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The United States is at a critical juncture in its ability to remain internationally competitive in STEM. At present, too few people from diverse populations, including women, participate in the STEM academic and workforce communities. This issue brief is the first in a series produced by the American Institutes for Research (AIR) to promote research, policy, and practice related to broadening the participation of traditionally underrepresented groups in STEM doctoral education and the workforce.

The Center for STEM Education and Innovation at AIR supports the national effort to prepare more students for educational and career success in science, technology, engineering, and mathematics by improving teaching and providing all students with 21st century skills needed to thrive in the global economy; meeting the diverse needs of all students—especially those from underrepresented groups; and using technology, evidence, and innovative practice to support continuous improvement and accountability.

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The Price of a Science PhD: Variations in Student Debt Levels Across Disciplines and Race/Ethnicity

Living in a society where a college degree is required for an increasing number of jobs and types of positions has its costs. Americans now owe over \$1 trillion in student loans, an amount that exceeds the accumulated credit card debt in the country (Student Aid Debt Clock, Kantrowitz 2010). About two thirds of all college graduates leave school with some educational debt, and African American and Hispanic students are more likely to graduate with loans than their white counterparts.

These increasingly high levels of student debt coincide with a growing demand for graduates with STEM (science, technology, engineering, and mathematics) degrees; a demand that can only be met by broadening participation in STEM fields to traditionally underrepresented groups, including African Americans, Hispanics and Native Americans (referred to in this brief as underrepresented minorities or URM) and females. Institutions of higher education have focused on “fixing the pipeline” so that these students who have traditionally been underrepresented on college campuses are able to obtain higher levels of education, including PhDs,¹ in the sciences. However, these traditionally underrepresented groups may be differentially impacted by increasing tuitions and an economic environment that challenges students’ and families’ abilities to finance postsecondary pursuits. Indeed, there remain several unanswered questions related to students’ academic trajectories and student debt: What is the debt level among STEM PhDs? Does debt differ by race/ethnicity and gender? How does the debt among STEM PhDs compare to the debt of students with PhDs in the social, behavioral, and economic (SBE) sciences? This brief examines these questions.

In this brief, though we touch on the debt STEM and SBE PhD recipients accrue during their undergraduate educational years, the primary focus is on graduate debt levels. Graduate student debt is often greater than undergraduate student debt due to the high costs associated with earning advanced degrees, yet graduate student debt levels have not been afforded the same amount of attention as undergraduate student debt in the national conversation.

¹ Over 99 percent of doctoral recipients in STEM and SBE fields in the Survey of Earned Doctorates received a PhD; the remaining respondents received another doctoral degree, such as a doctor of science or a doctor of engineering. In this brief, the term “PhD” includes all types of doctoral degrees.

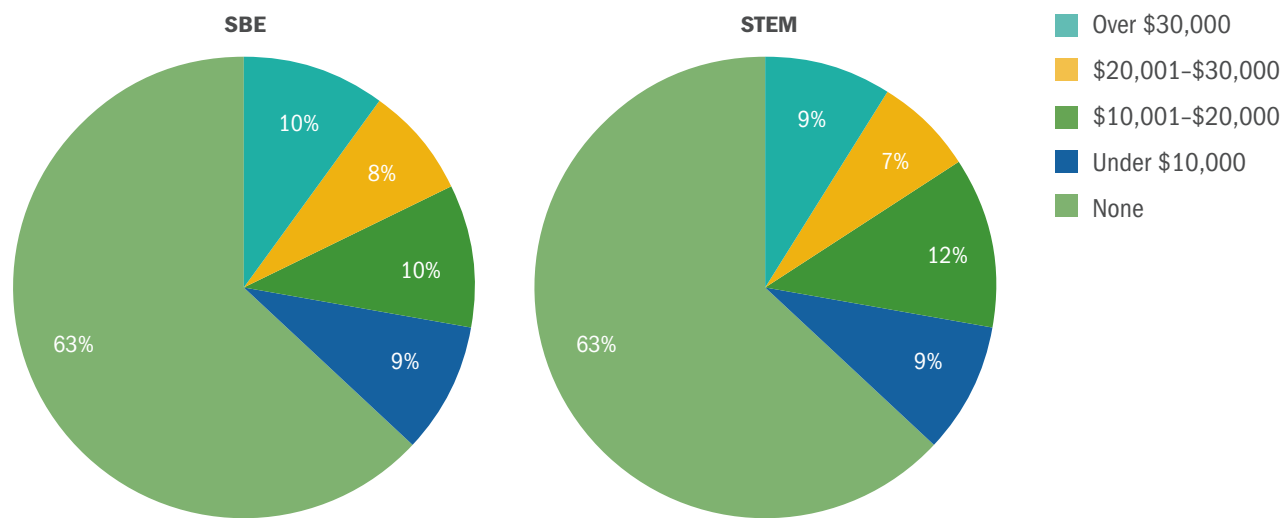
Overall, PhD recipients in SBE fields accrued higher levels of graduate student debt than PhD recipients in STEM fields; 37 percent of recipients in SBE fields, and 11 percent of recipients in STEM fields, accrued more than \$30,000 in debt during graduate school.

Our analysis uses data from the Survey of Earned Doctorates (SED) and focuses on STEM and SBE PhD recipients in 2010 who were U.S. citizens or U.S. legal permanent residents at the time they received their PhDs.²

STEM and SBE Undergraduate and Graduate Student Debt in 2010

Approximately two thirds of college seniors graduated with debt in the 2007-08 and 2009-10 school years (Project on Student Debt 2011, U.S. Department of Education 2011). However, only a little over one third of STEM and SBE PhD recipients in 2010 had student debt as undergraduates (see Figure 1). In fact, the percentages of PhD recipients with different levels of undergraduate debt were similar in SBE and STEM fields. These findings are consistent with data from the National Postsecondary Student Aid Study (NPSAS) from the National Center for Education Statistics (NCES), which found that, among graduate students in PhD programs in 2007-08, a full 71.4 percent did not borrow money to pay for their undergraduate education (U.S. Department of Education 2010). However, rates of borrowing for undergraduate education varied by field of study: among PhD students in doctoral programs in the life and physical sciences, 67.1 percent did not borrow money to pay for undergraduate education, while in the social and behavioral sciences, a full 79.2 percent of doctoral students did not borrow money to pay for undergraduate education (U.S. Department of Education 2010).

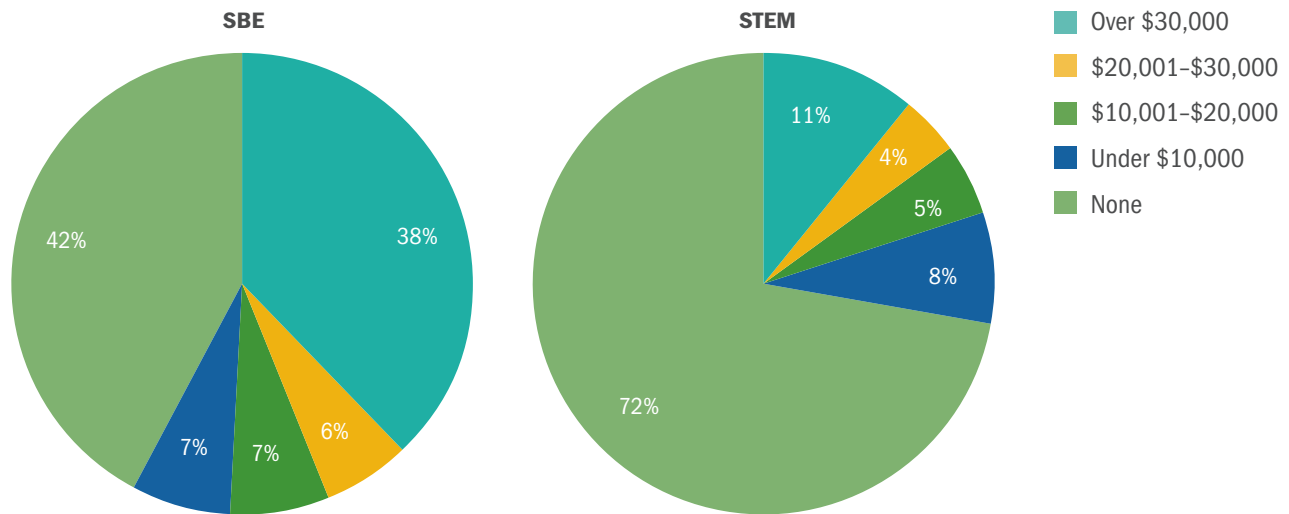
Figure 1. Undergraduate Student Debt for STEM and SBE PhD Recipients: 2010



However, the story changes in graduate school. Student debt levels are typically larger at the graduate school level than at the undergraduate level, and differences in student debt between PhD recipients in STEM and SBE fields are greater at the graduate school level. Overall, PhD recipients in SBE fields accrued higher levels of graduate student debt than PhD recipients in STEM fields. While 58 percent of PhD recipients in SBE fields accrued debt during graduate school, only 28 percent of PhD recipients in STEM fields accrued debt during graduate school (see Figure 2). Moreover, 38 percent of PhD recipients in SBE fields accrued more than \$30,000 in graduate student debt, compared with only 11 percent of STEM PhD recipients.

² Fewer than 4 percent of PhD recipients in 2010 had missing data for the questions surrounding student debt. This brief focuses on the 19,182 students with valid data surrounding undergraduate debt and the 19,144 students with valid data surrounding graduate school debt.

Figure 2. Graduate Student Debt for STEM and SBE PhD Recipients: 2010

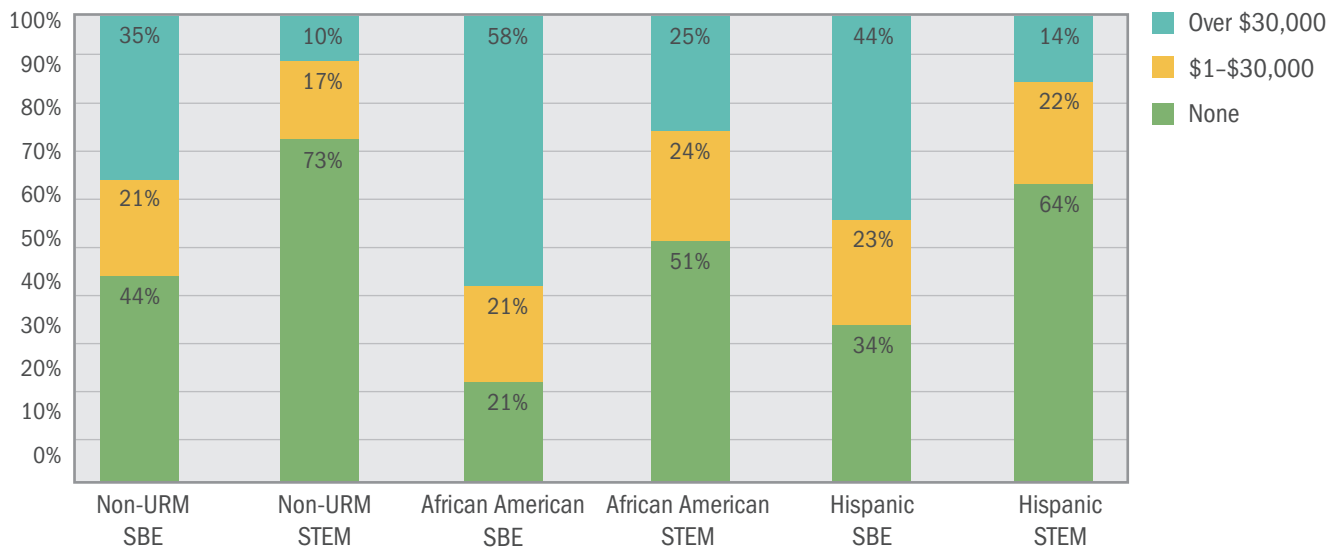


In the following sections, we more closely examine how graduate student debt differed between STEM and SBE PhD recipients and between students with different characteristics within these fields. For these analyses, we collapsed levels of graduate student debt into three categories: students who did not accrue debt during graduate school, students who accrued debt that amounted to less than \$30,000 during graduate school, and students who accrued over \$30,000 of debt during graduate school.

STEM and SBE Graduate Student Debt within the STEM and SBE Fields by Race/Ethnicity

Differences between the debt levels of URMs and non-URMs (including white, Asian, and multi-racial students) were pronounced at the graduate school level. For degree recipients in both the SBE and STEM fields, non-URM recipients tended to have lower levels of debt relative to Hispanic recipients, who in turn had lower levels of debt relative to African American recipients. Indeed, 44 percent of non-URM SBE PhD recipients and 73 percent of all non-URM STEM PhDs reported having no graduate debt at all. For African Americans, the percentage of PhD recipients who accrued any debt was more than 20 percentage points higher than the percentage of non-URM recipients who accrued any debt in both SBE fields (79 percent versus 56 percent) and STEM fields (49 percent versus 27 percent). Further, among STEM PhD recipients, African Americans were more than twice as likely as non-URM students (25 percent versus 10 percent) to report the highest levels of debt: debt in excess of \$30,000 (see Figure 3). Relative to those who received their PhDs in STEM fields, recipients from SBE fields were much more likely to accrue more than \$30,000 in graduate student debt, with 35 percent of non-URM recipients, 44 percent of Hispanic recipients, and 58 percent of African American recipients reaching this extreme level of student debt.

Figure 3. Graduate Student Debt by Race/Ethnicity and Disciplinary Focus: 2010



Graduate Student Debt by Gender

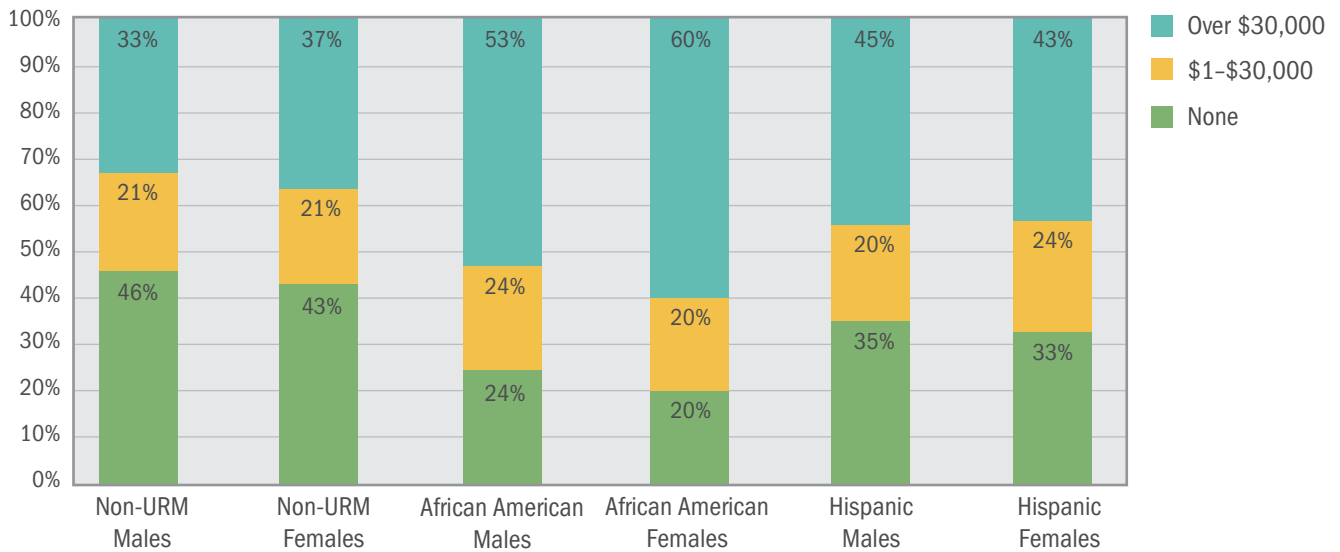
Among PhD recipients in SBE fields, gender differences in the accumulation of graduate student debt within race/ethnicity were relatively small for Hispanic and non-URM recipients, with differences between males and females never exceeding 3 percentage points (see Figure 4). On the other hand, African American women in SBE fields were slightly more likely to accrue debt during graduate school; 60 percent of African American women and 53 percent of African American men accrued more than \$30,000 in debt during graduate school.

Among PhD recipients in STEM fields, gender differences in debt accumulation were more pronounced among URM recipients relative to non-URM recipients, where differences between males and females again did not exceed 3 percentage points (see Figure 5). African American males were more likely to accrue debt during graduate school than African American females (52 percent versus 46 percent), and Hispanic males were slightly more likely to accrue debt than Hispanic females (39 percent versus 34 percent). However, while African American males were more likely to accrue debt that did not exceed \$30,000, African American females were more likely to accrue more than \$30,000 in graduate student debt relative to their male peers (27 percent versus 22 percent). Thus, among recipients in both the SBE and STEM fields, African American females were the subgroup that was most likely to accrue this extreme level of graduate student debt when examining the intersection of race/ethnicity and gender.

Notably, within both SBE and STEM fields, and among both males and females, African American recipients were more likely to accrue higher levels of debt relative to Hispanic recipients, who in turn were more likely to accrue higher levels of debt relative to non-URM recipients. Also, racial/ethnic disparities in graduate student debt were much larger than gender differences in debt accumulation.

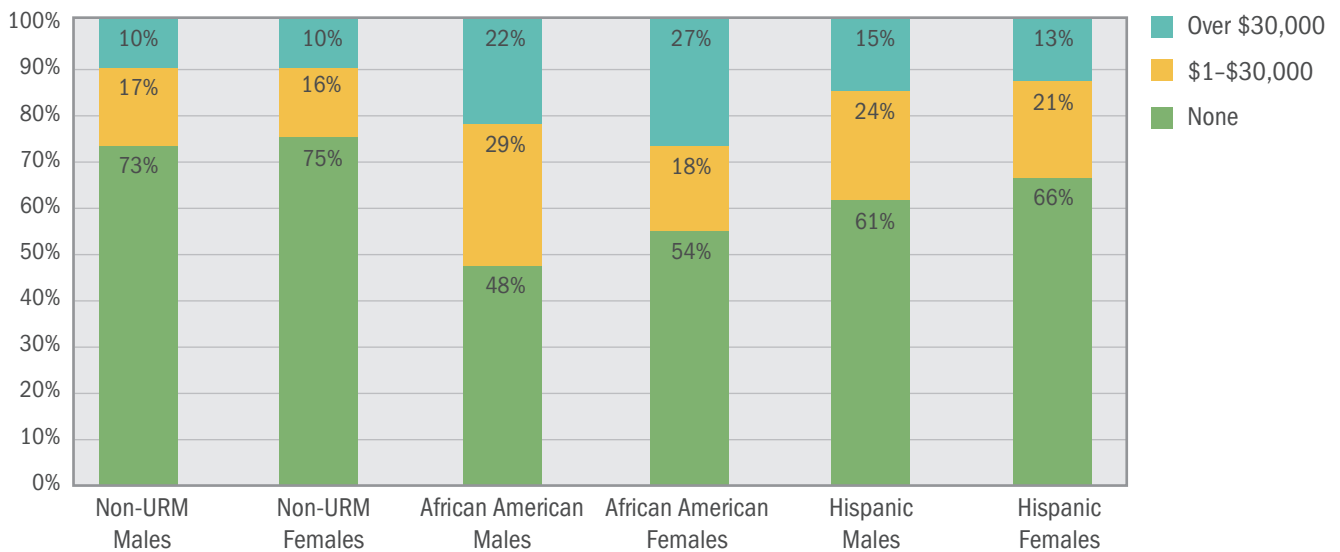
Within both SBE and STEM fields, and among both males and females, African American recipients were more likely to accrue higher levels of debt relative to Hispanic recipients, who in turn were more likely to accrue higher levels of debt relative to non-URM recipients.

Figure 4. Graduate Student Debt for SBE PhD Recipients by Race/Ethnicity and Gender: 2010



NOTE: Category totals are not always 100 percent due to rounding.

Figure 5. Graduate Student Debt for STEM PhD Recipients by Race/Ethnicity and Gender: 2010



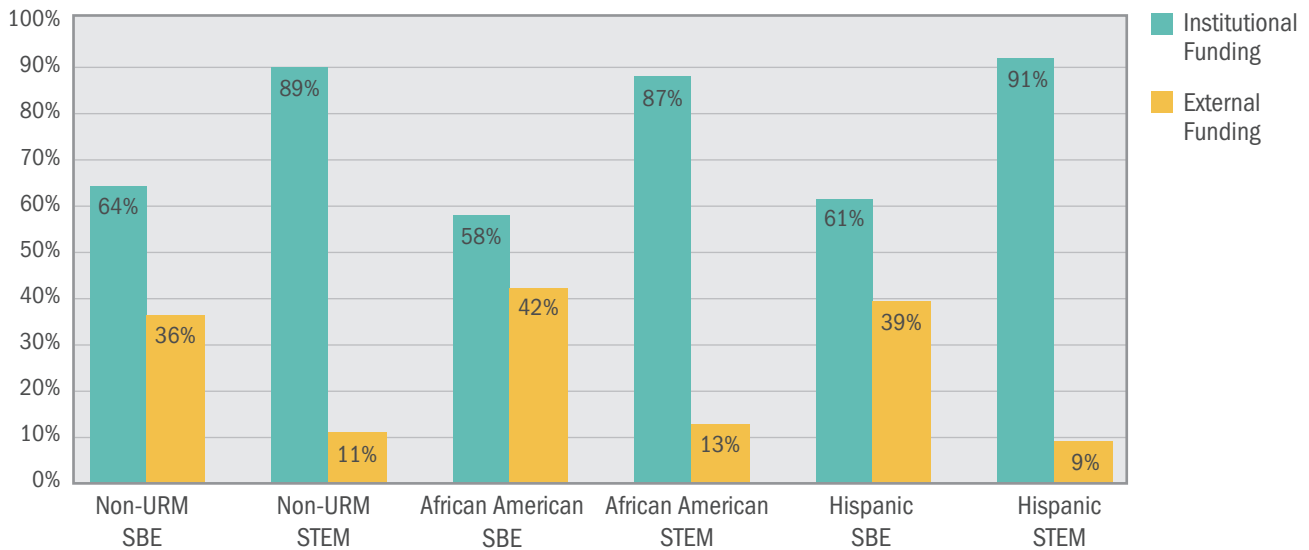
NOTE: Category totals are not always 100 percent due to rounding.

Primary Sources of Funding for STEM and SBE Graduate Students

Institutions often provide funding for graduate students in the form of research assistantships, teaching assistantships, or fellowships to attract students to study within the sciences. This is particularly the case for students studying within the STEM fields. Figure 6 demonstrates that students who received PhDs in STEM fields were much more likely to receive institutional funding than students in SBE fields. Over 80 percent of STEM PhD recipients, regardless of race/ethnicity, reported institutional support as a primary source of funding; less than 15 percent of these students cited external funding as a primary source of support.³ In contrast, between 36 and 42 percent of SBE PhD recipients relied primarily on external funding during graduate school. While African American recipients in both SBE (42 percent) and STEM (13 percent) fields were slightly more likely to rely on external funding than their non-URM (36 percent in SBE fields and 11 percent in STEM fields) and Hispanic (39 percent in SBE fields and 9 percent in STEM fields) peers, differences in funding sources were relatively small across racial/ethnic groups.

³ “External funding” includes nine separate sources of funding: other assistantship, internship/clinical residency, loans, personal savings, other personal earnings, spouse’s/partner’s/family’s earnings or savings, employer reimbursement, foreign support, and “other.” Thirty-two percent of recipients who relied on external funding reported loans as their primary source of funding.

Figure 6. Sources of Funding by Race/Ethnicity for STEM and SBE PhD Recipients: 2010



NOTE: Category totals are not always 100 percent due to rounding.

One would expect that students who receive funding for graduate school through external sources would be more likely to accrue higher levels of debt, and our analyses confirm that this is the case. Figures 7 and 8 illustrate levels of graduate student debt among PhD recipients in SBE and STEM fields by race/ethnicity and source of funding. Among recipients with the same primary source of funding, a pattern appears in which African American recipients accrued a larger amount of graduate debt, on average, relative to Hispanics, who in turn accrued a larger amount of graduate debt relative to non-URMs. Among recipients in SBE fields, African American and Hispanic recipients who primarily financed their graduate education through external sources were almost equally likely to accrue debt during graduate school, with approximately 80 percent of recipients accruing debt (compared with 66 percent of non-URMs who relied on external funding). In addition, African American recipients in SBE fields who relied on external funding

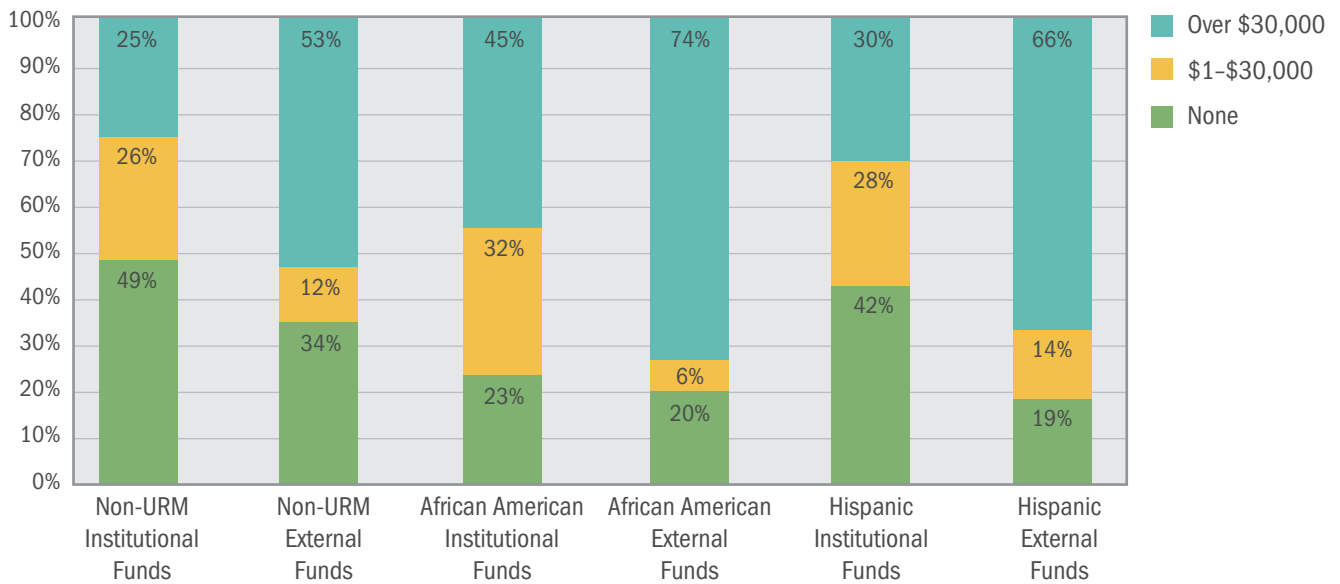
Racial/ethnic disparities in graduate student debt are observed both among recipients who received institutional funding and among students who relied on external sources to pay for graduate school.

were most likely to amass high levels of debt, with 74 percent of recipients in this group accruing over \$30,000 in graduate student debt. Notably, among recipients in SBE fields with the same race/ethnicity, the percentage of students who accrued over \$30,000 in graduate student debt is over 25 percentage points higher among students who relied on external funding relative to recipients who received institutional funding.

Similar patterns emerged for recipients in STEM fields, where approximately 24 percent of African Americans who relied on institutional funding, and 9 percent of non-URM recipients who relied on institutional funding, accrued over \$30,000 in graduate student debt. Slightly higher levels of graduate student debt were observed among PhD recipients

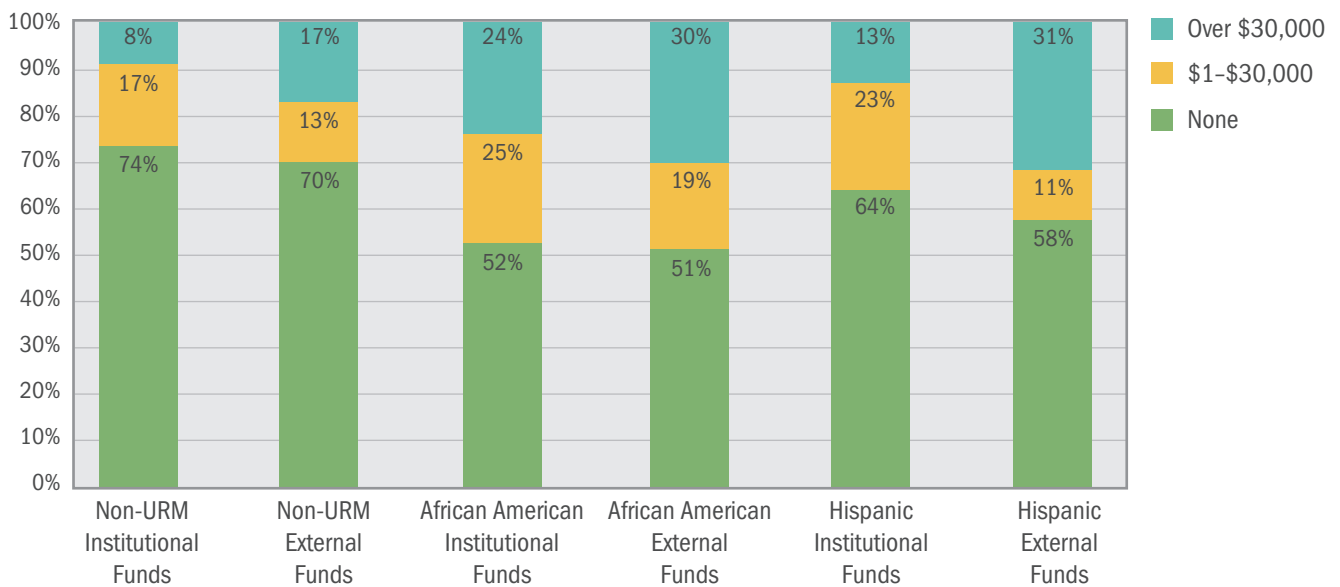
in STEM fields who relied on external funding sources, with 30 percent of African American recipients and 17 percent of non-URM recipients accruing over \$30,000 in debt. While 13 percent of Hispanic STEM PhD recipients with institutional funding accrued over \$30,000 in graduate student debt, Hispanic STEM PhD recipients who cited external sources as their primary source of funding were the group of STEM PhDs most likely to report this high level of student debt, with 31 percent accruing over \$30,000 in debt during graduate school.

Figure 7: Graduate Student Debt for SBE PhD Recipients by Race/Ethnicity and Primary Source of Funding: 2010



NOTE: Category totals are not always 100 percent due to rounding.

Figure 8: Graduate Student Debt for STEM PhD Recipients by Race/Ethnicity and Primary Source of Funding: 2010



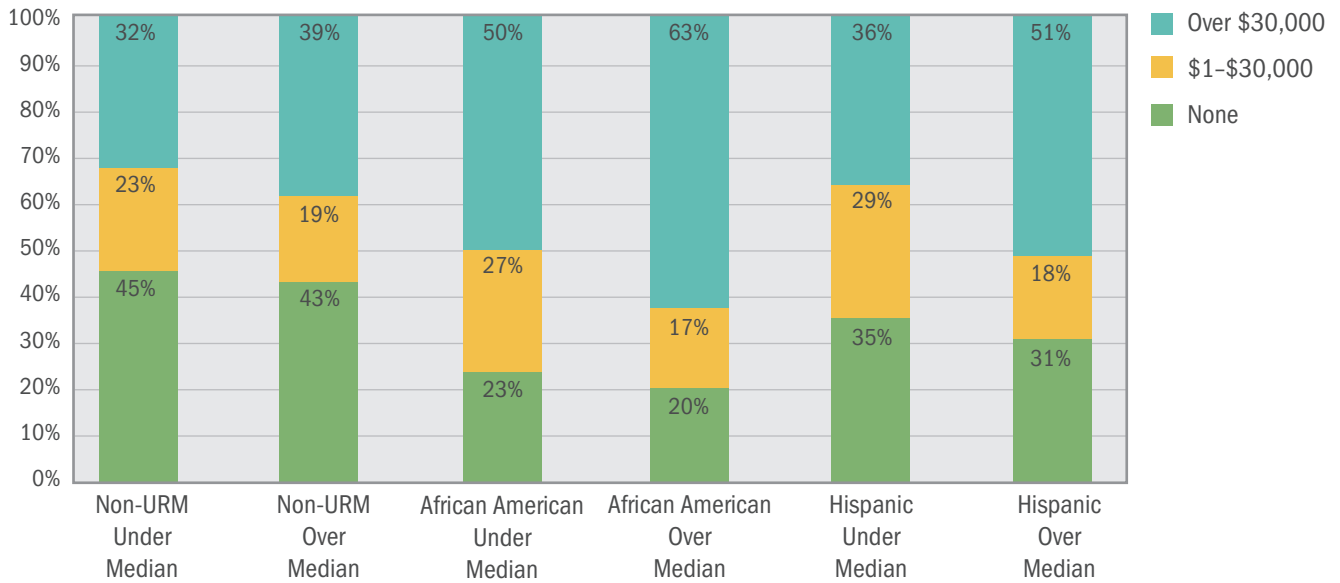
NOTE: Category totals are not always 100 percent due to rounding.

Level of Graduate Debt and Time to Complete a PhD

Not surprisingly, the longer an individual is in graduate school, the greater the debt. For Figures 9 and 10, we calculated the median time to completion (TTC) within the STEM and SBE disciplines in 2010, and respondents were categorized as either above this median TTC or at or below this median TTC.” In 2010, the median time to complete a PhD in a STEM field was 6.3 years, while the median time to complete a PhD in an SBE field was 7.7 years. Among recipients in SBE fields, African American and non-URM recipients whose TTC exceeded the median were approximately one fifth more likely to accrue over \$30,000 in graduate student debt, while Hispanic recipients whose TTC exceeded the median were almost 50 percent more likely to accrue over \$30,000 in debt, relative to their peers whose TTC was below the median. Differences in rates of accruing any graduate student debt between students with different TTCs were smaller in magnitude, never exceeding 5 percentage points.

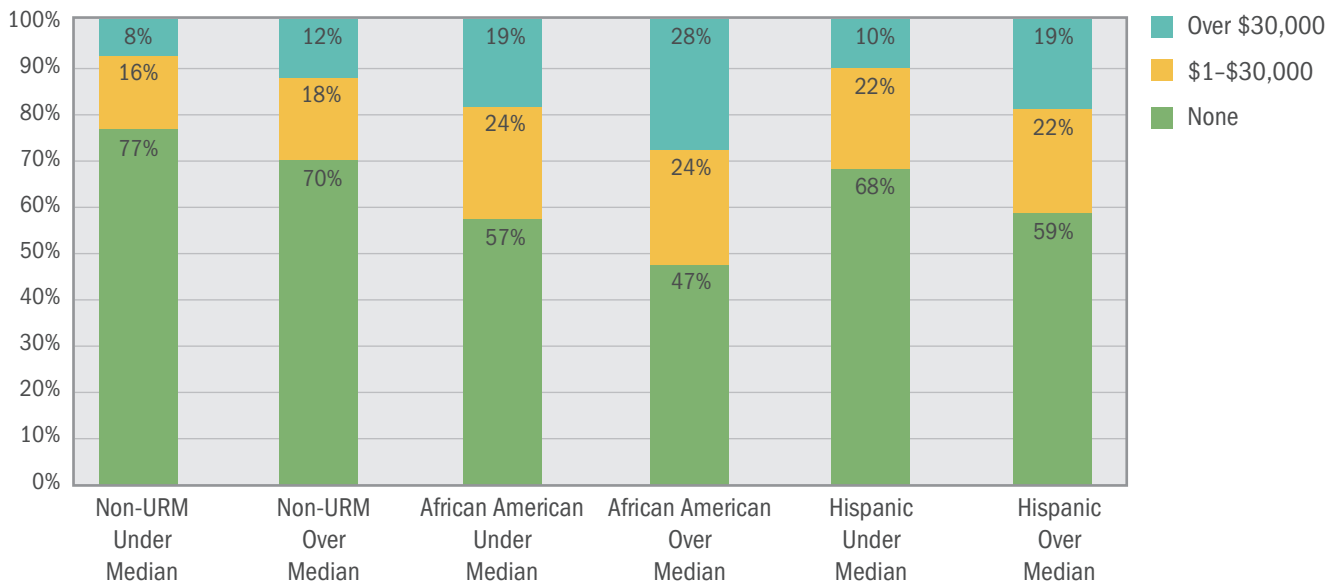
Among recipients in the SBE fields, it is apparent that racial/ethnic differences in debt accumulation existed even among recipients who took a similar amount of time to complete their PhD. Among recipients whose TTC exceeded the median TTC of 7.7 years, 39 percent of non-URMs, 51 percent of Hispanics, and 63 percent of African Americans accrued debt during graduate school that exceeded \$30,000. Similar patterns were observed for recipients in STEM fields: among recipients whose TTC exceeded the median of 6.3 years, African American recipients were more than twice as likely to accrue over \$30,000 in graduate student debt relative to non-URM recipients (28 percent versus 12 percent). Even among recipients in STEM fields whose TTC did not exceed the median, racial/ethnic differences in the accumulation of debt during graduate school existed such that 23 percent of non-URM recipients, 32 percent of Hispanic recipients, and 43 percent of African American recipients accrued debt during graduate school.

Figure 9: Graduate Student Debt for SBE PhD Recipients by Race/Ethnicity and Time to Completion: 2010



NOTE: Category totals are not always 100 percent due to rounding.

Figure 10: Graduate Student Debt for STEM PhD Recipients by Race/Ethnicity and Time to Completion: 2010



NOTE: Category totals are not always 100 percent due to rounding.

Implications

What might these findings mean? Other studies of student debt indicate that about two thirds of all undergraduates leave college with loans that need to be repaid, yet our data indicate that a much smaller percentage of STEM and SBE PhD recipients in 2010—about 37 percent—had debt resulting from their undergraduate studies. Our findings from the SED data are similar to NCES findings where closer to 30 percent of graduate students accumulated debt during their undergraduate careers (U.S. Department of Education 2010).

Financing a PhD in a STEM or SBE field, however, results in high levels of debt, particularly for SBE PhD recipients and for URMs. Notably, African American recipients were substantially more likely to accrue debt in excess of \$30,000 than non-URM recipients in both STEM and SBE fields. Additionally, other factors that are likely to be related to student debt, such as primary source of funding and time to PhD completion, failed to eliminate racial/ethnic differences in graduate student debt. These findings suggest that other factors may be influencing debt accumulation among URM students. Other factors that may be worth exploring include the distance that students travel to attend graduate school, spending patterns during graduate school, the family commitments of PhD students during graduate school (e.g., marital status and number of dependents), and salary expectations after leaving graduate school. If graduate students' spending patterns during graduate school are related to the expected financial pay-off of their PhDs, then differences in graduate student debt may be related to differences in students' inflated estimates of their future salaries.

The findings presented in this brief highlight the importance of examining rising tuition costs for graduate degrees, as well as the financial aid policies and practices at both the undergraduate and graduate levels. The findings also emphasize the need to effectively communicate to students the various options for financing their graduate school studies so they can make informed decisions when they receive offers from graduate programs.

In conclusion, if increasing the numbers of STEM and SBE PhDs, and particularly broadening participation among underrepresented minorities, is to remain a national priority, the policies and practices that aim to support students in financing their education need to be examined. As demonstrated in prior research, concerns about accumulating large amounts of debt influence students' decisions to pursue or complete advanced degrees (Malcolm and Dowd 2012). The findings in this report demonstrate that students' concerns about debt accumulation during graduate school are not unfounded.

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