

Education and Academic Career Outcomes for Women of Color in Science and Engineering

Donna K. Ginther

Professor, Department of Economics
Director, Center for Science, Technology & Economic Policy
University of Kansas
Lawrence, KS 66045
Email: dginther@ku.edu

and

Shulamit Kahn

Associate Professor, Department of Markets, Public Policy, and Law
School of Management
Boston University
Email: skahn@bu.edu

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Abstract: Using a variety of data sources including longitudinal NSF data, this report finds that Women of Color (WOC) are less likely than white women to graduate from college, to obtain a PhD in science and engineering (S&E) fields, and to obtain a tenure-track job at non-minority serving institutions other than top universities. In addition, WOC are more likely to be employed in non-tenure track positions in academia and be employed at under-represented minority-serving institutions (URM). Neither high school graduation nor academic tenure and promotion are the primary reasons that WOC are under-represented. Instead, the transition from high school graduation to college graduation, from college S&E major to S&E PhD, and finally the transition from an S&E PhD to a tenure-track job in a non-URM university are the key points where WOC are dropping out.

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This report uses national statistics to quantify the under-representation of women of color (WOC) in science and engineering (S&E) academic careers. It then identifies the stages of WOC's educational and career development that are key to this under-representation of WOC in S&E academia. Armed with this knowledge, those concerned about this under-representation can target interventions and policies that will be the most effective at increasing diversity in academic careers.

Using a variety of data sources including longitudinal NSF data, we find that WOC are less likely than white women to graduate from college, to obtain a PhD in S&E fields, and to obtain a tenure-track job at non-minority serving institutions other than top universities. In addition, WOC are more likely to be employed in non-tenure track positions in academia and be employed at minority-serving institutions. Neither high school graduation nor academic tenure and promotion are the primary reasons that WOC are under-represented. Instead, the transition from high school graduation to college graduation, from college S&E major to S&E PhD, and finally the transition from an S&E PhD to a tenure-track job in a non-URM university are the key points where WOC are dropping out.

The remainder of the paper is organized as follows. After summarizing the literature on academic WOC, we describe the most recent data on the racial and gender distribution of academics in S&E fields. We then evaluate race/ethnicity and gender differences in education pathways including high school graduation, undergraduate major in S&E fields, college graduation, and PhD in S&E fields. Turning to academic career outcomes, we measure the likelihood of obtaining a tenure track job within six years of the PhD, of being awarded tenure

within 11 years of the PhD, and of being promoted to full professor within seven years of receiving tenure. The final section discusses the implications of our results.

1. Background

Many science organizations and researchers have documented the under-representation of women and minorities in academic S&E (NCSES 2011, NSB 2012, NSF 2011, Nelson & Brammer 2007). Together these studies find that women and under-represented minorities make up smaller and smaller percentages of total academic S&E faculty as one proceeds up the academic ranks. However, few studies have examined the ‘double-bind’ – the representation of women of color (WOC) in S&E academic careers (Leggon 2006, Towns 2010). Leggon (2006) argues that data need to be disaggregated by race/ethnicity and gender in order to study WOC. Further, she conjectures that the tenure process may disadvantage WOC in academic careers but does not test this hypothesis with data. Towns (2010) uses data from Nelson & Brammer (2007) to show that there are few WOC in the top 100 S&E departments funded by the NSF. However, Towns does not explore the underlying causes of under-representation.

Much of the research on WOC in S&E academe has focused on their qualitative experiences as S&E faculty members (Malcolm & Malcolm 2011, Turner *et al.* 2011, Turner *et al.* 2008, MacLachlan 2000). Turner *et al.* (2008) reviews the mostly qualitative literature on faculty of color in academe and reports that the literature shows that faculty of color cite under-valuation of their research interests, isolation, and lack of department and institutional efforts to recruit and retain a diverse faculty as issues confronting them in academic careers. Ong *et al.* (2011) provides a synthesis of empirical research on WOC in Science, Technology, Engineering and Mathematics (STEM) disciplines. This literature review finds very few studies of WOC in

STEM fields in academe, many which focus on their experiences in undergraduate and graduate school. Ong *et al.* makes extensive recommendations for the future research agenda for WOC in STEM disciplines, including conducting studies that use longitudinal data on WOC in STEM disciplines, “as well as work that addresses transitions and points of loss between the secondary, postsecondary (2-year, 4-year, and graduate institutions), and career stages of the STEM pipeline.” (p. 42).

Two studies partially address Ong *et al.*’s recommendation for studying transitions in STEM education and careers. Ginther and Kahn (2009) examine gender differences in academic career outcomes in S&E fields. They find that married women with children are less likely to take tenure track jobs compared to men. However, they find no significant gender differences in promotion to tenure and full professor after controlling for demographic, family, employer, and productivity characteristics. Ginther *et al.* (2009) examines gender and race/ethnicity differences in academic biomedical careers. They find that women and under-represented minorities leave biomedical studies and biomedical research careers at different milestones. Under-represented minorities are lost between high school and college and between college and graduate school. However, Ginther *et al.* does not examine all S&E fields nor does it separate out women and men of color.

This paper addresses Ong *et al.*’s recommendation by examining each stage of education and career progression, from high school to full professor, in order to show the transition points where women of color leave the S&E academic career trajectory. Note that the analysis here is limited to S&E – life science, physical science, and engineering – because our previous research (Ginther and Kahn 2004, Ginther and Kahn 2006, and Ginther and Kahn 2009) shows that combining all STEM disciplines together including social sciences masks important trends in

academic careers, and particularly that social science disciplines have very different career outcomes for women compared to the S&E disciplines only.

2. The Representation of Women of Color in S&E Academia

We base our analysis of the representation of WOC in S&E academia¹ on the National Science Foundation's (NSF) Survey of Doctorate Recipients (SDR). The SDR is a biennial, longitudinal survey of US trained PhDs in S&E and social science fields. Respondents to the SDR are drawn from the NSF's annual Survey of Earned Doctorates (SED) and followed throughout their careers as long as they remain in the US, are less than 75 years old, or are eliminated from the sample to make way for new PhDs. The SDR over-samples women and under-represented groups, however there are still small numbers of WOC in the data.

Throughout the analysis, we define women of color as US-born² women who are African-American, Hispanic, or Native American/Pacific Islander. As we examine higher levels of education, the representation of women of color becomes much lower. In order to preserve the confidentiality of the data, we often must combine these race/ethnicity categories into the single group, women of color (WOC).

Tables 1 through 3, based on the 2008 SDR (the most-recent wave of the data), examine the current representation of WOC in S&E academic careers. Although the SDR provides the ideal data set for this analysis because it follows individuals over time and over-samples WOC, we are still dealing with very small numbers of WOC employed in academic jobs.

¹ Academia includes universities, 4-year colleges, and medical and other professional schools that award post-BA degrees.

² The exact definition depends on the data source. In some cases we include all US-born, in other cases we include all citizens or add permanent residents to the citizens.

Estimates from the SDR (shown in the last column of Table 2) show that there were only 2,724 WOC and 3,992 men of color (MOC)³ with S&E PhDs working in academic jobs compared with 25,900 white women and 57,837 white men. In other words, there are almost 10 times the number of white women and almost 20 times the number of white men as there are WOC working in S&E academia.

Table 1 shows the percentage of WOC compared to all other demographic groups in different academic rank groupings, as estimated from the SDR. For comparison, the last column of Table 1 shows each demographic group's percentage of the U.S population aged 25 to 69 years-old (from the 2000 Census).⁴ Although WOC make up 12.5% of the US population, they are only 2.3% of the tenured or tenure track faculty and 5.1% of non-tenure-track faculty (first 2 columns of Table 1). Non-tenure track faculty are the least prestigious and the lowest-paid of all faculty, and therefore this report concentrates on tenure-track and tenured faculty only. MOC as a percentage of tenured/tenure-track academia are almost twice the percentage of WOC (4.1%) but are still grossly under-represented relative to the population (11.9%). Instead, the majority of tenured/tenure-track faculty are white men (60.1%), a percentage two-thirds greater than their percentage of the population. Asians, while a small part of the population, are over-represented within tenured/tenure-track academic ranks, particularly Asian men whose percentage within academia is more than threefold their percentage in the population.

The next columns of Table 1 isolate those higher in the academic hierarchy: first, only academics who are tenured and second, the subset of these who have further been promoted to

³ As with women, MOC includes men who are African-American, Hispanic, or Native American/Pacific Islander.

⁴ For the Census data, there are far more racial categories, including many people with two or more races. For these data, we define people of color as anyone who is *not* a non-Hispanic white or an Asian. The black category here includes those who give their single race as "Black" or "African-American." Hispanics in these Census figures can be of any race. As can be seen in the tables, these categories of Black and Hispanic do not add up to the total URM, although they do double-count those who have Hispanic ethnicity but Black as their single race.

full professorships. As we move up the academic ranks, the proportion of WOC falls while the proportion of white men rises. At the most senior rank, 67% of full professors are white men compared to only 1.2% who are WOC and 3.8% who are MOC.

Table 2 shows the distribution of each demographic group across the *mutually exclusive* faculty ranks. Almost 30% of WOC work in non-tenure track positions compared to 12% of MOC, 23% of white women, and 11.5% of white men. Only 19% of WOC working in academic jobs are tenured associate professors and 16% are full professors, compared to 25% and 27% of white women and to 25% and 42% of white men. The corresponding percentages for MOC are more similar to white men than to WOC: MOC's percentage in non-tenure-track positions and in tenured associate positions resemble white men's, but their percentage in tenure-track untenured positions and in full professorships lie between white women's and white men's percentages.

The shrinking proportions of WOC between the tenure-track untenured rank and the tenured full professor rank may be due to the fact that women in general, and WOC in particular, only began getting S&E PhDs in large numbers in recent decades. Therefore, the most senior academics who would be eligible for full professorships received PhDs when men were the dominant gender. To identify whether there were indeed racial and gender hiring and promotion differences within academia, we need to analyze careers of individuals using longitudinal data. This is exactly what we do in Section 4 below.

Table 3 repeats the analysis of Table 1, but divides the sample by academic employer type — Under-represented Minority Universities or colleges (URM-universities) or non-URM-universities. URM-universities are defined as Historically Black Colleges or Universities (HBCU), minority-serving institutions (where more than 25 percent of the student body comes from under-represented groups including African-Americans, Hispanics, and Native Americans),

or Tribal Colleges or Universities (TCU). Note that the SDR data includes the Integrated Postsecondary Education Data System (IPEDS) institution code for all respondents employed at a higher education institutions, allowing us identify whether each academic worked for a URM-university, be it an HBCU, a TCU, or a minority serving university, or for a non-URM-University.

Although there are more URM faculty in non-URM universities than in URM-universities, WOC are disproportionately employed by URM universities. Only 1.1% of tenure-track or tenured faculty at non-URM institutions are WOC. Thus, of the estimated 57,030 tenure-track or tenured faculty at non-URM institutions, there are only 625 WOC. In contrast, 9.6% or 681 of the 7,090 tenured or tenure-track faculty at URM are WOC. In other words, more WOC are employed at URM-universities even though these universities employed only 11% of all tenure-track/tenured academics. MOC are also over-represented in URM-universities but not to the same extent specifically, a third of URM men are at URM-universities.

We cannot know from this evidence whether WOC and MOC are concentrated in URM-universities because they have chosen these positions or because these are the universities that will hire them and that will promote them. With longitudinal data, we will be able to compare promotion rates in URM and non-URM universities. Without application data, however, we cannot know whether the placement of WOC and MOC into URM universities was by choice or by necessity.

In the sections that follow, we use a variety of data sources to examine each education and academic career step in order to identify the transition points where women of color leave the S&E academic career trajectory.

3. Gender and Race/Ethnicity Differences in Education Outcomes

Our analysis of education outcomes begins by using data from the 1994-2010 waves of the Outgoing Rotations data from the Current Population Survey (CPS). In Figure 1, we compare the percentage of US citizens ages 24-25 who were WOC to the percentage of high-school graduates among the 24-25 year-old citizens who were WOC, and to the percentage of college graduates among the 24-25 year-old citizens who were WOC.

Since the 1990s, the percentage of WOC among the general population of 24-25 year-old citizens has been increasing from approximately 12 percent to over 14 percent. The percentage of WOC among the 24-25 year-old citizens who were high-school graduates is practically identical to the percentage of WOC among the total population this age, indicating that WOC are graduating high school at exactly the same rates as the national average. If anything, the high-school graduation rates for WOC seem slightly higher than the national average in some years (including the most recent ones). Thus, interventions are not needed to increase WOC's high-school graduation rates, although these statistics cannot speak to the quality or emphasis of the high-school education received by WOC compared to other demographic groups.

However, WOC are *not* graduating from college at a similar rate as the population as a whole. Figure 1 illustrates this by showing that WOC are a much smaller percentage of 24-25 year-old (citizen) college graduates than they are of high school graduates or of the whole population. Thus, in 2010, nearly 14% of (24-25 year-old) high school graduates were WOC but WOC made up less than 10 percent of college graduates among that age group. Nevertheless, this represents an increase in the percent of WOC among the total population of college graduates (24-25 years old), from 6.6% in 1994. The rate of increase over time in WOC's percentage of college graduates is somewhat greater than the rate of increase in WOC's

percentage of high-school graduates, which means that WOC are making some progress in completing college. However, the gap remains large.

Figure 2 puts this into perspective by making the same comparison for white women who make up a decreasing share of the total and high-school graduate population of 24-25 year-olds due to the fact that the proportion of non-whites in the US population is growing faster than whites. Thus, white women have gone from 39% of the total US 24-25 (citizen) population in 1996 to 32% in 2010, with quite similar proportions of high school graduates. However, white women's percentages of 24-25 year-olds college graduates are much higher overall than their percentage of the overall population or of high schools graduates, averaging 45%. Moreover, white women are *increasing* the gap between their percentage among college graduates and their percentage among high-school graduates, as higher proportions of white women graduate college. The more recent (2006-2010) college graduation rates are shown directly in Figure 3 as percentages of high school graduates among the 24-25 year-old natives who graduated from college.

In Figure 3 and later graphs, to facilitate our understanding of the representation of WOC, we compare them to white women, white men, and MOC (all native-born). We thus exclude Asians, who have the highest rates of representation among academics as indicated in Table 1. We see that WOC high-school graduates are significantly less likely to graduate from college than white women. Note that these graduation rates are expressed as a percentage of high school graduates, not of the entire 24-25 year-old population.⁵

⁵ However, if we had instead expressed them as a percentage of the total population of 24-25 year-olds in each racial group, we would find little change in this graph for WOC and white women, since for each of these race-sex groups the high school proportions and population proportions were similar (as shown in the previous Figures.) The same is true for white men and MOC as well, although it would not be for MOC if GED's had not been counted as equivalent to high school graduation, since a sizable proportion of MOC are getting GEDs instead of regular high school diplomas.

Figure 3 also shows that MOC high school graduates have even lower likelihoods of graduating college than do WOC, and that white men have lower likelihoods of graduating college than do white women. In fact, since 1990, men aged 25 to 29 have been less likely than women to graduate college, and this gender gap is growing.⁶

These data indicate that a particularly necessary point of intervention to increase diversity, both in terms of WOC and in terms of MOC, is the period between high school and college graduation. To isolate where WOC are dropping out, we investigated undergraduate enrollment rates using data from the *Digest of Education Statistics*. In 2008, nearly 17% of undergraduate students at either 2 or 4 year colleges were WOC (Snyder and Dillow 2011). This number is even larger than the percentage WOC among high school graduates shown in Figure 1, probably because the 2008 undergraduate students represent a later cohort than 24-25 year-olds in 2008 and later cohorts have increasingly higher percentages of persons of color. Thus, it appears that WOC are starting college at rates approximately proportional to their high school graduation rates. Our evidence here has shown, however, that they are not graduating from 4-year colleges at similar rates. This suggests that research and intervention should concentrate on preventing attrition of WOC from 4 year colleges and assisting WOC to transition from 2-year to 4-year colleges.

The education facts presented to this point do not isolate those who studied S&E. To examine college major, we used data from the Integrated Postsecondary Education Data System (IPEDS) over the last five available years of data (2005-2009) to determine the average

⁶ There is a racial difference in the growth of this gap: for under-represented minorities (URM's), the female-male gap between college graduation rates of 24-25 year olds was 3.3 percentage points in 1994 and for the last 5 years of data averaged 5.7 percentage points. For whites, the gap started smaller in 1994 – at 1.1 percentage points. In the last 5 years, however, it is exactly the same as for URMs (5.7 percentage points), suggesting that white males are falling behind white females at a faster rate than MOC are following behind WOC.

percentage of all college graduates who majored in S&E majors, by race and sex. This percentage is given in Figure 4 for WOC, MOC, white women and white men. Figure 4 shows that WOC college graduates are only slightly less likely to graduate with S&E majors than white women (19% compared to 22%),⁷ but that women of each of these racial groups are less likely than the corresponding men to graduate in these fields. It is interesting to note, however, that the greater tendency of women high school graduates to finish college than men balances out the greater tendency of men to major in S&E. A rough estimate, calculated by multiplying the likelihood of high school grads to graduate from college (by race and sex, from the CPS and Figure 3) times the likelihood of college grads to major in S&E (by race and sex, from the IPEDS and Figure 4) shows that close to the same percentage of WOC and MOC high school grads graduate college with an S&E major (3.4% v. 3.0% respectively) and that close to the same percentage of white female and white male high school grads graduate college with an S&E major (6.5% v. 6.8%).⁸ While previous research has shown that the under-representation of WOC and MOC in S&E majors may result from the lack of tracking of students of color into Advanced Placement courses in high school which limits their options to pursue S&E majors in college (Oakes *et al.* 1990), our analysis indicates that lower rates of college graduation contribute more to their under-representation.

How many of these S&E graduates go on to complete a PhD in S&E? To calculate this, we needed to combine data from different sources and to make “synthetic cohorts” that compare S&E college graduates with S&E PhD recipients 7 years later. We calculated 7 years as the approximate length of time between BA and PhD using the NSF’s Survey of Earned Doctorates (SED), the annual census of PhDs awarded in the US (during the relevant PhD years).

⁷ The corresponding numbers are 25% for MOC and 28% for white men.

⁸ Combining data from two sources can give only approximations because data methods and definitions may not be identical.

Specifically, we used IPEDS data on the number of college graduates majoring in S&E in our four race/sex categories (WOC, MOC, white men, and white women) averaged over the 2000-2002 waves of IPEDS and compared this to the numbers of S&E PhDs awarded 7 years later in the 2007-2009 waves of the SED.⁹

The probabilities estimated from these calculations (i.e. number of PhDs divided by number of BAs in the same synthetic cohort) are given in Figure 5. Among S&E majors, both WOC and MOC were only about 60% as likely as white women (6.9%/6.7% compared to 11.5%) to get an S&E PhD. White women were also more likely than white men (11.5% compared to 9.6%) to get an S&E PhD, an interesting reversal from earlier decades where women in science were rarities. The increasing numbers of women S&E PhDs are concentrated in biomedical sciences.

We made a similar calculation to obtain the probability that S&E majors graduated with a medical degree. As in our PhD calculation, we used the number of S&E college graduates from the 2000-2002 waves IPEDS and compared this to the corresponding numbers of MDs awarded 7 years later, as measured by the 2006-2009 waves of the Association of American Medical Colleges (AAMC) student data. The probabilities (i.e. number of MDs divided by number of BAs in the same synthetic cohort) are given in Figure 6. A smaller percentage of S&E majors obtained MDs than PhDs for each sex/race group shown. The percentages getting MDs and PhDs were relatively close for people of color (6.9%/6.7% PhDs and 5.3%/5.1% MDs for WOC/MOC). In contrast, both white men and women were significantly more likely to graduate with a PhD than an MD. In fact, as a percent of S&E majors, more people of color got MDs during this period than whites.

⁹ We used a shorter 3-year period rather than the 5-year period used for college estimates for two reasons. First, IPEDS did not publish 1999 data, and second, during this period PhD numbers changed rapidly and we wanted numbers most closely representing the present situation.

After examining each education transition, it is clear that greatest barriers to the increased participation of WOC in S&E academic careers occurs in the transition between high school graduation and college graduation, with a second barrier between college graduation and obtaining an S&E PhD. Programs and policies that seek to increase the diversity of academia should be targeted at these two key points. The next section examines the transition from S&E PhD to tenure track jobs and academic tenure and promotion.

4. Gender and Race/Ethnicity Outcomes in Academic Careers

In what follows, we examine whether key career transitions—obtaining a tenure track job, being awarded tenure, and becoming full professor—create barriers for the representation of WOC in academic careers. We do this by comparing WOC to the three comparison groups, MOC, white women, and white men. We also measure whether the race/sex patterns of transitions differ in URM-universities (as defined earlier, including HBCUs, TCUs, or a minority serving universities) compared to other universities. This analysis is based on the NSF’s Survey of Doctorate Recipients (SDR) described earlier. We use the SDR because it is the only longitudinal survey of S&E PhDs. The longitudinal nature of the SDR is key; cross-sectional snapshots cannot distinguish between race/sex differences in the size of the pool of S&E PhDs compared to race/sex differences in hiring and promotion rates. Only longitudinal data that follows individual S&E PhDs as their careers develop, like that available from the SDR, allows us to accurately pinpoint differential hiring and promotion.

The SDR contains detailed information on the respondent’s demographic characteristics (race/ethnicity and gender), education background (field of study and PhD year), employer characteristics (employer type) and academic rank/tenure-status as well as the IPEDS number

that allows us to categorize workplaces as URM-universities. It also includes the *Carnegie Classification of Institutions of Higher Education*, which allows us to separately study scientists' academic progression at top (Carnegie R1) universities.¹⁰ Note that we use samples of the SDR for this analysis that vary in size because of the timing of academic careers.

In Figure 7, we examine gender and race/ethnicity differences in the likelihood of getting a tenure-track job within approximately six years of the PhD (for S&E PhDs from 1993-2003).¹¹ Likelihoods are very different depending on whether the tenure track job is in URM and non-URM universities and we therefore separate these out in this figure. Panel A shows the percentage of S&E PhDs who got tenure-track jobs at non-URM universities for WOC, MOC, white women, and white men. Compared to whites, WOC – and MOC– are significantly less likely to obtain tenure-track jobs in non-URM universities. Specifically, WOC are only 72% as likely as white women to obtain tenure-track jobs in these universities. Panel B makes the same comparison for URM universities, where WOC are much *more* likely than white women (7 times as likely) to obtain tenure-track jobs. One-third of WOC who obtain tenure-track jobs work at URM universities. To get a sense of the disproportionate nature of this, note that over the time period that the Figure 7 probabilities were computed, non-URM-universities hired more than 10 times as many new tenure-track faculty than did URM-universities. Thus, WOC do obtain tenure-track jobs, but they are concentrated in URM-serving institutions.

Panel C shows that roughly the same percentage of WOC and white women receive tenure-track jobs at Research I institutions. Note that R1 Universities hired 24% of all new tenure-track academics during this period and a similar proportion (27%) of WOC.

¹⁰ We use the older Carnegie Rankings (pre-2005) because our data cover many years before the newer rankings were available. In addition, we focus on Research I institutions because they produce the largest numbers of S&E PhDs.

¹¹ Since the last SDR with microdata available was from 2008, we excluded those who got PhDs after 2003.

Having obtained a tenure-track job, the next hurdle for an academic is the tenure decision. Again, we have analyzed the probability of being awarded tenure at a non-URM university for those who had a tenure track job in a non-URM university (within 6 years of PhD) separately from tenure in an URM-university for those who started in a URM-university. Figure 8 shows the likelihood of receiving tenure 11 years past the PhD for S&E PhDs who graduated from 1993-1998.¹² As Figure 8 indicates, the majority of each of the four race/sex groups who started with a tenure-track job do receive tenure, although there are some differences across the kind of university and across race/sex groupings.

Panel A of Figure 8 shows that WOC who started in a non-URM university are somewhat less likely to receive tenure than white women at a non-URM university, although the difference (71% v. 76%) is not statistically significant. Panel B shows that for the much smaller sample of those who started at a URM-university, WOC are more likely to receive tenure at URM universities than other race/sex groups, although the difference is not statistically significant. Interestingly, white men are the least likely to receive tenure in these universities. Finally, Panel C looks at those who started in a tenure track position at a Research-1 university and shows that WOC are significantly *more* likely than white women (81% v. 67%) to get tenure. Thus, once WOC are on the tenure-track, they do not appear to be disadvantaged in getting tenure, and in fact, are more likely to be tenured at R1 universities. The tenure system does not appear to be an insurmountable hurdle for WOC.

Finally, we consider the likelihood of obtaining the highest academic rank, tenured full professorship, within 7 years of receiving tenure (for those who received tenure within 11 years of PhD.) Since we are talking about career progression across a total of 18 years, we include earlier PhDs (starting in the 1983 PhD cohort) but must cut off more recent PhDs (ending with

¹² See previous footnote.

the 1995 PhD cohort). Because women, both WOC and others, have been rapidly increasing their numbers in S&E fields, limiting ourselves to these earlier cohorts means there are few numbers of women, too few to separate out WOC at Research 1 universities. Thus we only divide universities by their URM-status.

Figure 9 examines the percentage of WOC, MOC, white women and white men who are tenured full professors within 7 years of receiving tenure. Panel A shows the percentage becoming full professor at non-URM universities and Panel B shows the same for URM-universities. The difference between WOC and white women in non-URM universities is tiny. In URM-universities, the difference is greater in percentage points. However, neither of these differences is statistically significant because of the small samples. On the other hand, men at non-URM universities – whether MOC or white men – have higher measured rates of being promoted to full professor than either white women or WOC.

In summary, this academic promotion evidence indicates that once WOC obtain tenure track jobs, they progress through the academic ranks at similar rates to white women. However, they are less likely to have obtained tenure-track jobs at non-URM universities other than Research I universities.

Overall, the lower probabilities for women of color in non-URM universities compound in their effect. The largest difference in academic advancement between WOC and white women occurs right at the beginning, in the lower likelihood of starting in a tenure-track job in a non-URM university. This is compounded with the smaller (and statistically insignificant) lower probabilities of getting tenure and of being promoted to full professor. Figure 10 was created by multiplying these three probabilities together to get the probability of proceeding from an S&E PhD to a tenured full professor. Because the cohorts included are not identical in all of these

three analyses, Figure 10 can only be considered suggestive. However, the differences across race/sex groups for non-URM universities is somewhat surprising. WOC end up with the lowest likelihood of proceeding from an S&E PhD to full professor in non-URM universities (only 8%), and the likelihoods increase as we move to MOC, white women and ending with white men (14%). WOC suffer along with MOC in getting hired on tenure-track jobs in these universities compared to whites, but fall behind MOC at the promotion to full transition.

5. Discussion

We have shown that there are very few WOC S&E PhDs working in academic jobs. More than a third of these few WOC are employed at URM-serving institutions that hire less than 9% of all academics while very few are tenured faculty at non-URM universities (625 or 1% of faculty at these universities). What is responsible for this lack of diversity in academe? It starts with the fact that women of color who graduated from high school are 40 percent less likely to complete a Bachelor's of Science compared to white women. For those WOC who received bachelor's degrees majoring in S&E, they are also 40 percent less likely than white women to receive a PhD in S&E, although equally likely to become medical doctors. Thus, many of the barriers to increased diversity in academia start at the beginning of the science career—graduating from college and getting an S&E PhD.

Once WOC have the S&E PhD, they do get tenure-track jobs, although they are less likely to get tenure-track jobs in non-URM universities outside top (Research 1) universities. Overall, WOC are about as likely as white women to be awarded tenure, with only small and insignificant differences between URM and non-URM universities. Finally, women of all races are less likely than men to be promoted from tenured associate to tenured full professors within 7

years of being awarded tenure at non-URM universities. Combining all of these factors, the probability of WOC progressing from S&E PhD receipt to tenured full professor in a non-URM university is lower than for the other three race/sex comparison groups. The shortfall of successful WOC academics is *not* concentrated at the top universities. Instead, it occurs at non-R1 non-URM universities.

This lack of diversity in higher education affects the next generation. Several papers have shown the importance of having a professor or instructor who shares the student's demographic characteristics. A series of papers have found that female students are more likely to pursue a major if they have female faculty (Bettinger and Long 2005, Canes and Rosen 1995, and Rask and Bailey 2002) and have better performance in courses (Hoffman and Oreopolous 2007). Carrell, Page, and West (2010) use the random assignment of students to courses at the Air Force Academy to identify the causal effect of having women instructors in STEM courses. They show that female students who were randomly assigned a female professor in introductory STEM courses were more likely to pursue a STEM major than those assigned to a male professor in a STEM course. Hoffman and Oreopoulos (2011) examine community college instructors and find that having an African-American instructor increases African-American students' academic performance. Price (2010) finds that black students are more likely to major in STEM disciplines if they have a STEM course taught by a black instructor; however, he finds that female students are less likely to major in STEM when they have female STEM instructors. Taken together, this evidence indicates that WOC working as faculty in S&E fields will increase the likelihood that WOC pursue S&E degrees. However, only 7,090 of 64,120 of S&E academics in 2008 were WOC.

In summary, this research has painted a statistical portrait of the representation of WOC in the S&E education and career paths. We have shown that the greatest barriers to WOC in the academy occur at the transitions from high school to college graduate, from college graduate to S&E PhD, and to a lesser extent from S&E PhD to a tenure-track job in a non-URM university. These key transition points should be the focus of policies designed to diversify S&E academia. In particular, increasing WOC S&E academics will require first increasing the number of WOC graduating from college (Stephan 2011). Policies designed to increase WOC college graduation should be a top priority for increasing the diversity of the academy.

As WOC progress to academic careers, we found that they are less likely to be employed in S&E tenure-track jobs at non-URM institutions. However, our analysis does not examine the causal factors behind the under-representation of WOC in these institutions. It could be that WOC are more likely to choose URM institutions. Alternatively, the climate at non-URM institutions may discourage WOC from applying or working there. The myriad data sets we have used in this study do not include information on job offers or the climate at these institutions. These topics would provide good avenues for future research on the under-representation of WOC in S&E academic careers.

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	% of non-Tenure Track Faculty	% of Tenure-Track/Tenured Faculty	% of Tenured Faculty	% of Full Professors	% of US Population
Women of color	5.1%	2.3%	1.7%	1.2%	12.5%
Black	2.3%	1.1%	0.7%	0.4%	6.2%
Hispanic	1.2%	1.0%	0.8%	0.7%	5.3%
Men of color	3.0%	4.1%	3.9%	3.8%	11.9%
Black	1.6%	1.8%	1.5%	1.2%	5.3%
Hispanic	1.1%	2.2%	2.2%	2.4%	5.6%
Other women	42.2%	26.1%	23.6%	20.1%	38.3%
White	38.5%	23.4%	21.9%	18.9%	36.2%
Asian	3.8%	2.6%	1.7%	1.2%	2.1%
Other men	49.6%	67.5%	70.8%	75.0%	37.3%
White	43.2%	60.1%	63.9%	67.4%	35.5%
Asian	6.5%	7.5%	6.9%	7.6%	1.9%
Total	100%	100%	100%	100%	100%
Total 2008 Number	15,473	85,164	62,469	36,365	

Table 1: Percentage of each academic rank in each race/sex category. Percentages for people of color are also broken down for two largest racial subgroups; percentages for other races are broken down into their two components. Note that the different academic rank groupings are not mutually exclusive, and particularly that Tenure-Track/Tenured Faculty includes Tenured Faculty (as well as untenured tenure-track faculty) and Tenured Faculty includes Full Professors (as well as Tenured Associate Professors). Source: 2008 NSF Survey of Doctorate Recipients (SDR). Finer racial distinctions have been suppressed to ensure the SDR's confidentiality as required by the NSF and as a result, Blacks and Hispanics do not add up to the total URM numbers. Calculations are based on weighted 2008 SDR data. See text for more details.

	% non-Tenure-Track Faculty	% Tenure-Track Untenured	% Tenured, not Full	% Full Professors		Total #
Women of color	29.2%	35.6%	19.0%	16.2%	100%	2,724
Black	27.5%	39.4%	22.8%	10.4%	100%	1,294
Hispanic	31.5%	30.3%	16.0%	22.2%	100%	1,190
Men of color	11.7%	29.8%	23.8%	34.8%	100%	3,992
Black	14.5%	32.4%	27.8%	25.3%	100%	1,755
Hispanic	8.4%	26.5%	21.4%	43.7%	100%	2,001
Other women	22.8%	27.2%	24.7%	25.3%	100%	28,723
White women	23.0%	25.6%	24.9%	26.5%	100%	25,900
Asian women	20.8%	42.2%	22.6%	14.5%	100%	2,823
Other men	11.8%	22.1%	24.4%	41.8%	100%	65,197
White men	11.5%	21.2%	24.9%	42.4%	100%	57,837
Asian men	13.6%	28.8%	20.2%	37.4%	100%	7,360

Table 2: Percentage of academics in each sex/racial category (and subcategory) at each *mutually-exclusive* academic rank. Source: 2008 NSF Survey of Doctorate Recipients (SDR). Finer racial distinctions have been suppressed to ensure the SDR's confidentiality as required by the NSF and as a result, Blacks and Hispanics do not add up to the total URM numbers. Calculations are based on weighted 2008 SDR data. See text for more details.

	NON-URM UNIVERSITIES				URM UNIVERSITIES			
	% of non-Tenure-Track Faculty	% of Tenure-Track faculty (includes tenured)	% of Tenured Faculty	% of Full Professors	% of non-Tenure-Track Faculty	% of Tenure-Track faculty (includes tenured)	% of Tenured Faculty	% of Full Professors
Women of color	3.6%	1.6%	1.1%	0.7%	19.5%	9.6%	7.5%	6.1%
Black	28.9%	0.7%	0.5%	0.2%	8.7%	5.4%	3.1%	1.8%
Hispanic	29.6%	0.7%	0.5%	0.4%	10.2%	4.1%	4.4%	4.3%
Men of color	2.5%	3.0%	2.7%	2.5%	7.5%	16.2%	17.3%	16.9%
Black	13.7%	1.2%	0.9%	0.7%	7.0%	7.9%	7.6%	6.7%
Hispanic	11.5%	1.6%	1.5%	1.6%	0.5%	8.3%	9.8%	10.1%
Other women	43.0%	26.7%	24.2%	20.4%	35.6%	19.2%	17.6%	16.4%
Other men	50.9%	68.7%	72.1%	76.4%	37.4%	55.0%	57.6%	60.7%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Total 2008 Number	13,960	78,070	57,030	33,050	1,510	7,090	5,440	3,320

Table 3: Percentage of each academic rank grouping within each university type (URM, Non-URM) in each sex/racial major and sub-grouping. Note that the different academic rank groupings are not mutually exclusive. URM-Universities include HBCUs, TCUs, and minority serving universities. Also see notes for Table 1.

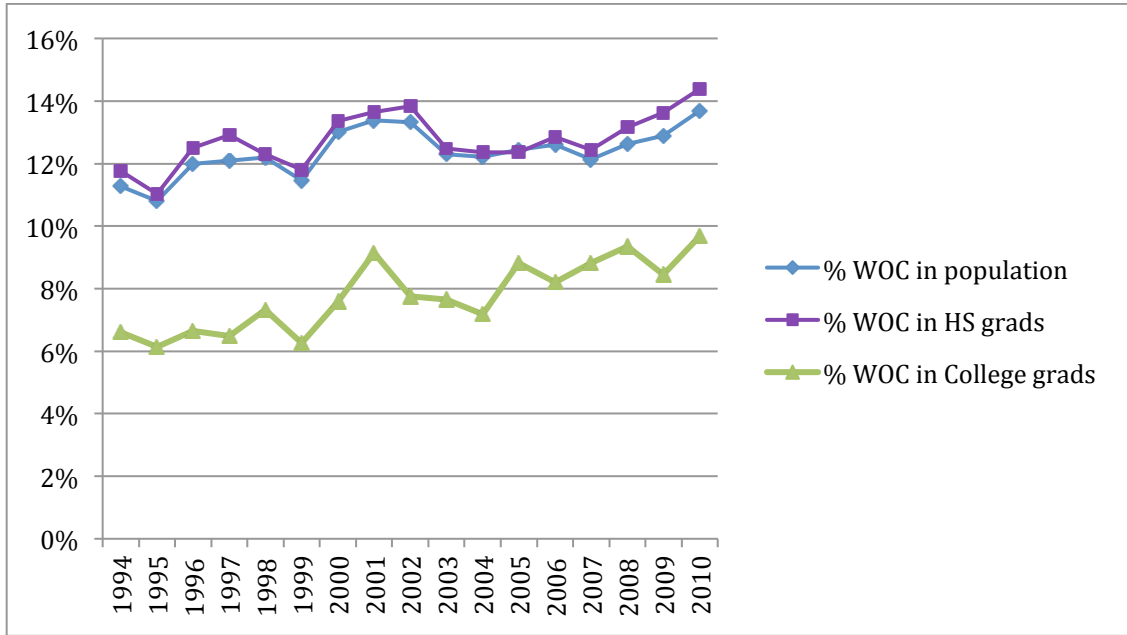


Figure 1: Percentage of US citizens ages 24-25 who are WOC out of (a) the total population of 24-25 year-old citizens, (b) the high school graduates among the 24-25 year-old citizens, and (c) the college graduates among the 24-25 year-old citizens. Source: 1994 – 2010 Outgoing Rotations of the Current Population Survey.

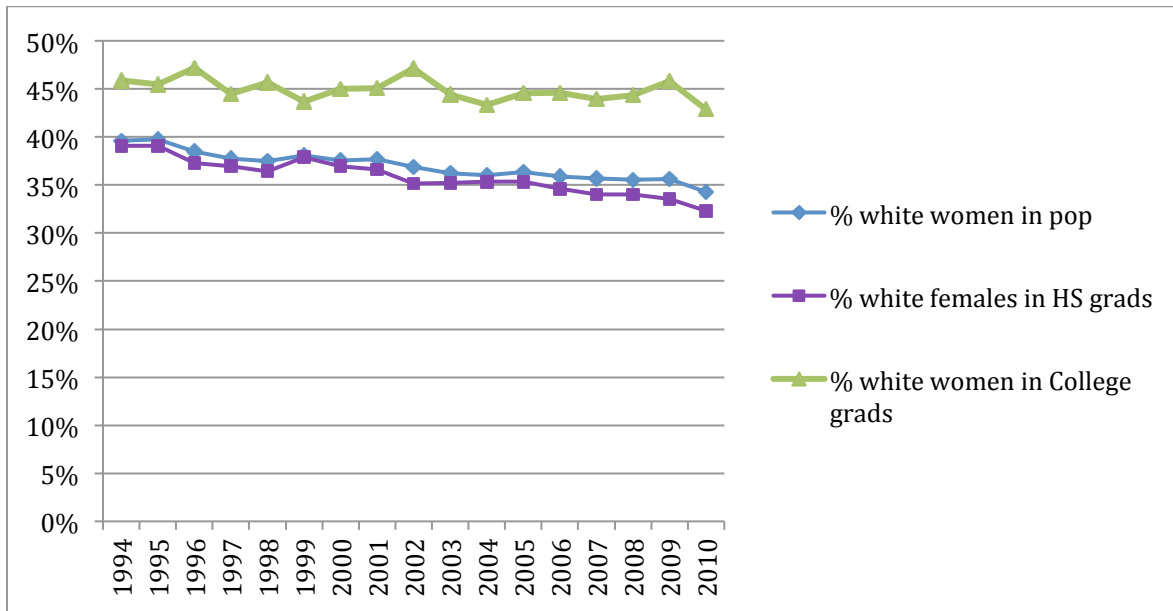


Figure 2: Percentage of US citizens ages 24-25 who are white women out of (a) the total population of 24-25 year-old citizens, (b) the high school graduates among the 24-25 year-old citizens, and (c) the college graduates among the 24-25 year-old citizens. Source: 1994 – 2010 Outgoing Rotations of the Current Population Survey.

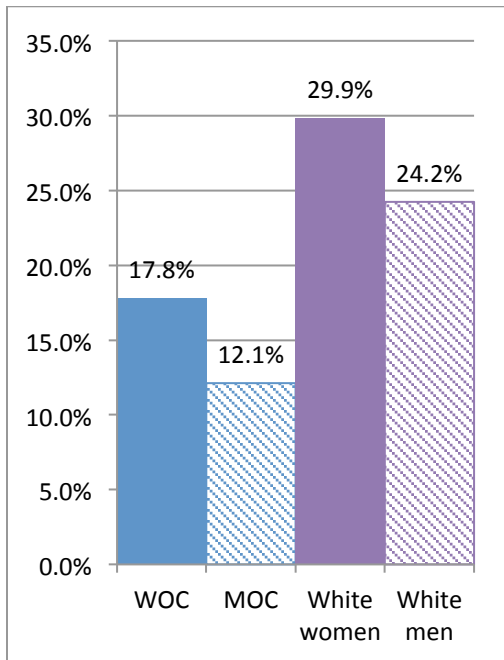


Figure 3: Percentage of 24-25 year-old high-school graduates who graduated from college for WOC, MOC, white women and white men, averaged over 2006-2010. Source: Outgoing Rotations of the Current Population Survey.

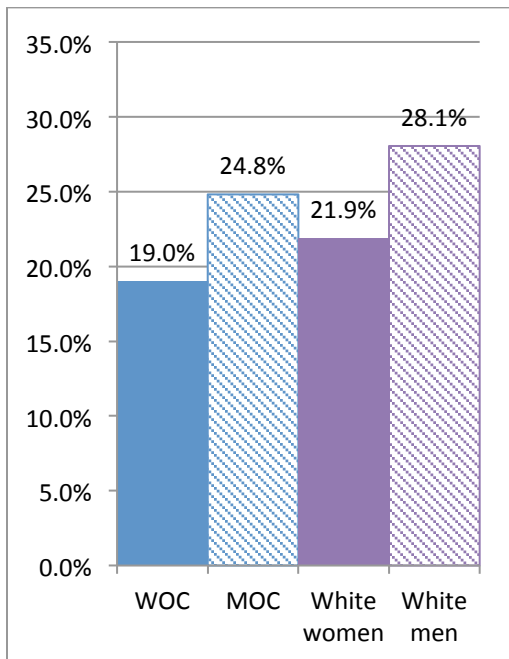


Figure 4: Percentage of WOC, MOC, white women and white men college graduates who graduated with S&E majors, averaged over 2005-2009 waves of the IPEDS data.

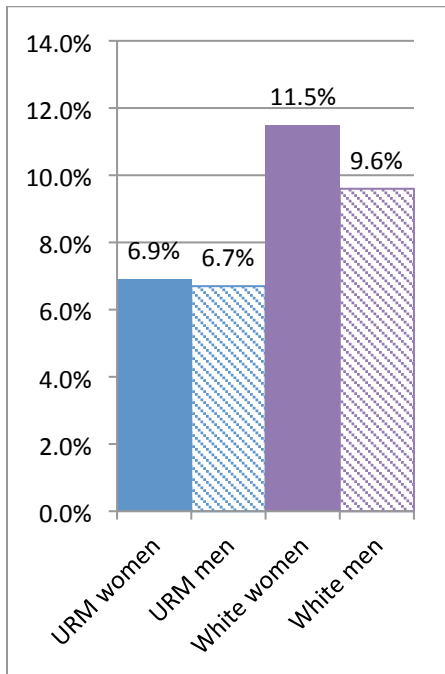


Figure 5: The likelihood that someone who received an S&E bachelor's degree 2000-2002 graduated with an S&E PhD between 2007-2009 inclusive. Source: College graduates from IPEDS data and PhD recipients based on Survey of Earned Doctorates (SED).

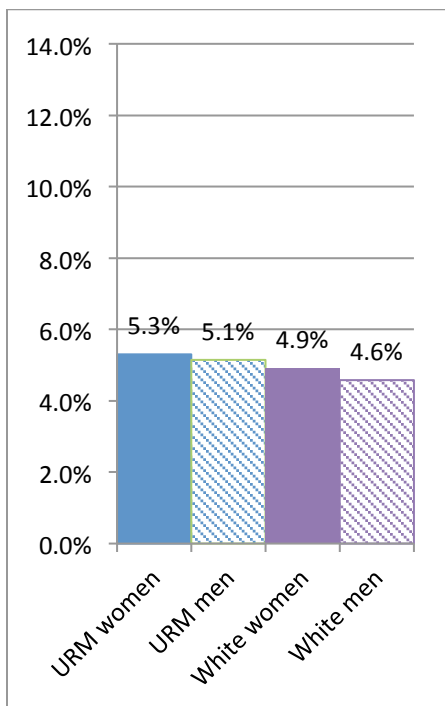


Figure 6: The likelihood that someone who received an S&E bachelor's degree 2000-2002 graduated with an MD between 2007-2009 inclusive. Source: College graduates from IPEDS data and MD recipients based on AAMC student data.

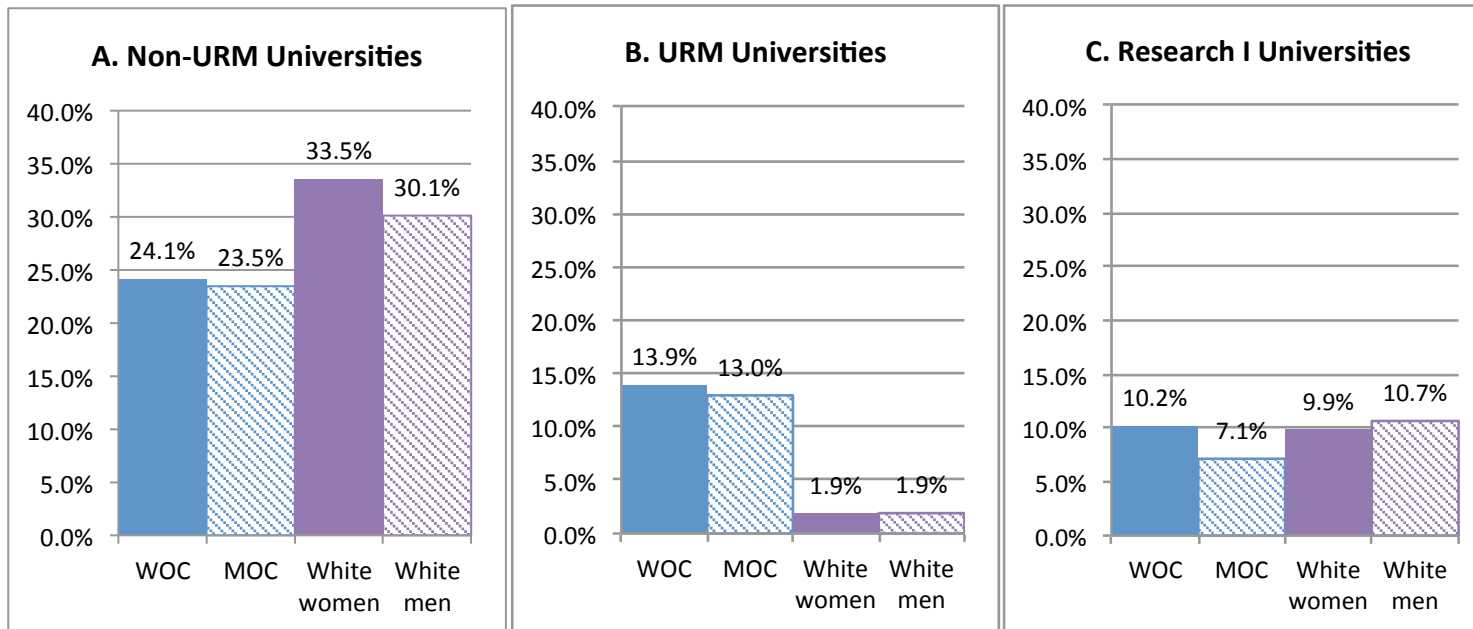


Figure 7: Probability of obtaining an S&E tenure track job within 6 years of PhD in non-URM, URM, and Research I universities using 1993-2008 waves of the SDR. See text for more details.

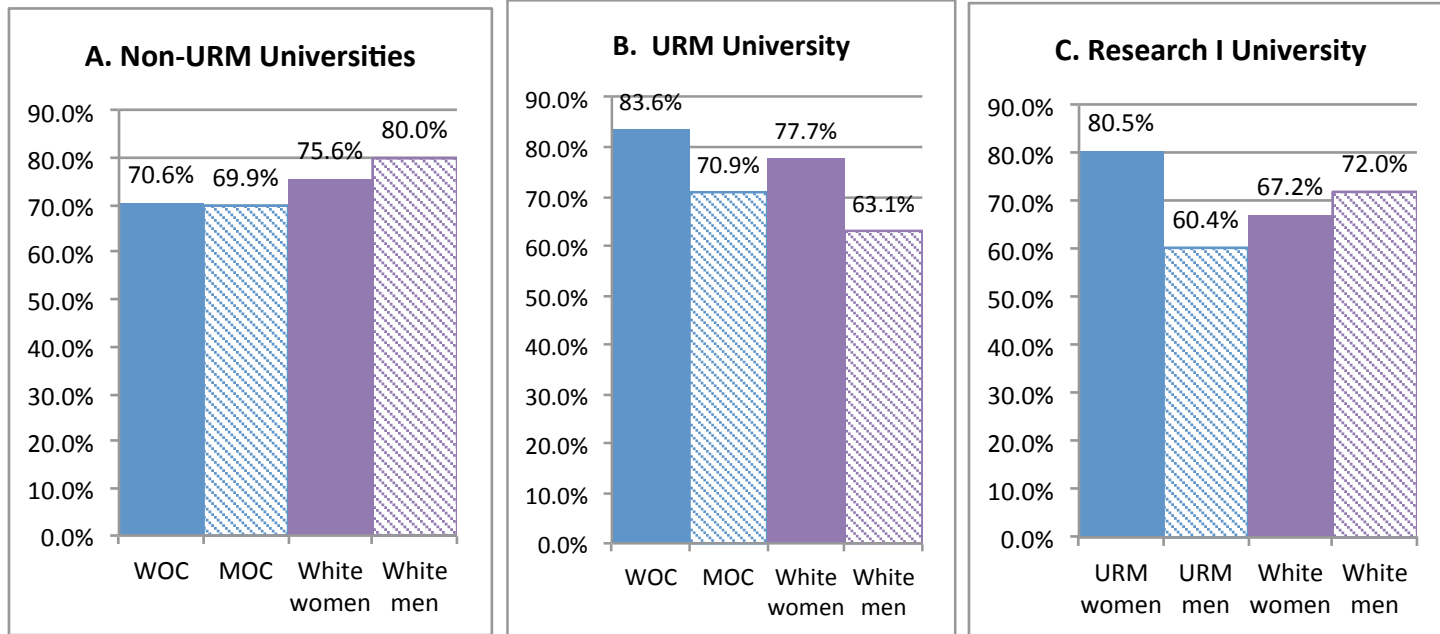


Figure 8: Probability of obtaining tenure in S&E job within 11 years of PhD in non-URM, URM, and Research I universities using 1993-2008 waves of the SDR. Source: SDR. See text for more details.

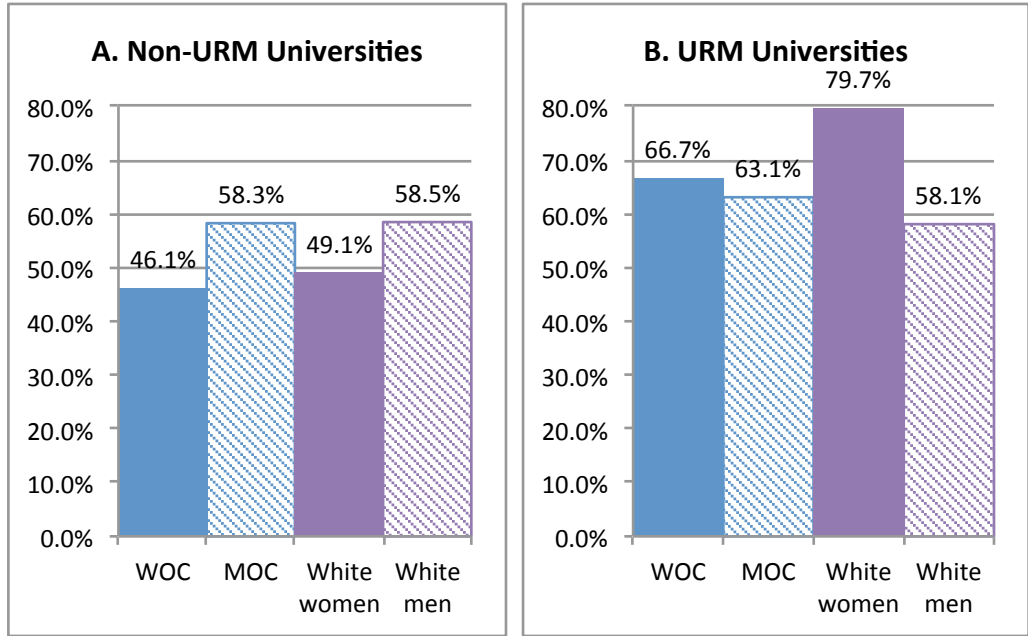


Figure 9: Probability of obtaining S&E full professor within 7 years of tenure in non-URM URM universities. Source: SDR. See text for more details.

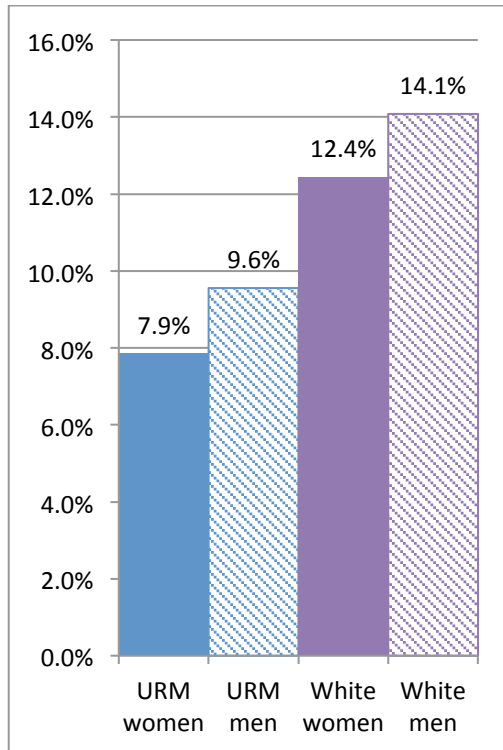


Figure 10: Probability of an S&E PhD progressing to tenured full professor in Non-URM Universities. Data sources SED and SDR. See text for more details.