

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



POLICY REPORT
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EXECUTIVE SUMMARY

This report examines whether levels of state funding for higher education are associated with college graduation rates, particularly among underrepresented racial and ethnic groups. The assessment is based on 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 most public four-year institutions in the nation, the analyses show that graduation rates can be expected to change as a function of varying levels of state appropriations revenue within institutions. Notably, the report did not examine how institutions specifically use appropriations revenue, which may also have a significant impact on student outcomes. Key findings and implications of three analyses are summarized below.

A Positive Effect on Average

The first analysis examined the average effect of appropriations on graduation rates within institutions over the six-year period. The results indicated that a 10% increase in appropriations would yield a modest percentage point increase in graduation rates: all students (.59 percentage points); Black students (.99 percentage points); Latinx students (.84 percentage points); and White students (.59 percentage points).

Effects Vary Across Institutions

While state appropriation levels have a positive effect on graduation rates on average, the second analysis demonstrated that the effect on graduation rates varies by institution. Specifically, for any particular institution, a 10% 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 (estimate did not vary), and -1.04 to 2.07 for White students.

Effects are Larger at HBCUs and Subsidy-Reliant Institutions

Tests were conducted to determine whether the effect of appropriations depended on three indicators of institutional type: Carnegie Classification, minority-serving status, and subsidy reliance. The results indicated that

the effect of state appropriations does not vary according to whether an institution is classified as a bachelor's institution, master's university, research university, or Hispanic Serving Institution (HSI). However, the effect of appropriations on graduation rates was much larger at HBCUs than at other institutions. A 10% increase in appropriations was associated with a 1.55 greater percentage point increase in graduation rates of Black students at HBCUs.

In addition, the effect of appropriations on graduation rates varied by the institution's degree of subsidy reliance, that is, the extent to which an institution relies on appropriations for educational expenditures. Specifically, the effects of state appropriations on the graduation rates of all students, Black students, and Latinx students were frequently larger at institutions characterized by higher levels of subsidy reliance, which equated to a .81 to 1.29 greater percentage point increase in graduation rates with a 10% increase in appropriations.

IMPLICATIONS AND POLICY OPTIONS

- The findings suggest that past reductions in appropriations have likely thwarted progress towards state college attainment goals by limiting institutional effectiveness. A simulation showed that a 10% increase in state appropriations nationally could have yielded about 5,500 more college graduates among students who entered public four-year institutions as first-time, full-time students in 2012.
- Although appropriations revenue is directly associated with tuition levels, the fundamental role of appropriations in promoting timely degree completion likely stems from the provision of a high-quality learning environment rather than lower prices. Accordingly, direct appropriations should be conceived as a complimentary rather than substitutive policy lever for addressing college affordability. 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. Policymakers should thus consider both affordability and quality dimensions to 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 3 to 10 percentage point difference. In addition, graduation rates at institutions characterized by higher levels of subsidy reliance and institutions designated as HBCU's 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 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. A federal-state partnership could be developed for higher education to provide direct federal funding for institutions and incentivize additional state funding.
- The provision of robust public funding should be met with an institutional commitment to quality assurance and accountability in demonstrating that taxpayer dollars are being used efficiently, such as ensuring that educational programs, policies, and services are 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, including advising, tutoring, career counseling, and mental health services. 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.
- Although this study established a link between state appropriations and 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.

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, & 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%) and Latinx (57%) students than among Asian (79%) and White (71%) 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 importance of improving college success among underrepresented students has only grown in recent years as the death of George Floyd in Minneapolis heightened national awareness of racial discrimination, and the COVID-19 pandemic disproportionately limited the employment (Klein & Smith, 2021) and college (Jaggars et al., 2021) prospects of Black and Latinx populations. 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 10%, compared to an increase in the Black and Latinx populations by 41% and 94%, 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 & Feldman, 2018); increases in tuition and fees have far outpaced the rate of inflation (Mumper & Freeman, 2005); and many institutions have implemented substantial cost-containment measures, such as the replacement of full-time and tenure-track faculty with part-time and non-tenure track faculty (Kezar & Eaton, 2014). The financial milieu in higher education was further stressed 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 & Lee, 2019; Ortagus et al., 2020).

The confluence of these 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 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.

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.

LINKING STATE APPROPRIATIONS AND GRADUATION RATES

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% of total revenue for all public four-year institutions in 2007-08 (NCES, 2021), compared to tuition and fees (17.9%). Over the following decade, the share of state appropriations revenue had declined to 16.6% of total revenue by 2017-18 (NCES, 2021), whereas the share of revenue from tuition and fees had increased to 20.5%. Other shares of revenue decreased slightly or increased: sales and services of auxiliary enterprises (7.8%), sales and services of hospitals (15.2%), government grants and contracts (18.3%), capital appropriations (1.3%), and investments (4.7%). (See the Addendum for further trends in postsecondary enrollment and completion, state appropriations, and factors that have been found to influence the level of state appropriations.)

The growth in tuition and other revenue categories 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 & Salancik, 2003; Slaughter & 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 & Koshal, 2000; Mumper & 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 10 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 & Walters, 2018; Leslie, Slaughter, Taylor, & 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. Institutions that rely significantly on appropriations for educational expenditures may be particularly sensitive to changes in state funding (Taylor & 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 & Curs, 2015).

Although a significant rise in tuition rates at public four-year institutions can influence enrollment decisions (Levine, Ma, & Russell, 2020), fluctuations in tuition rates have not been negatively associated with the enrollment of low-income students (Cook & Turner, 2022), the total number of degrees conferred (Deming & Walters, 2018; Zhao, 2018), or graduation rates (Zhang, 2009). Accordingly, a central assumption in the current study is that state appropriations revenue influences graduation rates through a quality rather than price mechanism. Specifically, 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 using resources to improve the quality of the learning environment with respect to the human and physical capital, programs, practices, and policies conducive to degree completion (see Horn & Tandberg, 2018). As state appropriations and tuition are the main sources of educational expenditures (Leslie, Slaughter, Taylor, & Zhang, 2012), changes in state appropriations may affect expenditures in such 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), which have been associated with various student outcomes (Mayhew et al., 2016).

Studies on student-faculty ratios, contingent faculty, and course registration policies – factors that partly depend on financial resources (e.g., Ehrenber, 2003; Kezar & Eaton, 2014) – provide a concrete illustration of the potential impact of the learning environment on graduation rates. 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 may also be reflected in the employment of contingent faculty. 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 & Zhang, 2005; Eagan & 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.

RESEARCH ON THE EFFECT OF RESOURCES ON DEGREE COMPLETION

Few studies have examined the effect of appropriations on graduation rates, though the effect on the number of degrees conferred has received greater attention. In the former, 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 10% increase in state appropriations per FTE student. Similarly, 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 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 contrast, a growing body of research has focused on the effect of appropriations on the number of degrees conferred (Bound et al., 2019; Deming & Walters, 2018; Monarrez, Hernandez, & Rainer, 2021; Titus, 2009; Trostel, 2012; Zhao, 2018; cf. Titus, Gray, & Lue, 2022). Titus (2009) examined state-level panel data from 1992 to 2004 that included both private and public four-year institutions. He found that state need-based aid per undergraduate enrollment and state per capita appropriations for higher education institutions were positively associated with bachelor's degrees conferred per enrollment. Specifically, the bachelor's degree production rate increased by 3% for every 10% increase in appropriations per capita. Trostel (2012) used state panel data from 1985 to 2006 and conducted an instrumental variable analysis of degrees produced by public institutions per the number of high school graduates four years prior. He concluded that the degree production rate increased by 3.2 percentage points for every \$1,000 of state funding per high school graduate. 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% increase in state appropriations was associated with a 3.5% 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 state appropriations on degrees conferred was greater at high appropriations-dependent institutions. The effect was also generally greater for Asian, Black, and Hispanic students than for White students. Specifically, a 1% increase in appropriations at institutions in which appropriations constituted 45% to 82% 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.

A similar area of research on graduation rates has documented positive, though not uniform, effects of educational expenditures in the areas of instruction, academic support, or student services (Astin, 1993; Chen, 2012; Crisp et al., 2018; Gansemer-Topf & Schuh, 2006; Garcia, 2013; Hamrick et al., 2004; Pike & Robbins, 2020; Ryan, 2004; Titus, 2006; Toutkoushian & Smart, 2001; Webber & Ehrenberg, 2010; Webber, 2012; see also Pike et al., 2011). For example, Pike and Robbins (2020) employed a within-between analysis of panel data from 2002 to 2006 and found that both instructional and academic support expenditures had positive within-effects on four-year graduation rates, though only instructional expenditures had a positive effect on six-year graduation rates. Moreover, two studies examined the effect of resources on graduation rates among underrepresented student groups (Crisp et al., 2018; Garcia, 2013). Garcia

(2013) found that educational expenditures predicted cohort graduation rates of Latinx students at four-year institutions. 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%) 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 effect of state appropriations cannot be made.

RELATED RESEARCH ON COVARIATES OF GRADUATION RATES

As the current study seeks to estimate the unique effect of state appropriations on institution-level graduation rates, a broader organizational framework is utilized to inform the selection of covariates. Following Berger and Milem's (2000) conceptual model of college student outcomes, student characteristics and structural-demographic attributes of institutions are presumed to influence graduation rates by reflecting or affecting students' predispositions, opportunities, and experiences related to academic and social engagement. Consistent with student-level analyses of college completion (e.g., Astin & Oseguera, 2012; Flores et al., 2017; Titus, 2006), institution-level analyses have revealed that several attributes pertaining to institutional type or structure, student demographics, and college costs are predictive of graduation rates at four-year institutions (Gansmer-Topf & Schuh, 2006; Horn & Lee, 2016; Pike 2013; Pike & Robbins, 2020; Ryan, 2004; Scott et al., 2006; Titus, 2004; Toutkoushian, 2019; Webber & Ehrenberg, 2010; Zhang, 2009).

Structural variables include Carnegie Classification, subsidy reliance, total enrollment, undergraduate-graduate student mix, admissions selectivity, 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 & Robbins, 2020; Toutkoushian, 2019), a negative effect of being a doctoral university (Oseguera, 2005), and

no direct effects of any classification type (Horn & Lee, 2016; Pike & 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.

The results of past analyses have varied in terms of the effect of institutional size and undergraduate-graduate student mix. Total enrollment or institutional size has been negatively (Oseguera, 2005) and positively associated with graduation rates (Pike & Robbins, 2020). Regarding the mix of students, Webber and Ehrenberg (2010) showed a negative effect of the number of graduate students on campus while controlling for undergraduate enrollment, whereas Pike and Robbins (2020) found that the percentage of undergraduate students was negatively associated with graduation rates. In contrast, analyses have shown a more consistent and positive effect of admissions selectivity – typically defined by single or composite measures of the admission rate, grade point average, high school class rank, and ACT/SAT scores – on graduation rates (Gansemer-Topf & Schuh, 2006; Horn & Lee, 2016; Oseguera, 2005; Pike, 2013; Titus, 2004; see also Crisp et al., 2019; Melguizo, 2010).

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 & 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 & 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 & Robbins, 2020; Richards & Awokoya, 2012; Sibulkin & Butler, 2005; see also Bowman & Denson, 2022) or statistically insignificant (Rodriguez & Galdeano, 2015; Flores & Park 2015; Kim & Conrad, 2006). For instance, although HBCU's had lower six-year graduation rates than non-HBCUs, Richards and Awokoya (2012) found that the expected graduation rate for Black

students was 14 percentage points higher at HBCU's 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 & 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 & Skewes-Cox, 2002). More generally, underrepresented students at high-diversity institutions report lower levels of racial stereotypes and discrimination (Hurtado & Ruiz, 2012), which can affect the likelihood of departure (Fischer, 2007; Johnson et al., 2014).

Student demographic variables include gender, race and ethnicity, family income, and traditionality. Whereas the percentage of female students has been positively associated with graduation rates (Horn & Lee, 2016; Pike & Robbins, 2020), other factors such as the percentage of students from underrepresented racial and ethnic groups, the percentage of Pell grant recipients, and the average age of undergraduate students have been negatively associated with graduation rates (Toutkoushian, 2019; Webber & Ehrenberg, 2010). Moreover, delayed enrollment – postponing postsecondary enrollment after graduating from high school – has been negatively correlated with the odds of obtaining a bachelor's degree at the individual level (Bozick & DeLuca, 2005); however, Pike and Robbins (2020) did not detect a robust effect at the institutional level.

Researchers have also examined the effects of college costs in terms of tuition rates and various types of financial aid. Since more selective institutions generally have both higher tuition and graduation rates, regression models have yielded a positive effect of tuition and fees on graduation rates (Zhang, 2009), though net price – tuition after subtracting financial aid – has been negatively associated with graduation rates (Bowen, Chingos, & McPherson, 2009). Whereas past studies on the effect of loan aid have yielded mixed results (Baum, 2020; Hillman, 2015), past research has demonstrated a positive effect of federal Pell aid on persistence (Bettinger, 2004), state need-based aid on persistence and degree completion (Castleman & Long, 2013; Chen & St. John, 2011; Gross, Williams-Wyche, & Williams, 2019; Titus, 2006; cf. Anderson et al., 2020), and institutional grant aid on degree

completion (DesJardins & McCall 2010; Pike & Robbins, 2020). For example, Castleman and Long's (2013) student-level analysis showed that receipt of the Florida Student Assistance Grant was associated with a five percentage-point increase in the likelihood of attaining a bachelor's degree within six years. However, Pike & Robbins' (2020) institution-level analysis indicated that only the average institutional grant aid amount – not loan aid or federal or state grant aid – was associated with six-year graduation rates. Analyses conducted at the institutional level may thus fail to replicate findings at the student level.

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, & 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 line with the conceptual framework, the effect of state appropriations

is examined while controlling for potentially confounding influences, including structural attributes, student demographics, and college costs. Consistent with past modeling approaches (Zhang, 2009) and the assumption of quality rather than price as the primary causal mechanism (Deming & 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 10% 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, & Lee, 2019; Toutkoushian, 1999) and effectiveness (Horn & 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. Hybrid regression modeling is thus employed to evaluate the fit of a random slope for appropriations, 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 analyses of Carnegie Classification as a potential moderator of appropriations have yielded mixed results (Bound et al., 2019; 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. The test for institutional type interaction is 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, & 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 most recent data year available).

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% of state funding is allocated to private four-year institutions for operating support (SHEEO, 2021). Third, following Pike & 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%), more sophisticated allocation and collapsing techniques were deemed unnecessary (cf. Jaquette & 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 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 exclude 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%, reference category), medium subsidy reliance (55% - 68%), and high subsidy reliance (69% 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 two 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). An HBCU is defined in the Higher Education Act of 1965 as a postsecondary institution “whose principal mission was, and is, the education of black Americans, and that is accredited by a nationally recognized accrediting agency or association determined by the Secretary [of Education] to be a reliable authority as to the quality of training offered or is, according to such an agency or association, making reasonable progress toward accreditation” (U.S. Department of Education, 2022a). In contrast, HSIs are defined in the Higher Education Act according to several non-mission criteria with the most prominent being that (a) at least 25% of the institution’s undergraduate FTE student enrollment is Hispanic and (b) at least 50% 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, & Sansone, 2019). Similar to past analyses (e.g., Stearns, Watanabe, & 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% 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 admission 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 (the sum of expenditures on instruction, student services, and academic support).

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

Finally, variables related college costs included published in-state tuition and fees, the average student loan debt, average federal grant amount, average state grant amount, and average institutional grant amount

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

TABLE 1. Descriptive Statistics

	Time 1		Time 12	
	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		0.37	
Subsidy Reliance: Medium	0.33		0.31	
Subsidy Reliance: High	0.34		0.32	
Focal Predictor				
State Appropriations (log)	17.91	0.98	17.82	1.00

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 to estimate the effects of state appropriations, institutional type, and potential interactions, 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 & Jones, 2015; Bell, Fairbrother, & 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, 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.

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

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

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

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. The variable representing the panel year, t , was modeled as a fixed slope using dummy variables. Finally, all models include a random error term ϵ_{it} .

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 10%, which was calculated as the product of the coefficient for state appropriations and 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 & Draper, 2006; Shor et al., 2007; Elff et al., 2021). Although multilevel models perform well even when normality assumptions are violated (see Maas & Hox, 2003; Beck & 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 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%) and the 25th percentile SAT scores (2.1%), which totaled to 2.2% 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 ($\Delta AIC = 21.40$ to 33.09). 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 10% and tuition is held constant: all students of any race (.58 percentage points), Black 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 ($b = -2.66$).

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%); Black students (2.59%); Latinx students (1.91%); and White students (1.17%).

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.

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
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 Between Effects								
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
Institutional Resources 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
ΔAIC	52.57		27.34		21.07		30.94	
n	2434		2265		2112		2391	

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

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

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 only 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% 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 10% 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.

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
Institutional Type Between Effects								
Bachelor's Institution	2.63*	1.10	4.34**	1.61	5.45***	1.61	4.18**	1.53
Research institution	0.53	0.94	-0.08	1.32	-0.47	1.18	0.33	1.12

	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>
Institutional Type Between Effects (continued)								
HSI	4.06**	1.41	5.74***	1.66	6.52***	1.56	3.07 ^a	1.64
HBCU	3.74*	1.77	10.08***	2.18	0.58	2.91	-3.80	2.56
Initial Subsidy Reliance: Medium	-0.96	0.75	0.33	1.14	-0.25	0.98	-1.03	0.82
Initial Subsidy Reliance: High	-1.46	1.02	0.53	1.57	-0.25	1.30	-2.67*	1.18
Institutional Resources Within Effect								
State Appropriations (log)	6.53***	1.78	11.97***	3.70	9.20*	3.65	5.39*	2.41
Covariance								
Institution-level intercept	22.28***	1.78	33.38***	3.26	21.44***	2.58	29.41***	2.41
State Appropriations (log)	159.50***	45.24	359.66*	144.06	32.06	63.55	265.85***	68.27
ΔAIC	26.55		13.36		1.65		40.20	
n	2434		2265		2112		2391	

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

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

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 second model yielded a non-significant HSI interaction in the Latinx student model ($b = -2.26$, $p > .10$). However, the third model showed that the HBCU interaction term was statistically significant and improved the predictive power of the Black

cohort model (ΔAIC = 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% 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 (ΔAIC = 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% 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% 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% increase in appropriations. The interaction term coefficients were not statistically significant in the model for White students ($p > .10$).

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
Average Institutional Grant (log)	0.86*	0.34	-0.19	0.76	1.09	0.88	0.81*	0.38
Institutional Type Between Effects								
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 ^a	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

	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>
Institutional Resources 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
ΔAIC	16.59		16.38		19.78		11.42	
n	2434		2265		2112		2391	

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

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

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 within-effect 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 10% 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 10% 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 transfer students.

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

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

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 the

relative effects of variables related to student enrollment, subsidy reliance, tuition, and average financial aid awards. 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 10% 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, & 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, & Lovenheim, 2020) as well as the relationship between expenditures and graduation rates (Pike & 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 10% 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's (2021) reported a similar pattern of results in their analysis of state funding and degree production. State appropriations 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 & 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 & Jaeger, 2008). Future research might profitably model such quality factors that presumably mediate the relationship between appropriations and graduation rates.

Although there was a positive effect of appropriations on average, most random slope models revealed substantial variation across institutions. Specifically, a 10% 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). Notably, the positive effect sizes indicate that the expected effect of state appropriations is much larger than average at some institutions, and the negative effects likely indicate 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 & 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% 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% of the variance.

Sources of systematic variation in the effect of state appropriations were identified in the moderation analyses of subsidy reliance and minority-serving status but not Carnegie classification. Consistent with sub-group analyses of degree production (Monarrez, Hernandez, & 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 amidst 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 10% 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, this study provides 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.

The analysis of interactions between appropriations and minority-serving status yielded mixed results. Following past institution-level research (Capers, 2019; Pike & Robbins, 2020; Richards & Awokoya, 2012), the 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. An "MSI advantage" may partly stem from a supportive and caring environment (Palmer & Gasman, 2008; Williams et al., 2022), a sense of community on campus (Outcalt & Skewes-Cox, 2002), and a more positive campus racial climate including less racial discrimination (Hurtado & 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 HBCU's and non-HBCU's 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, & Sansone, 2019)

Dissimilar to past research on degree production using subgroup analyses (Bound et al., 2019; Zhao, 2018), a direct interaction test indicated that the effect of state appropriations on graduation rates did not differ significantly across baccalaureate colleges, master's universities, and research universities. Although some institutional type variables were not significant moderators of appropriations, they nonetheless had significant direct effects on graduation rates. For instance, institutions designated as bachelor's institutions relative to master's universities had higher graduation rates in all models. As one potential causal factor, McCormick et al.'s (2009) indicator of baccalaureate colleges predicted higher levels of student-faculty interaction and enriching educational experiences, whereas their indicators of master's and doctoral institutions predicted lower perceived campus support among NSSE respondents. Social and academic engagement, in turn, have been identified as key predictors of student persistence (Tinto, 2012).

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, 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 earlier or later 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, knowledge workforce indicators, and state governance structures (e.g., Tandberg, 2013; Toutkoushian & 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% increase in state appropriations nationally would have yielded about 4,817

more college graduates among Black, Latinx, and White 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, & 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, & Reisel, 2011).⁵ And yet, the positive effects 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 & 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

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 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.

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 3 to 10 percentage point difference. In addition, graduation rates at institutions characterized by higher levels of subsidy reliance and institutions designated as HBCU's 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 & 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 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 & 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 & 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.

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ADDENDUM

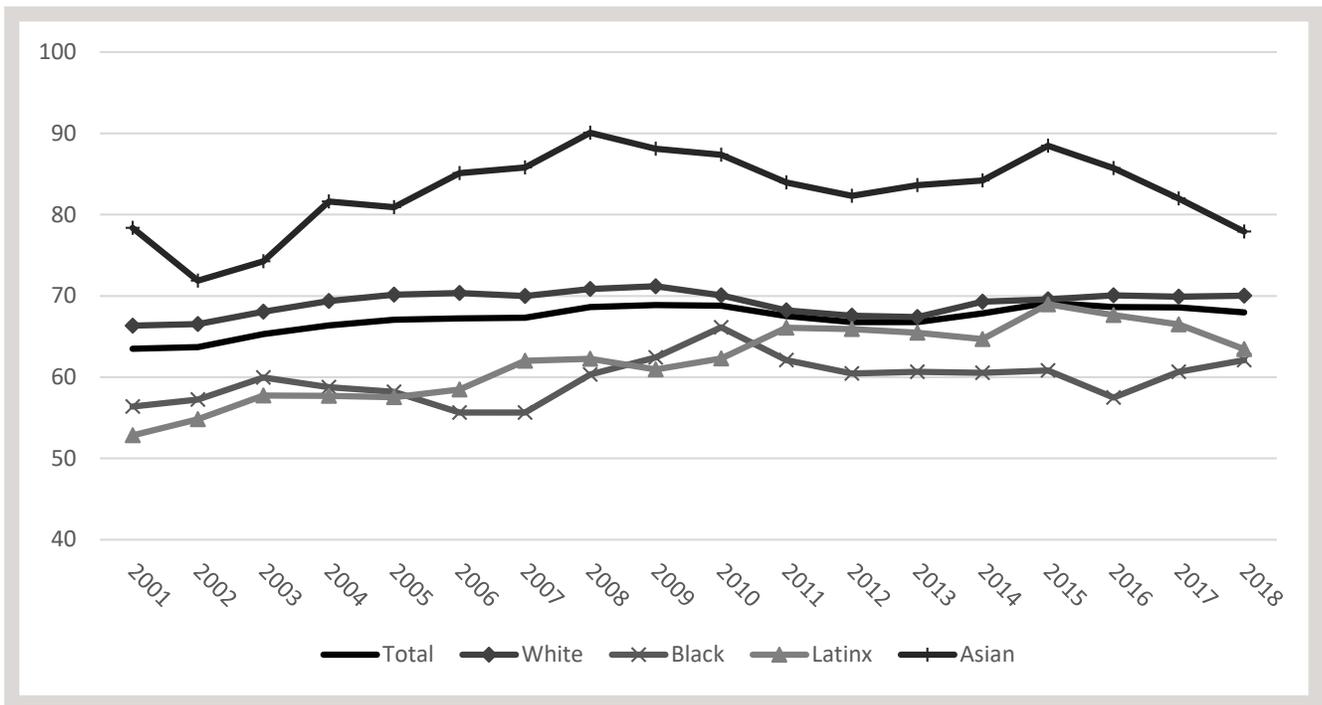
This Addendum provides an overview of national trends in postsecondary enrollment and completion, state appropriations, and factors that have been found to influence the level of state appropriations.

National Trends in Postsecondary Enrollment

Disparities are present at every step of the college pathway. Students from different racial and ethnic backgrounds enroll in college at different rates. Figure 1 indicates that Asian students have the highest enrollment rate directly

out of high school, while Black and Latinx students have the lowest rates. White students have a direct enrollment rate slightly higher than the national rate. The data indicate that direct enrollment rates have increased the most for Latinx students since 2001. Blacks and Whites have seen smaller increases over the time period, while the rate for Asians remains the same after increases and decreases.

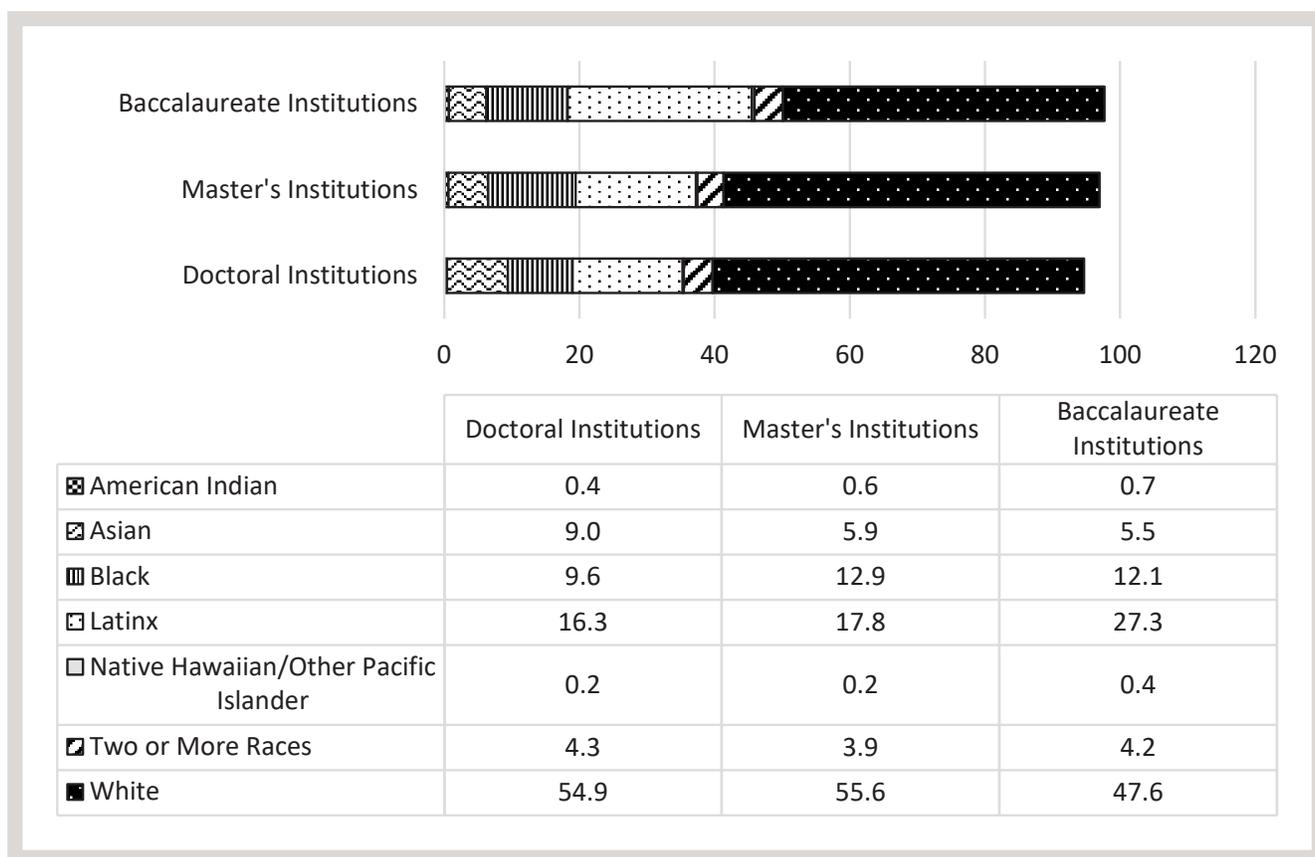
FIGURE 1. Percentage of Recent High School Completers Enrolled in College, by Race/Ethnicity (3-Year Moving Average)



Source. NCES.

Figure 2 shows differences in racial composition across public four-year institutions, wherein underrepresented students comprise a larger share of student enrollment at master’s universities than at research universities. In 2018, for instance, Black and Latinx students comprised 13% and 18% of total enrolment at master’s universities, compared to 10% and 16% at research universities (NCES, 2019). In contrast, the difference was smaller for White students, who represented 56% of students at master’s universities and 55% at research universities.

FIGURE 2. Enrollment Distribution by Race/Ethnicity at U.S. Public Four-Year Institutions, Fall 2018 (In Percentage Points)



Source. Authors’ analysis of IPEDS enrollment data.

Completion Gaps

Nationally, the completion gap between Whites and Blacks increased across all types of public four-year institutions from 2007 to 2018 (Table 1). Except for baccalaureate institutions, the completion gap between White and Latinx students decreased between 2007 and 2018. While the completion gap between Whites and underrepresented minorities increased at baccalaureate institutions, the gap slightly decreased at master's and doctoral institutions.

TABLE 1. National Race/Ethnicity Gaps in Six-Year Graduation Rates at Public Four-Year Institutions (In Percentage Points)

	White vs. Black	White vs. Latinx
All Institutions		
2007	18	12
2018	22	9
Baccalaureate Institutions		
2007	15	9
2018	21	10
Master's Institutions		
2007	16	14
2018	20	8
Doctoral Institutions		
2007	17	10
2018	21	9

Source. Authors' analysis of IPEDS graduation data.

Trends in State Appropriations

Nationally, Table 2 shows that total educational revenue, state and local appropriations, and tuition revenue increased from 2003 to 2018 at all types of public four-year institutions across the U.S.

TABLE 2. Postsecondary Educational Revenue per FTE Student by Institution Type at U.S. Public Four-Year Institutions

Year	Total Revenue per FTE	Total Appropriations per FTE	Total Tuition per FTE
Baccalaureate Institutions			
2003	\$9,818	\$6,424	\$3,394
2018	\$11,174	\$6,400	\$4,774
Master's Institutions			
2003	\$11,651	\$7,262	\$4,389
2018	\$12,909	\$6,455	\$6,454
Doctoral Institutions			
2003	\$16,182	\$9,977	\$6,205
2018	\$18,865	\$7,713	\$11,152

Source. Authors' analysis of IPEDS finance data.

Factors Influencing Appropriations Level

Several factors have been examined that attempt to explain levels of state support for higher education. Political conditions are identified as one factor. Several studies show that the presence of a Democratic governor or a Democratic-controlled legislature is positively related to state support of higher education (Ness & Tandberg, 2013). However, other studies show that due to increased competition among party priorities, this relationship between state spending on higher education and Democratic Party control is negative (Dar & Lee, 2014). Aside from party politics, political culture is another aspect of a state's political conditions that explain spending. States with a traditionalistic political culture spend more on higher education than do states with an individualistic political culture (Heck et al., 2014). Additionally, states with more professional legislatures have higher levels of higher education spending (McLendon et al., 2009; Tandberg, 2010).

A state's economic conditions constitute another factor that explains state support levels. Higher wealth and low unemployment are related to more spending on higher education (Heck et al., 2014; Toutkoushian & Hollis, 1998). Additionally, increased unemployment weakens the positive relationship between Democratic Party control and state higher education funding levels (Dar & Lee, 2014). Also, states with higher income inequality allocate more of their resources to higher education (Tandberg, 2009).

The organization and composition of higher education institutions affect funding levels as well. For instance, a state's governance structure of higher education impacts higher education funding levels. Consolidated governing boards negatively impact funding for higher education, as these types of boards act as a buffer by isolating decision makers from those who would have an interest in increasing state support for higher education (Tandberg, 2013). Additionally, the presence and size of private institutions within a state affects funding for public institutions. Doyle (2012) finds that as the number of students that enroll at private institutions in a state increases, tuition at public institutions decreases and state financial aid spending increases.

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7

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Vision MHEC members collaborate to address the region’s most pressing challenges in higher education and transform educational opportunities so that people and communities thrive.

Mission MHEC brings together midwestern states to develop and support best practices, collaborative efforts, and cost-sharing opportunities. Through these efforts it works to ensure strong, equitable postsecondary educational opportunities and outcomes for all.

Who MHEC Serves MHEC is comprised of member states from the midwestern United States. MHEC works with and for a variety of stakeholders within and across member states, including higher education system leaders, state policymakers, legislators, and institutional leaders, while always maintaining a focus on students and their success.

How MHEC Works MHEC’s strategic approach highlights member states’ strong desire for collaboration, effectiveness, and efficiency. MHEC believes that collaborative actions informed by research and best practices are the catalyst for improving quality, accessibility, relevance, and affordability of postsecondary educational opportunities. MHEC does this primarily through the following approaches: convenings, programs, research, and cost-savings contracts. Increasingly, MHEC looks to leverage these approaches in conjunction with each other to serve its strategic priorities.

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