rates and other student outcomes (Astin 1993; Chen 2012; Crisp et al. 2018; Gansemer-Topf and Schuh 2006; Garcia 2013; Hamrick et al. 2004; Pike and Robbins 2020; Ryan 2004; Titus 2006; Toutkoushian and Smart 2001; Webber and Ehrenberg

2010; Webber 2012; see also Mayhew et al. 2016; Pike et al. 2011).

Studies on student-faculty ratios, contingent faculty, and course registration policies—factors that partly depend on financial resources (e.g., Ehrenber 2003; Kezar and Eaton 2014)—provide concrete illustrations of the potential impact of changes in educational revenue. For example, in their analysis of eight-year completion rates in NLS:72 and NELS:92, Bound et al. (2010) found that increases in the student-faculty ratio explained about 25 percent of the decline in the average completion rate from 51 percent in the NLS:72 cohort to 46 percent in the NELS:92 cohort. Consequential changes in educational quality are also evident in other cost-containment measures, such as the replacement of full-time faculty with part-time faculty (Kezar and Eaton 2014). The proportion of part-time faculty on campus or exposure to part-time faculty has been negatively associated with student persistence and graduation rates at four-year institutions (Ehrenberg and Zhang 2005; Eagan and Jaeger 2008), which may be attributed to relatively lower instructional effectiveness (Umbach 2007). Finally, in his study of community colleges in California, Bahr et al. (2015) found that registration priority policies were used to manage student demand for coursework that surpassed institutional capacity, which erected barriers to degree progress for students relegated to course waitlists.

Accordingly, a central assumption in the current study is that state appropriations revenue influences graduation rates through a quality rather than price mechanism. Although a significant rise in tuition rates at public four-year institutions can influence enrollment decisions (Levine, Ma, and Russell 2020), fluctuations in tuition rates have not been negatively associated with the enrollment of low-income students (Cook and Turner 2022), the total number of degrees conferred (Deming and Walters 2018; Zhao 2018), or graduation rates (Zhang 2009). In fact, since more selective institutions generally have both higher tuition and graduation rates, regression models can yield a positive effect of tuition and fees on graduation rates (Zhang 2009).

RESEARCH ON THE EFFECT OF APPROPRIATIONS ON DEGREE COMPLETION

A few studies have examined the effect of state appropriations on graduation rates (Chakrabarti, Gorton, and Lovenheim 2020; Heck et al. 2014; Zhang 2009). Zhang (2009) analyzed a longitudinal panel of four-year institutions with cohorts entering between 1991 and 1998. His institutional fixed-effects model indicated that graduation rates would increase by .64 percentage points for every ten percent increase in state appropriations per FTE student, though the effect was larger at research/doctoral universities (1.10 percentage point increase) than at master's and baccalaureate colleges (.56 percentage point increase). Heck et

al.'s (2014) multi-level analysis of public four-year institutions between 1997 and 2007 indicated that a one SD increase in state-level appropriations was associated with a .28 SD increase in institutional graduation rates. Finally, using National Student Clearinghouse outcomes panel data between 2014 and 2018, Chakrabarti, Gorton, and Lovenheim's (2020) instrumental variable analysis indicated that a \$1,000 per student increase in state appropriations for four-year institutions is associated with a 1.5 percentage point increase in the probability that a student earns a bachelor's degree by age 25.

In a related area of research, two studies showed positive effects of resources on graduation rates among underrepresented student groups, though the role of state funding in particular was not examined (Crisp et al. 2018; Garcia 2013). Crisp, Doran, and Reyes (2018) used Bayesian model averaging with public four-year broad access institutions (those with an admissions rate of at least 80 percent) and found that a composite finance variable, including revenue and expenditures, was positively associated with the graduation rates of Black and Latinx students. Given their use of a composite finance variable, however, specific inferences about the significance of state funding cannot be made.

In contrast to the small number of studies analyzing graduation rates, a growing body of research has focused on the effect of appropriations on the number of degrees conferred (Bound et al. 2019; Deming and Walters 2018; Monarrez, Hernandez, and Rainer 2021; Titus 2009; Trostel 2012; Zhao 2018; cf. Titus, Gray, and Lue 2022). For example, Zhao (2018) conducted a fixed-effects panel regression to examine the effect of state appropriations at public institutions between 1987 and 2012. While controlling for net tuition and fee revenue, his results indicated that a one SD reduction in state appropriations per FTE student was associated with a decline of .44 bachelor's degrees per 100 FTE students at master's universities, though no effects were reliably detected at doctoral and bachelor's institutions. Bound et al. (2019) used instrumental variable fixed effects regression with data from 1996 to 2012 and found that a 10 percent increase in state appropriations was associated with a 3.5 percent increase in bachelor's degrees conferred at research universities, though effects were not significant among AAU-member universities and non-research universities.

More recently, Monarrez, Hernandez, and Rainer (2021) used fixed effects regression to estimate the effect of state appropriations between 1994 and 2017 on degrees conferred by race and ethnicity across institutions that varied in their degree of reliance on state appropriations for total revenue. They found that the effect of total state appropriations on degrees conferred was greater at high appropriations-dependent institutions relative to low and medium appropriations-dependent institutions. The effect was also generally larger for Asian, Black, and Hispanic students than for White students. Specifically, a

one percent increase in appropriations at institutions in which appropriations constituted 45 percent to 82 percent of revenue was associated with a .27 percent increase in degrees conferred to Asian students, .28 percent increase for Black students, .25 percent increase for Hispanic students, and .20 percent increase for White students.

RELATIONSHIP BETWEEN INSTITUTIONAL TYPE AND GRADUATION RATES

As indicated above, the relationship between state appropriations and completion outcomes may vary by institutional type, which has been frequently identified in past research as a significant source of variation in graduation rates. Following Berger and Milem's (2000) conceptual model of college student outcomes, structural-demographic attributes of institutions as well as student characteristics are presumed to be correlated with graduation rates by reflecting or affecting students' predispositions, opportunities, and experiences related to academic and social engagement. Three types of structural variables are of particular interest in the current study, namely Carnegie Classification, subsidy reliance, and minority-serving status.

Analyses of Carnegie classification have revealed variation in student engagement by classification type (McCormick et al. 2009) but have yielded mixed effects on graduation rates, including a positive effect of being a master's university relative to a baccalaureate college (Pike and Robbins 2020; Toutkoushian 2019), a negative effect of being a doctoral university (Oseguera 2005), and no direct effects of any classification type (Horn and Lee 2016; Pike and Graunke 2015). Regarding subsidy reliance, Taylor and Cantwell's (2019) stratification typology showed that institutions characterized by low dependence on tuition revenue for educational expenditures and low per-student expenditures had relatively low graduation rates. However, Titus's (2006) regression analysis indicated that appropriations as a percentage of total revenue was not directly associated with the student's likelihood of graduation.

Most research on minority-serving status has centered on Historically Black Colleges and Universities (HBCUs) and Hispanic Serving Institutions (HSIs). Although HBCUs and HSIs differ significantly in their origins, missions, and student populations (Conrad and Gasman 2015; Garcia 2017), they both have larger proportions of low-income and academically underprepared students as well as lower graduation rates than do non-MSIs (Flores and Park 2015). Once confounding factors are taken into account using student or institutional attributes, however, the effect of HBCU- or HSI-status on graduation rates has been either positive (Capers 2019; Pike and Robbins 2020; Richards and Awokoya 2012; Sibulkin and Butler 2005; see also Bowman and Denson 2022)

or statistically insignificant (Rodriguez and Galdeano 2015; Flores and Park 2015; Kim and Conrad 2006). For instance, although HBCUs had lower six-year graduation rates than non-HBCUs, Richards and Awokoya (2012) found that the expected graduation rate for Black students was fourteen percentage points higher at HBCUs after controlling for Pell dollars received and SAT 25th percentile scores. Indeed, qualitative studies have indicated that faculty, administrators, and peers at HBCUs provide substantial support for students (Palmer and Gasman 2008; Williams et al. 2022), and Black students at HBCUs have higher levels of satisfaction on a number of survey items related to diversity and social engagement (Outcalt and Skewes-Cox 2002). More generally, underrepresented students at high-diversity institutions report lower levels of racial stereotypes and discrimination (Hurtado and Ruiz 2012), which can affect the likelihood of departure (Fischer 2007; Johnson et al. 2014).

THE CURRENT STUDY

Three research objectives guide the current analysis. First, this study estimates the average effect of appropriations on the cohort graduation rates of all students as well as the subgroup graduation rates of Black, Latinx, and White students. State appropriations constitute an important source of revenue for educational expenditures, and thus changes in appropriations are assumed to affect institutional conditions conducive to timely degree completion. It is thus hypothesized that state appropriations will be positively associated with graduation rates while holding constant other variables such as tuition and the degree of subsidy reliance. Accordingly, this study seeks to extend past investigations that have focused on the effect of state appropriations on overall graduation rates (e.g., Zhang 2009), which limits confidence in the generalizability of effects to underrepresented student subgroups. Indeed, institutional resources may be particularly crucial for Black and Latinx students (Monarrez, Hernandez, and Rainer 2021), who are on average less academically prepared than their White counterparts (Flores et al. 2017) and may thus benefit most from resource-intensive supports (e.g., Scrivener et al. 2015; Tinto 2012). Moreover, past studies that examined the relationship between resources and the graduation rates of diverse students did not decompose within- and between-institution effects (e.g., Crisp et al. 2018), which can limit inferences about causality.

To this end, the current study utilizes hybrid fixed effects regression models with a six-year institution-level panel dataset to estimate the within-institution effects of appropriations on six-year graduation rates. In order to reduce the potential for confounding influences, several variables pertaining to institutional type, student demographics, and college costs are included in the regression models, which follows from past analyses of degree completion at the

student level (e.g., Astin and Oseguera 2012; Flores et al. 2017; Titus 2006) and institution level (Gansmer-Topf and Schuh 2006; Horn and Lee 2016; Pike 2013; Pike and Robbins 2020; Ryan 2004; Scott et al. 2006; Titus 2004; Toutkoushian 2019; Webber and Ehrenberg 2010; Zhang 2009). Consistent with past modeling approaches (Zhang 2009) and the assumption of quality rather than price as the primary causal mechanism (Deming and Walters 2018; Zhao 2018), tuition is included in the model as a control variable rather than excluded as a potential mediator. Effect estimates are then used in a simulation that illustrates the likely range of additional graduates if institutions nationwide were to receive a ten percent increase in funding.

Second, while the primary analysis estimates the average effect of appropriations on graduation rates among all institutions, this study also examines the extent to which the average effect is representative of institutions in the sample. Past research has indicated that four-year institutions vary in their efficiency (Horn, Lee, Jang, and Lee 2019; Toutkoushian 1999) and effectiveness (Horn and Lee 2016) in promoting degree completion. Accordingly, it is hypothesized that there will be significant variation in the magnitude of the effect of appropriations on graduation rates among institutions in the sample. A random slope for state appropriations is thus evaluated in the regression models, which also provides the basis for identifying possible sources of moderation.

Third, interaction tests are conducted to assess the potential moderating effect of three indicators of institutional type: Carnegie Classification, minority-serving status, and subsidy reliance. The significance of changes in appropriations for baccalaureate colleges or research universities relative to master's universities as well as HBCUs and HSIs relative to non-HBCUs and non-HSIs is examined in an exploratory fashion without directional hypotheses. Past subgroup analyses of Carnegie Classification have yielded mixed results (Bound et al. 2019; Zhang 2009; Zhao 2018), and interactions with minority-serving status have not been widely examined. However, a directional hypothesis can be propounded for subsidy reliance. Specifically, it is hypothesized that subsidy reliance positively moderates the effect of appropriations on graduation rates, as educational expenditures are likely more sensitive to fluctuations in appropriations at institutions with greater subsidy reliance. Tests for institutional type interactions are particularly relevant in the current study as Black and Latinx students comprise a larger share of the enrollment relative to White students at baccalaureate and master's institutions than at research universities, and they constitute a larger share at high subsidy-reliant institutions (Monarrez, Hernandez, and Rainer 2021) and at HBCUs and HSIs, respectively (NCES 2019).

METHODOLOGY

Data Source

A six-year institution-level panel dataset was constructed with the Integrated Postsecondary Education Data System (IPEDS). The data years for graduation rates spanned from 2007 to 2018. The sample included all colleges and universities in the nation with the following characteristics: (a) Title IV participating and degree-granting; (b) public four-year; (c) full-time, first-time undergraduate students are present with a cohort of at least 45 students; (d) Basic Carnegie Classification: research university, master's university, and baccalaureate college; (e) does not have a military or maritime specialization; (f) reported receiving state appropriations during the panel period; and (g) was not a parent in a parent-child relationship. These restrictions yielded an initial sample of 415 four-year institutions.

Three points of clarification are in order. First, two-year colleges were excluded from the sample since their cost structures, student bodies, control over tuition, and reliance on local and state appropriations can differ significantly from four-year institutions. Second, private four-year institutions were excluded from the sample for similar reasons; nationally, only 0.3 percent of state funding is allocated to private four-year institutions for operating support (SHEEO 2021). Third, following Pike and Robbins' (2020) approach, institutions that were classified as a parent in a parent-child relationship were also excluded from the sample, which also results in the exclusion of a full-child institution that does not report its own campus data. As this simple solution to the parent-child problem affected a fairly small percentage of institutions (13 percent), more sophisticated allocation and collapsing techniques were deemed unnecessary (cf. Jaquette and Parra 2014).

Variables

Data were obtained for graduation rates, state appropriations, institutional type moderators, and control variables. The data years for six-year graduation rates spanned from 2013 to 2018, and the data years for most of the predictor variables are contemporaneous with entering freshman cohorts between 2007 and 2012. Similar to past research (e.g., Zhang 2009; Bound et al. 2019), resource levels over multiple prior years are expected to affect graduation rates in any particular year. In the current study, finance variables were averaged over the cohort's first five years under a six-year time-to-completion scenario, including state appropriations, subsidy reliance, and tuition rates. All finance variables were adjusted for inflation using the Consumer Price Index to reflect 2018 dollars. Table 1 provides descriptive statistics for the first and last data years.

Graduation rates. Six-year graduation rates by race and ethnicity were

Table 1: Descriptive Statistics

	Time 1		Time 6	
	Mean	SD	Mean	SD
Dependent Variables				
Total six-year graduation rate	48.53	16.43	52.06	16.26
Black six-year graduation rate	37.60	18.83	41.89	19.01
Latinx six-year graduation rate	43.53	19.19	47.69	18.23
White six-year graduation rate	50.53	17.37	54.10	16.75
Control Variables				
Admissions rate	69.98	18.27	67.81	18.72
SAT 25th Percentile	904.83	141.16	914.60	141.91
Subsidy reliance	59.93	18.94	49.71	18.53
FTE Total Enrollment (log)	8.96	0.87	9.03	0.88
FTE Graduate Enrollment Percent (log)	6.45	1.94	6.49	1.85
Percent Female: All Students	55.33	7.78	55.38	8.03
Percent Female: Black Students	54.68	16.60	54.62	15.91
Percent Female: Latinx Students	54.99	14.39	55.64	12.48
Percent Female: White Students	53.86	10.42	53.62	10.38
Percent Underrepresented Students (log)	2.91	0.85	3.07	0.79
Percent Pell Recipient	32.18	15.31	42.21	16.42
Percent Over 25 (sqrt)	4.27	1.30	4.22	1.31
Percent delayed enrollment (log)	2.02	0.82	2.02	0.77
Tuition and Fees (log)	2.00	0.29	2.15	0.26
Average Loan (1,000's)	5.83	1.53	6.93	1.27
Average Pell Grant (log)	8.20	0.13	8.45	0.08
Average State Grant (log)	7.99	0.52	8.01	0.63
Average Institutional Grant (log)	8.19	0.52	8.35	0.53
Institutional Type Moderators				
Bachelor's Institution	0.11		0.11	
Master's or Doctoral	0.56		0.56	
Research institution	0.33		0.33	
HSI	0.07		0.07	
HBCU	0.08		0.08	
Subsidy Reliance: Low	0.33		0.33	

Table 1 (continued)

Subsidy Reliance: Medium	0.33		0.33	
Subsidy Reliance: High	0.34		0.34	
Focal Predictor				
State Appropriations (log)	17.91	0.98	17.82	1.00

obtained for six freshman cohorts entering between 2007 and 2012. Graduation rates represent the percentage of full-time, first-time, bachelor's degree-seeking students who completed their program at their starting institution within six years, minus exclusions (e.g., death, military service, Peace Corps service). Racial and ethnic categories in IPEDS are currently defined as American Indian or Alaska Native; Asian; Black or African American; Hispanic; Native Hawaiian or Other Pacific Islander; White; Two or more races; race/ethnicity unknown; and nonresident alien. In addition to graduation rates reflecting all students, three racial and ethnic categories were used in this study: Black/African American; Hispanic/Latinx; and White. The graduation rates of students in other racial and ethnic groups were not examined separately due to small cohort sizes across data years or a limited number of institutions with students in a particular group.

State appropriations. The key predictor of interest is total state appropriations, which includes funding for current operating expenses and excludes funding for particular projects and programs as well as funding earmarked for purchasing, developing, or improving capital assets (e.g., buildings, equipment, land).

Institutional type moderators. Institutional type moderators were based on Carnegie classification, subsidy reliance, and minority-serving status. The 2018 Carnegie classification was operationalized as research (high or very high), baccalaureate, or master's and doctoral non-research (the reference category). The institution's initial level of subsidy reliance in 2007 was defined by total appropriations as a percentage of educational expenditures (total spending on instruction, academic support, and student services), which was dummy-coded as low subsidy reliance (0 – 54 percent, reference category), medium subsidy reliance (55 percent - 68 percent), and high subsidy reliance (69 percent and above). These cutoffs correspond approximately with the 33rd and 67th percentiles in the subsidy reliance distribution. Institutions with low subsidy reliance had higher average graduation rates (51.96 vs. 45.14), higher SAT 25th percentile scores (923.50 vs. 868.54), and higher total log educational expenditures (18.72 vs. 18.15) than did institutions with high subsidy reliance.

Minority-serving status related to the underrepresented student subgroups in this study (Black and Latinx students) was represented by dichotomous variables

(0 = no; 1 = yes) for Historically Black Colleges and Universities (HBCUs) and Hispanic-Serving Institutions (HSIs). While an HBCU is defined in the Higher Education Act of 1965 by a mission to educate Black students (U.S. Department of Education 2022a), HSIs are defined according to several non-mission criteria with the most prominent being that (a) at least 25 percent of the institution's undergraduate FTE student enrollment is Hispanic and (b) at least 50 percent of the Hispanic students have a low income (U.S. Department of Education 2022b). Accordingly, HSIs differ in the degree to which they are intentionally engaged in serving Latinx students (Garcia 2017; Garcia, Nunez, and Sansone 2019). Similar to past analyses (e.g., Stearns, Watanabe, and Snyder 2002), the current study errs on the side of inclusivity by employing only the enrollment threshold criterion. Specifically, an institution was classified as being an HSI if at least 25 percent of its FTE undergraduate enrollment was Hispanic in 2007.

Control variables. Several control variables were created to minimize confounding influences in relation to structural attributes, student demographics, and college costs. Variables related to structural attributes and institutional type included the admissions rate, ACT/SAT scores, total enrollment, undergraduate-graduate student mix, and subsidy reliance. The admissions rate refers to the percentage of applicants who were admitted.² The institution's 25th percentile SAT test score (math plus verbal) for first-time, degree/certificate-seeking undergraduate students served as a proxy for the average academic preparedness of students. ACT scores were converted to SAT scores for institutions that have a relatively low proportion of students who submit SAT scores (e.g., ACT 2012). Institutions that systematically omit SAT/ACT scores for every panel year due to an open admission policy were imputed with the minimum SAT score.

Total enrollment was indexed by the full-time equivalent student enrollment (undergraduate and graduate). Undergraduate-graduate student mix is defined as the percentage of graduate students on campus. Since the degree of subsidy reliance can change significantly over time, a continuous indicator was defined by state appropriations revenue as a percentage of total educational expenditures.

Student demographic variables included gender, race/ethnicity, socioeconomic status, and non-traditionality. Gender and race/ethnicity data pertained directly to the degree/certificate-seeking cohorts. Gender was defined by the percentage of female students, which was calculated for each racial/ethnic group. The percentage of underrepresented students includes American Indian, Black, and Latinx students. The percentage of full-time, first-time, degree-seeking undergraduate students receiving federal grant aid served as a proxy for the socioeconomic status of students. The presence of non-traditional students was

2. Some researchers have also used the admissions yield rate as a predictor, though preliminary analyses indicated it did not improve model fit.

defined by (a) the percentage of undergraduate students aged 25 and older and (b) the percentage of first-time students who delayed enrollment, that is, did not graduate from high school within the previous 12 months.

Finally, variables related to college costs included published in-state tuition and fees as well as the average student loan debt, the average federal grant amount, the average state grant amount, and the average institutional grant amount for first-time, full-time students.

Data Analysis

Maximum likelihood hybrid regression with Huber-White robust standard errors was used to estimate the direct effect of state appropriations on six-year graduation rates for all students and students within selected racial and ethnic groups. Although the standard linear mixed model could be used, fixed effects regression models—when properly specified—are more effective in reducing omitted variable bias, thereby improving confidence in causal estimation (Schneider et al. 2017). However, whereas a standard fixed effects model using a comprehensive set of dummy variables representing institutions eliminates heterogeneity bias, it does not allow modeling of time-invariant factors, such as institutional type. The current study thus employs so-called within-between or hybrid regression (see Allison 2009; Bell and Jones 2015; Bell, Fairbrother, and Jones 2019), which provides the same within-effect results as standard fixed effects regression while also showing how time-invariant factors such as institutional type are associated with a dependent variable (e.g., graduation rates). Akin to the shortcomings of standard fixed effects models, however, hybrid regression models are nonetheless susceptible to providing biased causal estimates to the extent that relevant time-variant variables are omitted.

In the hybrid regression model, the within-institution effects of state appropriations indicate the extent to which within-institution change in state appropriations is associated with within-institution change in graduation rates. The within-institution effect of state appropriations is also hypothesized to vary significantly across institutions, and thus both fixed and random slope models are tested. As depicted below, three types of hybrid models (a, b, c) include time-invariant structural attributes (e.g., institutional type), institutional means, and deviations from institutional means. The third type of model (c) also includes interactions between state appropriations and institutional type variables.

$$(a) y_{it} = \beta_0 + \beta_{1W}(x_{it-i}) + \beta_{2B}i + \gamma z_i + u_{0i} + \epsilon_{it}$$

$$(b) y_{it} = \beta_0 + \beta_{1W}(x_{it-i}) + \beta_{2B}i + \gamma z_i + u_{0i} + u_{1i}(x_{it-i}) + \epsilon_{it}$$

$$(c) y_{it} = \beta_0 + \beta_{1W}(x_{it-i}) + \beta_{2B}i + \gamma z_i + \beta_3(\text{State Appropriations}_{it} \times \text{Institutional Type}) + u_{0i} + u_{1i}(x_{it-i}) + \epsilon_{it}$$

The equations show institutions $i = 1, \dots, n$ (level 2) that are measured at

times $t = 1, \dots, T$ (level 1). Here y_{it} is the dependent variable, x_{it} is a time-varying (level 1) independent variable, and z_i is a time-invariant (level 2) independent variable. The variable x_{it} is divided into two, with each part having a separate effect. Thus, β_{1W} represents the average within effect of x_{it} , while β_{2B} represents the average between effect of x_{it} . The γ parameter represents the between effect of the time-invariant variable z_i . β_3 represents the effect of state appropriations (a time-varying (level-1) independent variable) for each institutional type (a time-invariant (level 2) independent variable). The random part of the models includes terms at level 2: a random effect (u_{0i}) attached to the institution-level intercept and a random effect (u_{1i}) attached to the within slope for state appropriations. Variables representing the panel year, t , and state location, s , were modeled as fixed slopes using dummy variables. Finally, all models include a random error term ϵ_{it} .

The Akaike Information Criterion (AIC) was used to assess improvements in model fit. Preliminary analyses showed that AIC values were relatively high in the Black and Latinx cohort models due to variability in the number of students in the cohort. Accordingly, samples were restricted to institutions with a cohort of at least five students of the race/ethnicity in question for all six panel years.

The effect sizes were estimated in terms of the expected percentage point increase in graduation rates within institutions if appropriations were to increase by ten percent, which was calculated as the product of the coefficient for state appropriations and $\text{LN}(1.1)$. The regression models hold tuition constant, and thus the increase in state appropriations is assumed to enhance total revenue rather than offset tuition. In addition, the effect sizes were used to conduct a simulation of the number of additional completions that would have resulted from the 2012 first-time, full-time, bachelor's degree-seeking cohort at public four-year institutions nationwide.

Assumptions, Transformations, and Missing Data

The current study employs maximum likelihood estimation, which yields unbiased estimates in multilevel modeling that are comparable to those using Bayesian Markov Chain Monte Carlo, though both analytical approaches may yield biased variance estimates at the upper level with small samples (Browne and Draper 2006; Shor et al. 2007; Elff et al. 2021). Although multilevel models perform well even when normality assumptions are violated (see Maas and Hox 2003; Beck and Katz 2007; Elff et al. 2021), several variables were transformed to minimize deviations from normality and reduce the influence of outliers. A square root transformation was used for the percentage of students over the age of 25 to correct moderate positive skewness. A logarithmic transformation was used to correct positive skewness for total enrollment, the percentage of

graduate students, the percentage of students not enrolling within 12 months of high school graduation, tuition and fees, the average Pell grant, the average state grant, the average institutional grant, and state appropriations. Extreme multivariate outliers identified through standardized residuals, Cook's *D*, and Mahalanobis distance were deleted to ensure more stable solutions. A subsequent inspection of residual plots did not reveal significant deviations from normality, homoscedasticity, and linearity assumptions. Finally, the potential for multicollinearity was checked using the variance inflation factor (VIF), which indicated relatively low levels of multicollinearity. For example, the VIF for the state appropriations within-effect was less than 2.5 for all models. Finally, the presence of missing data was most significant though not problematic for the admissions rate (1.8 percent) and the 25th percentile SAT scores (2.1 percent), which totaled to 2.2 percent of all cases with missing data. Given the low rate of missingness, multiple imputation was not applied. Moreover, all available data points were included in the analyses: the deletion of missing cases in any particular year did not affect data in other years for a particular institution. The final sample size ranged from 2,112 to 2,434 cases.

RESULTS

The first section below presents the results of models predicting six-year graduation rates for all students, Black students, Latinx students, and White students. The second section extends the first analysis by adding a random slope for appropriations to assess variability in the effect of appropriations across institutions. The third section summarizes the results of interaction models that test the extent to which institutional type variables—Carnegie Classification, minority-serving status, and subsidy reliance—moderate the relationship between appropriations and graduation rates.

Within Effect of State Appropriations

The first analysis seeks to determine whether there is evidence of an effect of state appropriations on six-year graduation rates within institutions. As seen in Table 2, the addition of the state appropriations variable enhanced model fit relative to the base model containing all control and institutional type covariates ($\Delta\text{AIC} = 21.07$ to 52.97). Specifically, there was a positive association between state appropriations and six-year graduation rates, though the effects varied across models: all students of any race ($b = 6.13$), Black students ($b = 10.20$), Latinx students ($b = 8.72$), and White students ($b = 6.22$). The effect sizes can be conceptualized in terms of the expected percentage point increase in graduation rates within institutions if appropriations were to increase by ten percent and tuition were held constant: all students of any race (.58 percentage points), Black

Table 2. Hybrid Fixed Effects Regression Model Predicting Six-Year Graduation Rates by Race/Ethnicity at Public Four-Year Institutions

	All		Black		Latinx		White	
	<i>b</i>	<i>se</i>	<i>b</i>	<i>se</i>	<i>b</i>	<i>se</i>	<i>b</i>	<i>se</i>
Intercept	-135.76***	57.29	-115.32**	64.38	-185.12**	58.34	-196.91***	59.92
Control Variable Within Effects								
Admissions rate	-0.01	0.01	-0.04 ^a	0.02	-0.01	0.03	-0.02	0.01
SAT 25th Percentile	0.02**	0.01	0.02*	0.01	0.03*	0.01	0.02*	0.01
Subsidy reliance (continuous)	-0.06 ^a	0.04	-0.15 ^a	0.08	-0.17*	0.08	-0.08	0.06
FTE Total Enrollment (log)	-2.12	1.51	-11.65***	3.19	-9.25*	3.80	-3.95	2.87
FTE Graduate Enrollment Percent (log)	-0.41	0.61	1.32	1.51	0.15	1.86	0.14	0.82
Percent Female	0.14***	0.04	0.10**	0.03	0.10**	0.04	0.01	0.04
Percent Underrepresented Students	-3.64***	0.62	-4.55**	1.44	0.11	1.62	-2.40**	0.76
Percent Pell Recipient	-0.04 ^a	0.03	-0.11*	0.06	-0.06	0.06	-0.01	0.03
Percent Over 25 (sqrt)	-0.32	0.58	-2.32*	1.16	1.14	1.43	-0.42	0.72
Percent delayed enrollment (log)	-0.42	0.27	-1.55**	0.52	-0.42	0.65	0.25	0.32
Tuition and Fees (log)	9.13***	2.65	7.97 ^a	4.74	12.87*	5.34	9.51**	3.44
Average Loan (1,000's)	-0.19*	0.08	-0.24	0.18	-0.72**	0.26	-0.10	0.14
Average Pell Grant (log)	0.50	1.00	5.84*	2.67	1.19	3.14	-0.32	1.50

Table 2 (continued)

Average State Grant (log)	-0.21	0.33	-1.57*	0.67	0.49	0.95	-0.15	0.41
Average Institutional Grant (log)	0.72*	0.36	-0.17	0.78	0.91	0.87	0.70 ^a	0.38
Institutional Type								
Bachelor's Institution	2.62*	1.10	4.32**	1.61	5.45***	1.61	4.30**	1.54
Research institution	0.53	0.94	-0.07	1.32	-0.47	1.18	0.41	1.11
HSI	4.06**	1.41	5.76***	1.66	6.52***	1.56	3.13 ^a	1.64
HBCU	3.77*	1.76	10.10***	2.17	0.58	2.91	-3.65	2.56
Subsidy Reliance: Medium	-0.96	0.75	0.32	1.14	-0.25	0.98	-1.08	0.82
Subsidy Reliance: High	-1.46	1.02	0.51	1.57	-0.25	1.30	-2.66*	1.18
Appropriations Within Effect								
State Appropriations (log)	6.13***	1.43	10.20**	3.59	8.72*	3.68	6.22***	1.77
Covariance								
Institution-level intercept	22.18***	1.71	33.09***	3.26	21.40***	2.58	29.04***	2.39
Δ AIC	52.57		27.34		21.07		30.94	
n	2434		2265		2112		2391	

* $p < .10$, ** $p < .05$, *** $p < .01$, **** $p < .001$.

Note. The Δ AIC compares models with and without the state appropriations variable. All models include institutional means for time variant variables and dummy variables for time and state location.

students (.97 percentage points), Latinx students (.83 percentage points), and White students (.59 percentage points).³

Table 2 also shows that institutional type was variously associated with graduation rates in all models. For example, bachelor's institutions consistently had higher expected graduation rates relative to master's universities ($b = 2.62$ to 5.45). Institutions that were designated as HBCUs had higher graduation rates for all students ($b = 3.77$) and Black students ($b = 10.10$), whereas institutions designated as HSIs had higher graduation rates in all models ($b = 3.13$ to 6.52).⁴ Finally, the institution's initial level of subsidy reliance at the beginning of the panel period was not directly associated graduation rates in most cases, while controlling for other variables such as change in subsidy reliance over time. The one exception was observed among White students, wherein a high level of subsidy reliance was negatively associated with graduation rates relative to low subsidy reliance ($b = -2.66$).

Appropriations Random Slope

While state appropriation levels have a positive effect on graduation rates on average, it is also possible that the effect varies by institution. The second analysis thus builds upon the hybrid model by adding a random intercept and slope for appropriations. As depicted in Table 3, model fit was enhanced by adding the random slope to the models for all students, Black students, and White students ($\Delta AIC = 13.36$ to 40.20) but not for Latinx students ($\Delta AIC = 1.65$). The point estimates for state appropriations retained statistical significance and varied by model: all students of any race ($b = 6.53$), Black students ($b = 11.97$), Latinx students ($b = 9.20$), and White students ($b = 5.39$). Covariance estimates for the appropriations slope ranged from 159.50 for all students to 265.85 for White students and 359.66 for Black students. The magnitude of variability can be expressed in 68 percent confidence intervals for the estimates of the state appropriations slope coefficient: all students ($b = -6.09$ to 19.15), Black students ($b = -6.99$ to 30.93), and White students ($b = -10.91$ to 21.69). Stated differently, for any particular institution, a ten percent increase in appropriations would be associated with a percentage point change in graduation rates of $-.58$ to 1.83 for all students, $-.67$ to 2.95 for Black students, $.88$ for Latinx students, and -1.04 to 2.07 for White students.

3. As a point of reference, these percentage point increases are equivalent to small *percent* increases from mean graduation rates for each group: all students (1.20 percent); Black students (2.59 percent); Latinx students (1.91 percent); and White students (1.17 percent).

4. A sensitivity analysis showed that the positive effects of HSI status and HBCU status were due to suppression. Specifically, the HSI and HBCU status are negatively correlated with graduation rates when omitting controls for the percentage of Pell recipients and underrepresented students.

Institutional Type Moderation

Institutional type defined by Carnegie classification, minority-serving status, and subsidy reliance may be a source of variation in the effect of state appropriations. In order to determine whether institutional type moderates the effect of appropriations, four moderation models were tested by adding interaction terms to the base random slope models. In the first set of moderation models, the interaction term for bachelor's institution and appropriations was not statistically significant: all students of any race ($b = 1.38, p > .10$), Black students ($b = -16.76, p > .10$), Latinx students ($b = 10.63, p > .10$), and White students ($b = -1.76, p > .10$). In addition, the interaction term for research institution and appropriations was not statistically significant: all students of any race ($b = -.12, p > .10$), Black students ($b = -1.38, p > .10$), Latinx students ($b = -2.34, p > .10$), and White students ($b = 1.48, p > .10$).

Regarding minority-serving status, the Latinx student model yielded a non-significant HSI interaction ($b = -2.26, p > .10$). However, the HBCU interaction term was statistically significant and improved the predictive power of the Black cohort model ($\Delta AIC = 8.97$). Specifically, the within-effect of state appropriations on Black cohort graduation rates ($b = 10.96, p < .01$) was larger at HBCUs ($b = 16.27, p < .05$) than at other institutions. Accordingly, a 10 percent increase in appropriations is associated with a 1.55 greater percentage point increase in graduation rates of Black students at HBCUs.

Finally, Table 4 shows that the addition of subsidy reliance interaction terms improved the fit of all models ($\Delta AIC = 11.42$ to 19.78), though the statistical significance and magnitude of interaction effects varied across models. In the model for all students, the within-effect of state appropriations ($b = 4.66$) was larger at institutions characterized by high subsidy reliance ($b = 8.48$) than at institutions with low subsidy reliance, which is equivalent to a .81 greater percentage point increase in graduation rates with a 10 percent increase in appropriations. In the model for Black students, the within-effect of state appropriations ($b = 6.44, p > .10$) was larger at institutions characterized by medium subsidy reliance ($b = 13.34$) than at institutions with low subsidy reliance, which is equivalent to a 1.27 greater percentage point increase in graduation rates with a 10 percent increase in appropriations. In the model for Latinx students, the within-effect of state appropriations ($b = 4.80, p > .10$) was larger at institutions characterized by medium subsidy reliance ($b = 12.96$) and high subsidy reliance ($b = 13.56$) than at institutions with low subsidy reliance, which is equivalent to a respective 1.24 and 1.29 greater percentage point increase in graduation rates with a 10 percent increase in appropriations. The interaction term coefficients were not statistically significant in the model for White students ($p > .10$).

Table 3. Hybrid Fixed Effects Regression Model with Random Slope Predicting Six-Year Graduation Rates by Race/Ethnicity at Public Four-Year Institutions

	All		Black		Latinx		White	
	<i>b</i>	<i>se</i>	<i>b</i>	<i>se</i>	<i>b</i>	<i>se</i>	<i>b</i>	<i>se</i>
Intercept	-139.99***	57.30	-116.53***	65.61	-185.17**	58.34	-201.05***	59.86
Control Variable Within Effects								
Admissions rate	-0.01	0.01	-0.04 ^a	0.02	-0.01	0.03	-0.02	0.01
SAT 25th Percentile	0.02**	0.01	0.02*	0.01	0.03*	0.01	0.01*	0.01
Subsidy reliance (continuous)	-0.07 ^a	0.04	-0.17*	0.08	-0.17*	0.08	-0.09 ^a	0.06
FTE Total Enrollment (log)	-2.30	1.56	-12.41***	3.25	-9.28*	3.80	-4.87 ^a	2.54
FTE Graduate Enrollment Percent (log)	-0.43	0.62	1.51	1.53	0.12	1.87	0.24	0.85
Percent Female	0.13***	0.04	0.09**	0.03	0.10*	0.04	0.01	0.04
Percent Underrepresented Students	-3.47***	0.62	-4.43**	1.43	0.13	1.62	-2.41***	0.72
Percent Pell Recipient	-0.04	0.03	-0.12*	0.06	-0.06	0.06	-0.02	0.03
Percent Over 25 (sqrt)	-0.48	0.61	-2.48*	1.11	1.13	1.43	-0.37	0.73
Percent delayed enrollment (log)	-0.43	0.28	-1.72***	0.52	-0.44	0.65	0.16	0.32
Tuition and Fees (log)	9.98***	2.93	10.24*	4.86	13.29*	5.34	8.93**	3.30
Average Loan (1,000's)	-0.19*	0.08	-0.24	0.18	-0.72**	0.26	-0.11	0.14
Average Pell Grant (log)	0.31	1.02	5.70*	2.62	1.19	3.14	-0.65	1.50
Average State Grant (log)	-0.14	0.33	-1.58*	0.68	0.49	0.96	-0.12	0.42
Average Institutional Grant (log)	0.84*	0.35	-0.26	0.76	0.93	0.87	0.80*	0.38

Table 4. Hybrid Fixed Effects Regression Model with Interactions Predicting Six-Year Graduation Rates by Race/Ethnicity at Public Four-Year Institutions

	All		Black		Latinx		White	
	<i>b</i>	<i>se</i>	<i>b</i>	<i>se</i>	<i>b</i>	<i>se</i>	<i>b</i>	<i>se</i>
Intercept	-140.45***	56.83	-112.94**	66.79	-184.48**	58.33	-200.63***	59.88
Control Variable Within Effects								
Admissions rate	-0.01	0.01	-0.04 ^a	0.02	-0.01	0.03	-0.02	0.01
SAT 25th Percentile	0.02**	0.01	0.02*	0.01	0.03*	0.01	0.01*	0.01
Subsidy reliance (continuous)	-0.09*	0.04	-0.20*	0.09	-0.25**	0.09	-0.11 ^a	0.06
FTE Total Enrollment (log)	-2.57 ^a	1.56	-13.04***	3.33	-10.20**	3.84	-5.07*	2.51
FTE Graduate Enrollment Percent (log)	-0.39	0.61	1.78	1.54	0.38	1.85	0.25	0.85
Percent Female	0.13***	0.04	0.09**	0.03	0.10**	0.04	0.01	0.04
Percent Underrepresented Students	-3.57***	0.61	-4.60***	1.42	0.00	1.60	-2.49***	0.72
Percent Pell Recipient	-0.04	0.03	-0.12*	0.06	-0.07	0.06	-0.02	0.03
Percent Over 25 (sqrt)	-0.44	0.60	-2.42*	1.10	1.23	1.43	-0.34	0.73
Percent delayed enrollment (log)	-0.44	0.27	-1.76***	0.51	-0.54	0.64	0.15	0.32
Tuition and Fees (log)	10.47***	2.93	12.45*	5.13	16.59**	5.30	9.17**	3.39
Average Loan (1,000's)	-0.18*	0.08	-0.25	0.18	-0.75**	0.26	-0.10	0.14
Average Pell Grant (log)	0.32	1.02	5.79*	2.61	1.30	3.15	-0.65	1.50
Average State Grant (log)	-0.14	0.33	-1.53*	0.68	0.57	0.96	-0.13	0.42

Table 4 (continued)

Average Institutional Grant (log)	0.86*	0.34	-0.19	0.76	1.09	0.88	0.81*	0.38
Institutional Type								
Bachelor's Institution	2.63*	1.10	4.34**	1.61	5.46***	1.61	4.18**	1.53
Research institution	0.53	0.94	-0.06	1.32	-0.46	1.18	0.33	1.12
HSI	4.07**	1.41	5.75***	1.66	6.52***	1.56	3.08*	1.64
HBCU	3.74*	1.77	10.12***	2.19	0.63	2.91	-3.78	2.56
Subsidy Reliance: Medium	-0.97	0.75	0.33	1.15	-0.25	0.98	-1.04	0.83
Subsidy Reliance: High	-1.47	1.02	0.53	1.58	-0.24	1.30	-2.67*	1.18
Appropriations Within Effect								
State Appropriations (log)	4.66**	1.79	6.44	4.40	4.80	3.67	4.81*	2.16
Interaction Terms								
Medium Subsidy Reliance x appropriations	1.05	2.47	13.34*	5.82	12.96**	4.85	-0.96	3.23
High Subsidy Reliance x appropriations	8.48*	3.39	10.89	7.55	13.56**	4.98	5.33	5.24
Covariance								
Institution-level intercept	22.26***	1.78	33.46***	3.27	21.43***	2.58	29.43***	2.41
State Appropriations (log)	154.02***	44.14	348.44*	147.50	-	-	261.31***	68.30
Δ AIC	16.59		16.38		19.78		11.42	
n	2434		2265		2112		2391	

*p < .10, ** p < .05, *** p < .01, **** p < .001.

Note. The Δ AIC compares models with and without the interaction terms. All models include institutional means for time-variant variables and dummy variables for time and state location.

Table 5. Simulated Additional Graduates in the 2012 First-time, Full-time, Bachelor's Degree-Seeking Cohort at Public Four-Year Institutions

Region	4-yr inst.	2012 First-Time, Full-Time Cohort				Actual 2018 Graduates				Simulated Additional 2018 Graduates			
		Total	Black	Latinx	White	Total	Black	Latinx	White	Total	Black	Latinx	White
Midwest	125	238,036	19,508	12,221	174,962	145,726	6,935	6,320	112,349	1,476	222	108	892
Northeast	99	113,726	9,291	11,937	70,774	72,529	4,749	6,637	46,877	705	106	105	361
South	206	361,939	65,530	43,403	208,520	211,328	27,983	23,655	132,206	2,244	747	382	1,063
West	82	176,359	5,969	44,827	72,304	112,806	2,983	26,050	45,962	1,093	68	394	369
U.S.	512	890,060	100,298	112,388	526,560	542,389	42,650	62,662	337,394	5,518	1,143	989	2,685

Note. Sub-group totals do not sum to total students due to each sub-group projection being based on unique percentage point increases in graduation rates.

Simulation of Additional Graduates

A simulation was conducted to estimate the additional completions that could have resulted from the 2012 first-time, full-time, bachelor's degree-seeking cohort at public four-year institutions. The fixed slope estimates in the random slope models were used for all students (.62 percentage point increase), Black students (1.14 percentage point increase), Latinx students (.88 percentage point increase), and White students (.51 percentage point increase). The simulation assumes that other variables such as tuition revenue are held constant; increases in public funding are not offset by decreases in tuition revenue. Based on the total cohort models, a ten percent increase in state appropriations nationally could have yielded about 5,518 more graduates, with the largest gains expected in the Southern and Midwestern regions (see Table 5). Drawing upon the national sub-group model estimates, a ten percent increase in state appropriations could have yielded about 1,143 more Black graduates; 989 Latinx graduates; and 2,685 White graduates. It is noteworthy that these simulations do not account for the potential effects of funding on part-time and non-first-time students.

DISCUSSION

Research on student outcomes in higher education has demonstrated that institutional resource levels can influence the cohort graduation rates of diverse students (Crisp et al. 2018). The purpose of the current study was to estimate the specific effect of state appropriations revenue on the six-year graduation rates of all students as well as Black, Latinx, and White student subgroups at public four-year institutions. This study extended past research by employing a hybrid regression model with six-year panel data that accounted for variation in the effect of state appropriations across institutions. The potential for confounding influences was also reduced by modeling variables related to institutional type, student demographics, tuition, and average financial aid. Overall, the results across models indicate that changes in state appropriations can indeed impact the graduation rates of students from underrepresented racial groups as well as White students. The magnitude of the impact, however, varies considerably across institutions, and it varies systematically by degree of subsidy reliance and HBCU status. Further consideration of these findings underscores important policy implications and directions for future research.

While controlling for a host of potentially confounding factors, the analyses of all students and particular racial and ethnic cohorts revealed a positive effect of state appropriations on six-year graduation rates. Specifically, the within-effects suggest that a ten percent increase in state appropriations would be associated with a .58 percentage point increase in graduation rates for all students. This

finding is consistent with past research on the effect of public funding on degree production (Bound et al. 2019; Monarrez, Hernandez, and Rainer 2021; Titus 2009; Trostel 2012; Zhao 2018), cohort graduation rates (Heck et al. 2014; Zhang 2009), and the likelihood of bachelor's degree completion (Chakrabarti, Gorton, and Lovenheim 2020) as well as the relationship between expenditures and graduation rates (Pike and Robbins 2020) and the effect of total finances on diverse cohort graduation rates (Crisp et al. 2018). Moreover, while the current study confirmed that state appropriations for institutions is critical for the graduation rates of students in all racial groups, the significance of funding may be greatest for underrepresented students. Whereas a ten percent increase in state appropriations would be associated with a .59 percentage point increase in graduation rates for White students, it would be associated with a .97 percentage point increase for Black students and a .83 percentage point increase for Latinx students. Notably, Monarrez, Hernandez, and Rainer (2021) reported a similar pattern of results in their analysis of state funding and degree production. State appropriations revenue may thus ultimately have a modest compensatory effect on the graduation rates of underrepresented students, who enter college with a lower average level of academic preparation than do White students (Flores et al. 2017).

As the current study controlled for tuition rates and financial aid, the effect of state appropriations is most likely a function of investments in educational quality rather than changes in the price of enrollment (see Deming and Walters 2018). Given a direct linkage with educational expenditures (Leslie et al. 2012), an increase in state appropriations revenue while holding tuition constant may enable institutions to maintain and improve educative conditions conducive to student engagement and timely degree completion, such as promoting instructional excellence, expanding highly effective programs, and strengthening academic and social support (Kuh et al. 2011). Conversely, in the absence of adequate revenue, institutions may inadvertently create structural barriers to student progress by limiting the number and availability of courses (Bahr et al. 2015), allowing student-faculty ratios to become too high (Bound et al. 2010), and relying heavily on part-time and contingent faculty (Eagan and Jaeger 2008). Future research might profitably model such quality factors that presumably mediate the relationship between educational revenue and graduation rates.

Although there was a positive effect of appropriations on average, most random slope models revealed substantial variation across institutions. Specifically, a ten percent increase in appropriations at any particular institution was associated with both negative and positive percentage point changes in graduation rates ranging from -1.04 to 2.95 for all students, Black students, and White students (the covariance estimate was not statistically significant in the Latinx student

model). Whereas the positive effect sizes indicate that the expected effect of state appropriations is much larger than average at some institutions, the negative effects suggest that graduation rates are expected to decrease at some institutions despite increases in state appropriations. This is consistent with past research showing that postsecondary institutions differ in their degree of efficiency (Toutkoushian 1999) and the extent to which they are effective in promoting timely graduation after accounting for differences in the quality of inputs and educational expenditures (Horn and Lee 2016). The upper bound estimates in particular are illustrative not only of the potential impact of public funding but also of its potential limits. Indeed, the college completion problematique involves campus practices as well as broader educational and social factors that are beyond the control of colleges and universities. For example, Flores et al.'s (2017) analysis of college completion gaps in Texas revealed that postsecondary factors such as expenditures per student accounted for only 35 percent of the variance for Black and Latinx students relative to White students, compared to precollege factors such as poverty and academic preparation that explained more than 60 percent of the variance.

In the final set of analyses, sources of systematic variation in the effect of state appropriations were identified in the degree of subsidy reliance and minority-serving status but not Carnegie classification. Consistent with sub-group analyses of degree production (Monarrez, Hernandez, and Rainer 2021), the effect of state appropriations on graduation rates was generally larger at institutions with initially medium or high levels of subsidy reliance relative to those with low subsidy reliance. The degree of subsidy reliance presumably shapes the mix of budget cuts and tuition increases that institutions can pursue when faced with reductions in state funding, such that fluctuations in state appropriations have a much greater impact on instructional expenditures among institutions with relatively high subsidy reliance (see Bound et al. 2019).

There was also some evidence that the subsidy moderation effect varies across racial groups. A ten percent increase in appropriations was associated with a .81 greater percentage point increase in graduation rates for all students of any race at high subsidy-reliant institutions, compared to a 1.27 greater percentage point increase in the graduation rates of Black students at medium subsidy-reliant institutions and a 1.24 to 1.29 greater percentage point increase in graduation rates of Latinx students at medium- and high-subsidy reliant institutions. The smallest and non-significant point estimates for the subsidy moderation effect were observed in the model for White students. Overall, these findings provide support for Taylor and Cantwell's (2019) contention that subsidy-reliant institutions would be most efficient in using additional state appropriations to increase completion rates, particularly for underrepresented students.

In the case of minority-serving status, following past institution-level research (Capers 2019; Pike and Robbins 2020; Richards and Awokoya 2012), expected graduation rates were higher for Black students (10.08 percentage points) and Latinx students (6.52 percentage points) at HBCUs and HSIs, respectively, than at other institutions. Such an “MSI advantage” may partly stem from a supportive and caring environment (Palmer and Gasman 2008; Williams et al. 2022), a sense of community on campus (Outcalt and Skewes-Cox 2002), and a more positive campus racial climate including less racial discrimination (Hurtado and Ruiz 2012), which has been negatively associated with persistence (Fischer 2007; Johnson et al. 2014). The effect of public funding on graduation rates, however, differed significantly only in the case of HBCUs. Whereas a similar effect of appropriations on the graduation rates of Latinx students is expected at HSI and non-HSI institutions, the effect of appropriations on the graduation rates of Black students was 2.48 times greater at HBCUs than at other institutions. Additional research could elucidate the basis of this interaction effect by focusing on specific institutional differences between HBCUs and non-HBCUs related to campus culture and the mission-driven origins of HBCUs, resource allocation, and campus practices for promoting timely degree completion for Black students. Future interaction analyses should also assess the moderating role of more refined HSI typologies that account for an institution’s degree of “servingness” rather than solely enrollment thresholds (see Garcia, Nunez, and Sansone 2019)

Several limitations are suggestive of future directions for research. First, the results cannot be necessarily generalized to other time periods and institutions beyond the sample, including special focus institutions and community colleges. Presumably, the effect of potential changes in state appropriations would be substantial for community colleges, which frequently have a very limited ability to compensate for lost public revenue by raising tuition rates. Second, the models were limited to the completion outcomes of first-time, full-time students, and thus inferences cannot be made about the effect of appropriations on the outcomes of transfer students, part-time students, continuing students, and students who didn’t enroll during the fall. Third, many institutions experienced relative stagnation in state appropriations during several years of the selected period, which might have led to an underestimation of within-effects. The inclusion of data years with greater requisite variance may improve effect estimation. Fourth, the present study controlled for state fixed effects rather than modeling state-level variables. Future research might consider the role of such factors as unemployment rates, workforce indicators, and state governance structures (e.g., Tandberg 2013; Toutkoushian and Hollis 1998). Finally, while the study provides estimates of the expected effect of an increase in appropriations on graduation

rates, it did not provide a full accounting of the costs and benefits needed to calculate a return on investment. State appropriations could enable and improve colleges and universities in a number of ways that are not captured by six-year graduation rates, such as higher-quality courses and student support services, better learning outcomes, lower time-to-degree, greater research productivity, and faster technology transfer, among others. Consequently, a marginal rate of return based solely on the estimates in the current study would likely be sorely underestimated. A cost-effectiveness analysis would also be useful in identifying various types of institutional interventions that are likely to yield the highest return on state appropriations.

IMPLICATIONS

The findings indicate that changes in state appropriations can have modest but meaningful effects on whether students from diverse racial and ethnic backgrounds ultimately succeed in college. Moreover, past reductions in appropriations have likely thwarted progress towards state college attainment goals by limiting institutional effectiveness. Assuming that increases in public funding are not offset by decreases in tuition revenue, the simulation results indicated that a 10 percent increase in state appropriations nationally would have yielded about 5,500 more college graduates among students who entered public four-year institutions as first-time, full-time students in 2012. These hypothetical college graduates would have presumably benefited from greater job security and personal income, and state governments would have profited from greater tax revenues and public welfare savings, among other positive externalities of higher education (McMahon 2009; Trostel 2010).

The current study underscores the potential role of state appropriations in fostering a high-quality learning environment rather than lowering tuition rates. Nonetheless, the affordability of enrollment should continue to be monitored and improved as it pertains to college access, persistence, and student loan debt (Baum 2020; Gross, Williams-Wyche, and Williams 2019). Need-based grant aid, for instance, is crucial for ensuring that students of modest means are able to afford college tuition, fees, and the associated cost of living, particularly without excessive loan borrowing (Baum 2020) and the necessity of working more than 15 hours per week (Attewell, Heil, and Reisel 2011).⁵ And yet, the positive effects

5. Whereas past research using student-level data has generally corroborated a positive effect of state, federal, and institutional grant aid (e.g., Hossler et al. 2009), the current analysis of institution-level data only revealed a positive effect of institutional grant aid. This pattern is consistent with the results of Pike and Robbins's (2020) within-between model of six-year graduation rates for all students. However, a null effect of grant aid using average institution-level data should not be construed as the absence of an effect for underrepresented students on average. Indeed, caution should be exercised when interpreting the results of financial aid variables that represent average

of greater investments in state grant aid may be offset by declining institutional appropriations if the ability of campuses to promote student learning and timely degree completion is diminished. A reduction in the net price of college enrollment in the absence of high educational quality is tantamount to expanding college access without improving opportunities for student success (Taylor and Cantwell 2019). Policymakers must thus account for quality as well as affordability dimensions of higher education finance.

The direct effects of institutional type and interactions with appropriations raise some important questions for higher education finance. Particularly in the wake of the COVID-19 pandemic, a central policy challenge is to ensure that any reductions and stratification in state funding for higher education account for the differential ability of institutions to raise tuition revenue to compensate for lost appropriations as well as differences in the resource needs of institutions with students of varying academic backgrounds, social capital, and financial circumstances. Of concern in the current study are institutions that rely heavily on public subsidies for educational expenditures and enroll a relatively large share of students from diverse racial and ethnic backgrounds. Specifically, bachelor's institutions, HBCUs, and HSIs frequently had higher predicted graduation rates than did other institutions, ranging from a three to ten percentage point difference. In addition, graduation rates at institutions characterized by higher levels of subsidy reliance and institutions designated as HBCUs are most sensitive to fluctuations in state appropriations. Severe funding cuts for such institutions could have a negative impact on a state's progress toward meeting postsecondary attainment goals, particularly attainment equity for diverse populations.

Policymakers should also consider the role of federal funding for colleges and universities. While state governments must balance their budgets, the federal government does not. Constrained state budgets and higher education's ability to generate alternative revenue (mainly from tuition) have caused higher education to be treated as the balance wheel of state budgets (Delaney and Doyle 2011). A federal-state partnership could be developed for higher education to provide direct federal funding for institutions and incentivize additional state funding. Similarly, there have been calls for a Title I-type program that would provide federal funding for colleges and universities that serve large shares of low-income students (Cummings, et al. 2021). Such federal approaches have the potential to provide significantly more public funding for higher education. However, careful attention would need to be paid to program design and any potential negative externalities.

Finally, as noted above, institutions appear to differ in the extent to which

financial aid amounts that are not specific to the racial/ethnic cohort in question or the degree to which aid is targeted by financial need or merit.

additional state funding is ultimately converted into higher graduation rates, presumably owing largely to variation in institutional effectiveness and efficiency. The provision of robust public funding should thus be met with quality assurance efforts by institutional leaders to ensure that educational programs, policies, and services are in fact conducive to timely degree completion. Past research has indicated that a comprehensive student support system, for example, can influence the likelihood of persistence and degree completion (Tinto 2012), including advising, tutoring, and career counseling (Scrivener et al. 2015) as well as mental health services (Francis and Horn 2017). Moreover, a set of institutional quality indicators by race and ethnicity could help identify access gaps and convey to policymakers any funding needs for improving educational equity (e.g., Horn and Tandberg 2018).

CONCLUSION

Most states in the nation have articulated a commitment to improve college attainment rates over the next decade (Lumina Foundation 2019). The realization of state attainment goals will partly depend upon whether cohort completion rates can be improved among all students and especially among students in Black and Latinx populations, which are projected to increase considerably through 2060 (Johnson 2020). And yet, public colleges and universities are increasingly expected to do more with less, to improve student completion rates as direct appropriations decline and college costs rise. In contradistinction, this study demonstrates that state funding for public institutions should be bolstered, not weakened, to raise college completion rates. A reassessment of state appropriation levels is in particular need for under-resourced and minority-serving institutions that have experienced diminished financial health under performance-based funding models (Ortagus et al. 2020). Concomitantly, institutions might consider conducting a comprehensive quality audit to ensure that campus-based practices and policies add value to student learning outcomes and in fact promote timely completion among diverse student groups. The provision of adequate resources and their effective utilization will ultimately help ensure that public higher education minimizes the reproduction of racial inequalities and instead realizes its potential as an equalizer of economic and civic opportunity.

REFERENCES

- ACT. (2012). *ACT-SAT concordance*. Retrieved from <http://www.act.org/aap/concordance/>
- Allison, P. D. (2009). *Fixed effects regression models*. Thousand Oaks, CA: SAGE Publications.
- Anderson, D. M., Broton, K. M., Goldrick-Rab, S., and Kelchen, R. (2020). Experimental

- evidence on the impacts of need-based financial aid: Longitudinal assessment of the Wisconsin Scholars Grant. *Journal of Policy Analysis and Management*, 39(3), 720-739.
- Archibald, R. A., and Feldman, D. H. (2018). *Drivers of the rising price of a college education*. Midwest Higher Education Compact (MHEC). Retrieved from https://www.mhec.org/sites/default/files/resources/mhec_affordability_series7_20180730_2.pdf
- Astin, A. W., and Oseguera, L. (2012). Pre-college and institutional influences on degree attainment. In A. Seidman (Ed.), *College student retention: Formula for student success*. Rowman and Littlefield Publishers.
- Astin, A. W. (1993). What matters in college: Four critical years revisited. San Francisco: Jossey-Bass.
- Attewell, P., Heil, S., and Reisel, L. (2011). Competing explanations of undergraduate noncompletion. *American Educational Research Journal*, 48(3), 536-559.
- Rodríguez, A., and Galdeano, E. C. (2015). Do Hispanic-Serving Institutions really underperform? Using propensity score matching to compare outcomes of Hispanic-Serving and non-Hispanic-Serving Institutions. In *Hispanic-Serving Institutions* (pp. 210-230). Routledge.
- Azur, M. J., Stuart, E. A., Frangakis, C., and Leaf, P. J. (2011). Multiple imputation by chained equations: what is it and how does it work?. *International journal of methods in psychiatric research* 20(1), 40-49.
- Bahr, P. R., Gross, J. L., Slay, K. E., and Christensen, R. D. (2015). First in line: Student registration priority in community colleges. *Educational Policy*, 29(2), 342-374.
- Beck, N., and Katz, J. N. (2007). Random coefficient models for time-series—cross-section data: Monte Carlo experiments. *Political Analysis*, 15(2), 182-195.
- Bell, A., and Jones, K. (2015). Explaining fixed effects: Random effects modeling of time-series cross-sectional and panel data. *Political Science Research and Methods*, 3(1), 133-153. <https://doi.org/10.1017/psrm.2014.7>
- Bell, A., Fairbrother, M., and Jones, K. (2019). Fixed and random effects models: Making an informed choice. *Quality and Quantity*, 53(2), 1051-1074. <https://doi.org/10.1007/s11135-018-0802-x>
- Berger, J. B., and Milem, J. F. (2000). Organizational behavior in higher education and student outcomes. In J.C. Smart (Ed.), *Higher education: Handbook of theory and research*. (Vol. XV, pp. 268-338). New York: Springer.
- Bettinger, E. (2004). How financial aid affects persistence. In C. M. Hoxby (Ed.), *College choices: The economics of where to go, when to go, and how to pay for it*. University of Chicago Press.
- Bhutta, N., Chang, A. C., Dettling, L. J., and Hsu, J. W. (2020). Disparities in wealth by race and ethnicity in the 2019 survey of consumer finances. Retrieved from <https://www.federalreserve.gov/econres/notes/feds-notes/disparities-in-wealth-by-race-and-ethnicity-in-the-2019-survey-of-consumer-finances-20200928.htm>
- Bound, J., and Turner, S. (2007). Cohort crowding: How resources affect collegiate attainment. *Journal of Public Economics*, 91(5-6), 877-899.
- Bound, J., Lovenheim, M. F., and Turner, S. (2010). Why have college completion rates declined? An analysis of changing student preparation and collegiate resources. *American Economic Journal: Applied Economics*, 2(3), 129-57.
- Bound, J., Braga, B., Khanna, G., and Turner, S. (2019). Public universities: The supply side of building a skilled workforce. *RSF: The Russell Sage Foundation Journal of the Social Sciences*, 5(5), 43-66.
- Bowen, W. G., Chingos, M. M., and McPherson, M. S. (2009). *Crossing the finish line: Completing college at America's public universities*. Princeton University Press.
- Bowman, N. A., and Denson, N. (2022). Institutional racial representation and equity

- gaps in college graduation. *The Journal of Higher Education*, 93(3), 399-423.
- Bozick, R., and DeLuca, S. (2005). Better late than never? Delayed enrollment in the high school to college transition. *Social Forces*, 84(1), 531-554.
- Browne, W. J., and Draper, D. (2006). A comparison of Bayesian and likelihood-based methods for fitting multilevel models. *Bayesian analysis*, 1(3), 473-514.
- Capers, K. J. (2019). Representation's Effect on Latinx College Graduation Rates. *Social Science Quarterly*, 100(4), 1112-1128.
- Carnevale, A. P., Cheah, B., and Strohl, J. (2013). Hard times: College majors, unemployment and earnings: Not all college degrees are created equal.
- Castleman, B. L., and Long, B. T. (2016). Looking beyond enrollment: The causal effect of need-based grants on college access, persistence, and graduation. *Journal of Labor Economics*, 34(4), 1023-1073.
- Chakrabarti, R., Gorton, N., and Lovenheim, M. F. (2020). *State investment in higher education: Effects on human capital formation, student debt, and long-term financial outcomes of students* (No. w27885). National Bureau of Economic Research.
- Cheema, J. R. (2014). A review of missing data handling methods in education research. *Review of Educational Research*, 84(4), 487-508.
- Chen, R. (2012). Institutional characteristics and college student dropout risks: A multilevel event history analysis. *Research in Higher Education*, 53(5), 487-505.
- Chen, R., and John, E. P. S. (2011). State financial policies and college student persistence: A national study. *The Journal of Higher Education*, 82(5), 629-660.
- Conrad, C., and Gasman, M. (2015). *Educating a diverse nation: Lessons from minority-serving institutions*. Harvard University Press.
- Cook, E. E., and Turner, S. (2022). Progressivity of pricing at US public universities. *Economics of Education Review*, 88, 102239.
- Crisp, G., Doran, E., and Reyes, N. A. S. (2018). Predicting graduation rates at 4-year broad access institutions using a Bayesian modeling approach. *Research in Higher Education*, 59(2), 133-155.
- Deming, D. J., and Walters, C. R. (2018). *The Impact of State Budget Cuts on U.S. Postsecondary Attainment*. Retrieved from https://eml.berkeley.edu/~cswalters/papers/deming_walters.pdf
- DesJardins, S. L., and McCall, B. P. (2010). Simulating the effects of financial aid packages on college student stopout, reenrollment spells, and graduation chances. *The Review of Higher Education*, 33(4), 513-541.
- Dougherty, K. J., Jones, S. M., and Pheatt, L. (2016). *Performance funding for higher education*. JHU Press.
- Eagan, M. K., and Jaeger, A. J. (2008). Closing the gate: Part-time faculty instruction in gatekeeper courses and first-year persistence. *New Directions for Teaching and Learning*, (115), 39-53.
- Ehrenberg, R. G. (2003). Studying ourselves: The academic labor market: Presidential address to the Society of Labor Economists, Baltimore, May 3 2002. *Journal of Labor Economics*, 21(2), 267-287.
- Ehrenberg, R. G., and Zhang, L. (2005). Do tenured and tenure-track faculty matter? *Journal of Human Resources*, 40(3), 647-659.
- Elff, M., Heisig, J. P., Schaeffer, M., and Shikano, S. (2021). Multilevel analysis with few clusters: improving likelihood-based methods to provide unbiased estimates and accurate inference. *British Journal of Political Science*, 51(1), 412-426.
- Espinosa, L. L., Turk, J. M., Taylor, M., and Chessman, H. M. (2019). *Race and ethnicity in higher education: A status report*.
- Fischer, E. M. J. (2007). Settling into campus life: Differences by race/ethnicity in college involvement and outcomes. *The Journal of Higher Education*, 78(2), 125-161.
- Flores, S. M., Park, T. J., and Baker, D. J. (2017). The racial college completion gap:

- Evidence from Texas. *The Journal of Higher Education*, 88(6), 894-921.
- Fraga, B. L. (2018). *The turnout gap: Race, ethnicity, and political inequality in a diversifying America*. Cambridge University Press.
- Gansemer-Topf, A. M., and Schuh, J. H. (2006). Institutional selectivity and institutional expenditures: Examining organizational factors that contribute to retention and graduation. *Research in Higher Education*, 47(6), 613-642.
- Garcia, G. A. (2013). Does percentage of Latinas/os affect graduation rates at 4-year Hispanic Serving Institutions (HSIs), emerging HSIs, and non-HSIs?. *Journal of Hispanic Higher Education*, 12(3), 256-268.
- Garcia, G. A. (2017). What does it mean to be Latinx-serving? Testing the utility of the typology of HSI organizational identities. *Association of Mexican American Educators Journal*, 11(3), 109-138.
- Garcia, G. A., Núñez, A. M., and Sansone, V. A. (2019). Toward a multidimensional conceptual framework for understanding “servingness” in Hispanic-serving institutions: A synthesis of the research. *Review of Educational Research*, 89(5), 745-784.
- Hagood, L. P. (2019). The financial benefits and burdens of performance funding in higher education. *Educational Evaluation and Policy Analysis*, 41(2), 189-213.
- Hamrick, F. A., Schuh, J. H., and Shelley, M. C. (2004). Predicting Higher Education Graduation Rates from Institutional Characteristics and Resource Allocation. *Education Policy Analysis Archives*, 12(19), n19.
- Heck, R. H., Lam, W. S., and Thomas, S. L. (2014). State political culture, higher education spending indicators, and undergraduate graduation outcomes. *Educational Policy*, 28(1), 3-39.
- Hillman, N. W. (2015). Borrowing and Repaying Federal Student Loans. *Journal of Student Financial Aid*, 45(3).
- Horn, A. S., and Lee, G. (2016). The reliability and validity of using regression residuals to measure institutional effectiveness in promoting degree completion. *Research in Higher Education*, 57(4), 469-496.
- Horn, A. S., and Lee, G. (2019). Evaluating the accuracy of productivity indicators in performance funding models. *Educational Policy*, 33(5), 702-733.
- Horn, A. S., Lee, G., Jang, S., and Lee, J. (2019). Towards reasonable efficiency in degree production: A method for benchmarking the educational expenditures of postsecondary institutions. *KEDI Journal of Educational Policy*, 16(1).
- Horn, A. S., and Tandberg, D. A. (2018). Indicators of educational quality for postsecondary accountability systems. In H. P. Weingarten, M. Hicks, and A. Kaufman (Eds.), *Assessing quality in postsecondary education: International perspectives* (pp. 3-26). Montréal and Kingston: McGill-Queen's University Press. Retrieved from https://www.mhec.org/sites/default/files/resources/20180226Assessing_Quality_in_PS_Ed_ch1.pdf
- Hout, M. (2012). Social and economic returns to college education in the United States. *Annual Review of Sociology*, 38, 379-400.
- Hurtado, S., and Ruiz Alvarado, A. (2012). The climate for underrepresented groups and diversity on campus. Retrieved from <https://vtechworks.lib.vt.edu/handle/10919/83067>
- Jaggars, S. S., Motz, B. A., Rivera, M. D., Heckler, A., Quick, J.D., Hance, E. A., and Karwischka, C. (2021). *The Digital Divide Among College Students: Lessons Learned From the COVID-19 Emergency Transition*. Midwestern Higher Education Compact. Retrieved from https://www.mhec.org/sites/default/files/resources/2021The_Digital_Divide_among_College_Students_1.pdf
- Jaquette, O., and Curs, B. R. (2015). Creating the out-of-state university: Do public universities increase nonresident freshman enrollment in response to declining state

- appropriations?. *Research in Higher Education*, 56(6), 535-565.
- Jaquette, O., and Parra, E. E. (2014). Using IPEDS for panel analyses: Core concepts, data challenges, and empirical applications. In *Higher education: Handbook of theory and research* (pp. 467-533). Springer, Dordrecht.
- Johnson, S. (2020). *A changing nation: Population projections under alternative immigration scenarios*. Retrieved from <https://www.census.gov/content/dam/Census/library/publications/2020/demo/p25-1146.pdf>
- Johnson, D. R., Wasserman, T. H., Yildirim, N., and Yonai, B. A. (2014). Examining the effects of stress and campus climate on the persistence of students of color and White students: An application of Bean and Eaton's psychological model of retention. *Research in Higher Education*, 55(1), 75-100.
- Kezar, A., and Eaton, J. (2014). An examination of the changing faculty: Ensuring institutional quality and achieving desired student learning outcomes. CHEA Occasional Paper, CHEA.
- Kim, M. M., and Conrad, C. F. (2006). The impact of historically Black colleges and universities on the academic success of African-American students. *Research in Higher Education*, 47(4), 399-427.
- Koshal, R. K., and Koshal, M. (2000). State appropriation and higher education tuition: What is the relationship? *Education Economics*, 8(1), 81-89.
- Kuh, G. D., Cruce, T. M., Shoup, R., Kinzie, J., and Gonyea, R. M. (2008). Unmasking the effects of student engagement on first-year college grades and persistence. *The journal of higher education*, 79(5), 540-563.
- Leslie, L. L., Slaughter, S., Taylor, B. J., and Zhang, L. (2012). How do revenue variations affect expenditures within US research universities? *Research in Higher Education*, 53(6), 614-639.
- Levine, P. B., Ma, J., and Russell, L. C. (2020). Do college applicants respond to changes in sticker prices even when they don't matter?. *Education Finance and Policy*, 1-62.
- Lumina Foundation. (2019). States with higher education attainment goals. Retrieved from https://www.schev.edu/docs/default-source/about-section/council-files/2019-council-meetings/june-council-retreat/attainment_goal_state-rundown_021519.pdf
- Maas, C. J., and Hox, J. J. (2004). The influence of violations of assumptions on multilevel parameter estimates and their standard errors. *Computational statistics and data analysis*, 46(3), 427-440.
- Mayhew, M. J., Rockenbach, A. N., Bowman, N. A., Seifert, T. A., and Wolniak, G. C. (2016). *How college affects students: 21st century evidence that higher education works*. John Wiley and Sons.
- McCormick, A. C., Pike, G. R., Kuh, G. D., and Chen, P. S. D. (2009). Comparing the utility of the 2000 and 2005 Carnegie classification systems in research on students' college experiences and outcomes. *Research in Higher Education*, 50(2), 144-167.
- McGuinness, A. C. (2011). The states and higher education. In P. G. Altbach, P. J. Gumpert, and R.O. Berdahl (Eds.), *American higher education in the twenty-first century* (pp. 139-169). Baltimore: Johns Hopkins University Press.
- McMahon, W. W. (2009). *Higher learning, greater good: The private and social benefits of higher education*. Baltimore, MD: The John Hopkins University Press.
- Melguizo, T. (2010). Are students of color more likely to graduate from college if they attend more selective institutions? Evidence from a cohort of recipients and nonrecipients of the Gates Millennium Scholarship Program. *Educational Evaluation and Policy Analysis*, 32(2), 230-248.
- Monarrez, T., Hernandez, F., and Rainer, M. (2021). *Impact of state higher education finance on attainment*. Urban Institute.
- Mumper, M., and Freeman, M. L. (2005). The causes and consequences of public college tuition inflation. In *Higher education: Handbook of theory and research* (pp. 307-361).

- Springer, Dordrecht.
- Muthén, B., and Satorra, A. (1995). Complex sample data in structural equation modeling. In P.
- Marsden (Ed.), *Sociological methodology* (pp. 216–316). Cambridge: Blackwell.
- National Student Clearinghouse. (2022). *Completing college national and state reports: Appendix*. Retrieved from <https://nscresearchcenter.org/completing-college/>
- NCES. (2019). *Table 306.50. Total fall enrollment in degree-granting postsecondary institutions, by control and classification of institution, level of enrollment, and race/ethnicity of student: 2018*.
- NCES. (2021). *Table 333.10. Total revenue of public degree-granting postsecondary institutions, by source of revenue and level of institution: Selected years 2007-08 through 2019-20*. Retrieved from https://nces.ed.gov/programs/digest/d21/tables/dt21_333.10.asp?current=yes
- NCES. (2022). *IPEDS survey components: Finance glossary*. Retrieved from <https://nces.ed.gov/ipeds/use-the-data/survey-components/2/finance>
- Ortagus, J. C., Kelchen, R., Rosinger, K., and Voorhees, N. (2020). Performance-Based Funding in American Higher Education: A Systematic Synthesis of the Intended and Unintended Consequences. *Educational Evaluation and Policy Analysis*, 42(4), 520-550.
- Oseguera, L. (2005). Four and six-year baccalaureate degree completion by institutional characteristics and racial/ethnic groups. *Journal of College Student Retention: Research, Theory and Practice*, 7(1), 19-59.
- Outcalt, C. L., and Skewes-Cox, T. E. (2002). Involvement, interaction, and satisfaction: The human environment at HBCUs. *The Review of Higher Education*, 25(3), 331-347.
- Palmer, R., and Gasman, M. (2008). “It takes a village to raise a child”: The role of social capital in promoting academic success for African American men at a Black college. *Journal of college student development*, 49(1), 52-70.
- Pfeffer, J., and Salancik, G. R. (2003). *The external control of organizations: A resource dependence perspective*. Stanford University Press.
- Pike, G. R. (2013). NSSE benchmarks and institutional outcomes: A note on the importance of considering the intended uses of a measure in validity studies. *Research in Higher Education*, 54(2), 149-170.
- Pike, G. R., and Graunke, S. S. (2015). Examining the effects of institutional and cohort characteristics on retention rates. *Research in Higher Education*, 56(2), 146-165.
- Pike, G. R., and Robbins, K. R. (2020). Using panel data to identify the effects of institutional characteristics, cohort characteristics, and institutional actions on graduation rates. *Research in Higher Education*, 61(4), 485-509.
- Pike, G. R., Kuh, G. D., McCormick, A. C., Ethington, C. A., and Smart, J. C. (2011). If and when money matters: The relationships among educational expenditures, student engagement and students’ learning outcomes. *Research in Higher Education*, 52(1), 81-106.
- Richards, D. A., and Awokoya, J. T. (2012). *Understanding HBCU retention and completion*. Frederick D. Patterson Research Institute, UNCF.
- Rosenbaum, J. (2012). Degrees of health disparities: Health status disparities between young adults with high school diplomas, sub-baccalaureate degrees, and baccalaureate degrees. *Health Services and Outcomes Research Methodology*, 12(2-3), 156-168.
- Ryan, J. F. (2004). The relationship between institutional expenditures and degree attainment at baccalaureate colleges. *Research in higher education*, 45(2), 97-114.
- Schneider, B., Carnoy, M., Kilpatrick, J., Schmidt, W. H., and Shavelson, R. J. (2007). Estimating causal effects using experimental and observational designs. Retrieved from <https://www.aera.net/Publications/Books/Estimating-Causal-Effects-Using-Experimental-and-Observational-Designs>

- Scott, M., Bailey, T., and Kienzl, G. (2006). Relative success? Determinants of college graduation rates in public and private colleges in the US. *Research in higher education*, 47(3), 249-279.
- Scrivener, S., Weiss, M. J., Ratledge, A., Rudd, T., Sommo, C., and Fresques, H. (2015). *Doubling graduation rates: Three-year effects of CUNY's Accelerated Study in Associate Programs (ASAP) for developmental education students*. Retrieved from <https://files.eric.ed.gov/fulltext/ED558511.pdf>
- SHEEO. (2021). *State higher education finance: FY 2020*. Retrieved from https://shef.sheeo.org/wp-content/uploads/2021/05/SHEEO_SHEF_FY20_Report.pdf
- Shor, B., Bafumi, J., Keele, L., and Park, D. (2007). A Bayesian multilevel modeling approach to time-series cross-sectional data. *Political Analysis*, 15(2), 165-181.
- Sibulkin, A. E., and Butler, J. S. (2005). Differences in graduation rates between young black and white college students: Effect of entry into parenthood and historically black universities. *Research in Higher Education*, 46(3), 327-348.
- Slaughter, S., and Leslie, L. L. (1997). *Academic capitalism: Politics, policies, and the entrepreneurial university*. The Johns Hopkins University Press.
- Stearns, C., and Watanabe, S. (2002). *Hispanic Serving Institutions: Statistical Trends from 1990 to 1999*. Retrieved from <https://eric.ed.gov/?id=ED468731>
- Taylor, B. J., and Cantwell, B. (2019). *Unequal higher education: Wealth, status, and student opportunity*. Rutgers university press.
- Tinto, V. (2012). *Completing college: Rethinking institutional action*. University of Chicago Press.
- Titus, M. A. (2004). An examination of the influence of institutional context on student persistence at 4-year colleges and universities: A multilevel approach. *Research in higher education*, 45(7), 673-699.
- Titus, M. A. (2006). Understanding college degree completion of students with low socioeconomic status: The influence of the institutional financial context. *Research in Higher Education*, 47(4), 371-398.
- Titus, M. A. (2009). The production of bachelor's degrees and financial aspects of state higher education policy: A dynamic analysis. *The Journal of Higher Education*, 80(4), 439-468.
- Titus, M. A., Gray, S. M., and Lue, K. (2022). Bachelor's degree production and state higher education finance policy in the pre-and post-recessionary period (pp. 27-40). *American Higher Education: Contemporary Perspectives on Policy and Practice*.
- Toutkoushian, R. K. (1999). The value of cost functions for policymaking and institutional research. *Research in Higher Education*, 40(1), 1-15.
- Toutkoushian, R. K., and Smart, J. C. (2001). Do institutional characteristics affect student gains from college? *The Review of Higher Education*, 25(1), 39-61.
- Toutkoushian, R.K. (2019). *College student diversity and graduation rates*. Paper presented at the meetings of the Southern Economic Association, Fort Lauderdale, FL, November 2019.
- Trostel, P. A. (2009). The Effects of Public Support on College Attainment. WISCAPE Working Paper. *Wisconsin Center for the Advancement of Postsecondary Education (NJI)*.
- Umbach, P. D. (2007). How effective are they? Exploring the impact of contingent faculty on undergraduate education. *The Review of Higher Education*, 30(2), 91-123.
- University of Minnesota. (2001). *Improving our graduation rates*. Retrieved from <https://conservancy.umn.edu/handle/11299/117147>
- U.S. Department of Education. (2022a). *What is an HBCU?* Retrieved from <https://sites.ed.gov/whhbcu/one-hundred-and-five-historically-black-colleges-and-universities/>
- U.S. Department of Education. (2022b). *Definition of Hispanic-Serving Institutions*. Retrieved from <https://www2.ed.gov/print/programs/idueshsi/definition.html>

- Verba, S., Schlozman, K. L., and Brady, H. E. (1995). *Voice and equality: Civic voluntarism in American politics*. Harvard University Press.
- Von Hippel, P. T. (2007). 4. Regression with missing Ys: an improved strategy for analyzing multiply imputed data. *Sociological Methodology*, 37(1), 83-117.
- Webber, D. A. (2012). Expenditures and postsecondary graduation: An investigation using individual-level data from the state of Ohio. *Economics of Education Review*, 31(5), 615-618.
- Webber, D. A., and Ehrenberg, R. G. (2010). Do expenditures other than instructional expenditures affect graduation and persistence rates in American higher education? *Economics of Education Review*, 29(6), 947-958.
- Webber, D. A. (2017). State divestment and tuition at public institutions. *Economics of Education Review*, 60, 1-4.
- Williams, K. L., Mobley, S. D., Campbell, E., and Jowers, R. (2022). Meeting at the margins: culturally affirming practices at HBCUs for underserved populations. *Higher Education*, 1-21.
- Zhang, L. (2009). Does state funding affect graduation rates at public four-year colleges and universities? *Educational Policy*, 23(5), 714-731.
- Zhao, B. (2018). Disinvesting in the future?: A comprehensive examination of the effects of state appropriations for public higher education.