

Women in the Academic Pipeline for Science, Technology, Engineering and Math: Nationally and at AAUDE Institutions

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Prepared by Rebecca Carr, Director
Association of American Universities Data Exchange



Introduction

The underrepresentation of women in STEM fields (Science, Technology, Engineering, & Mathematics) is a growing concern in both education and government. The purpose of this study is to examine changes in the proportion of women in the pipeline from degree completions to faculty positions in the STEM disciplines over time.

The U.S. Department of Education collects data on degree completions by discipline, but their data on faculty demographics are available only as institutional totals. Since AAUDE collects faculty demographic data at the discipline level, we are in a unique position to study patterns at this detailed level.

The populations of institutions analyzed were selected based on available data. The data sources used include: (1) *IPEDS HR* for faculty headcounts at all degree-granting institutions, (2) *Faculty Profile by CIP* for 35 AAUDE institutions, and (3) *IPEDS Completions* for counts of bachelor and doctoral degrees at all doctoral-research institutions and 67 additional institutions. See the methodology section on page 8 for details.

We prepared this study to demonstrate the power of combining data from multiple sources in the AAUDE data warehouse and to highlight the unique information available from the Faculty Profile by CIP data collection. We consider this a preliminary, descriptive study to identify patterns and spark questions for future investigation.

Results

Tenure-line Professorial Faculty

National Picture of All Disciplines

This first set of analyses use IPEDS HR (Fall Staff) data on tenure-line faculty in profes-

Figure 1. Gender distribution of tenure-line professorial faculty

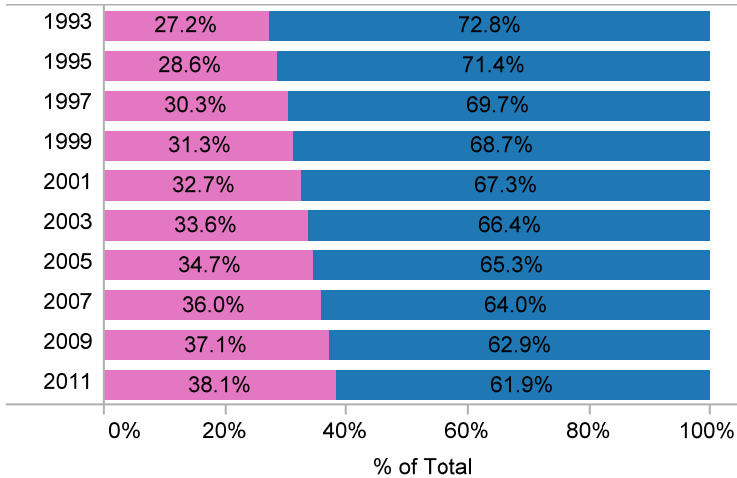


Figure 2. Number and cumulative change in number of tenure-line professorial faculty by gender

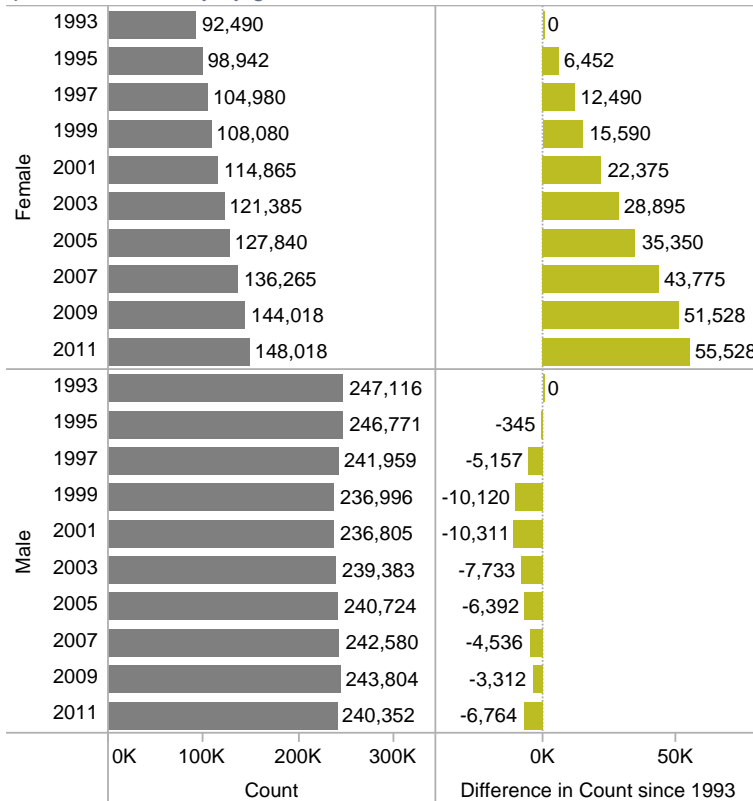


Figure 3. Gender distribution of tenure-line professorial faculty by rank

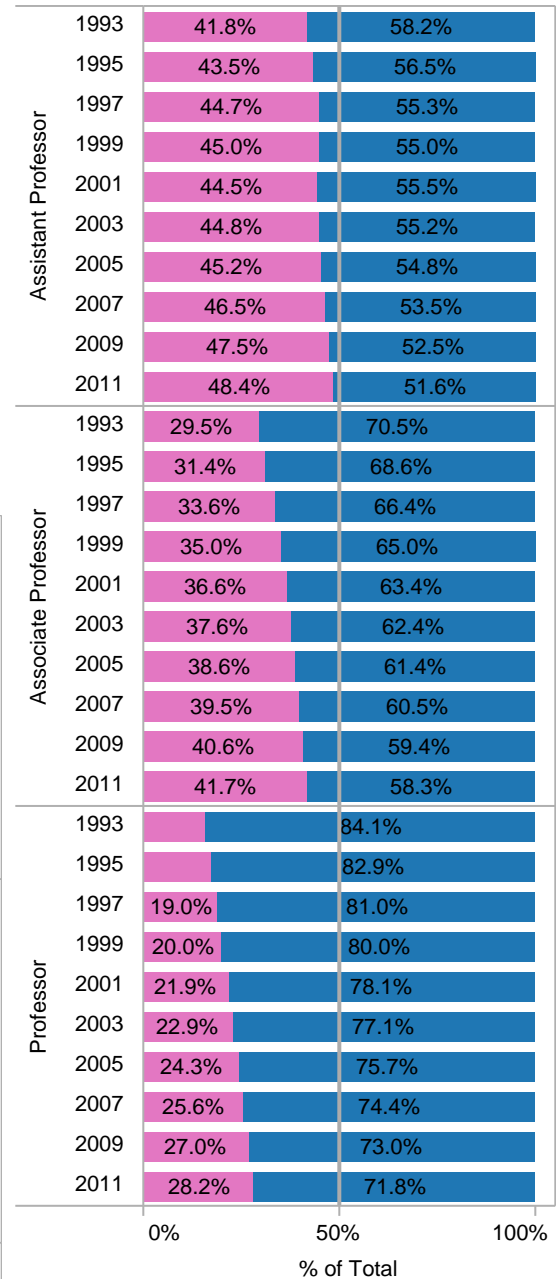
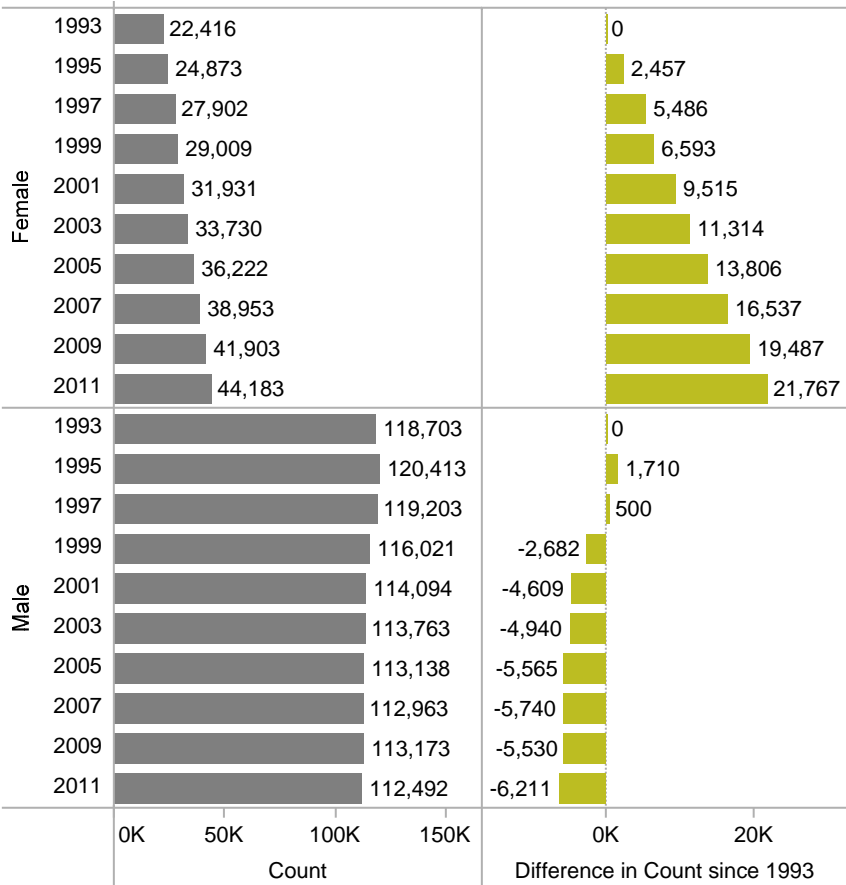


Figure 4. Number and cumulative change in number of full professors by gender



rial ranks in all disciplines for all degree-granting institutions in the U.S. In 2011, this covered 511,592 faculty members at 1,869 institutions.

Women are a growing proportion of tenure-line professorial ranks in the U.S. As shown in Figure 1, the proportion of women in tenure-line professorial ranks of the colleges and universities in the U.S. has grown by more than 10 percentage points since 1993. In 1993, just over one-quarter (27.2%) of tenure-line professorial faculty in the U.S. were women. By 2011, this proportion had grown to 38%.

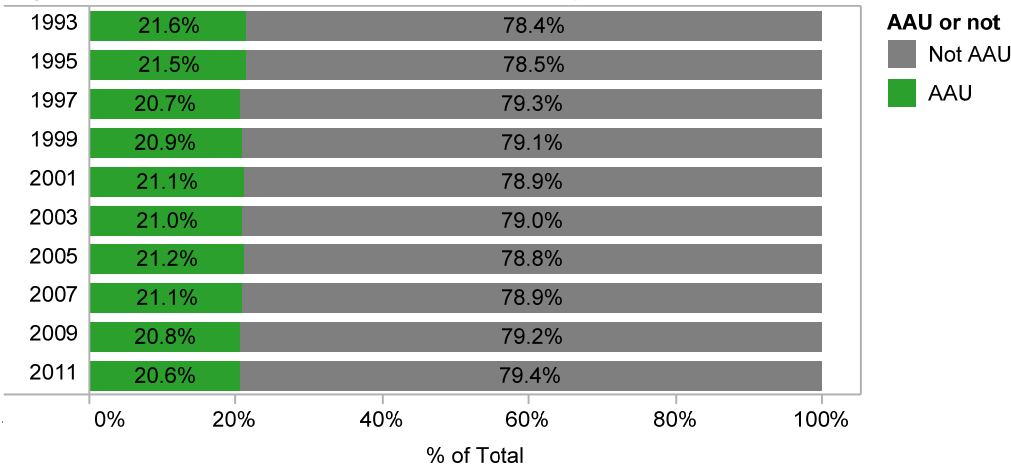
Figure 2 shows the number of tenure-line professorial faculty by gender and the cumulative change in their counts since 1993. Though the number of women in these roles is considerably lower (148,018 compared to 240,352 for men in 2011), all of the growth has been among women. Compared to 1993, there are 55,528 more females in these faculty positions as compared to 6,764 fewer males.

full professors in 2011, compared to associate and assistant levels, where women accounted for 42 and 48 percent respectively. Since it takes roughly ten years to advance from assistant to full professor, these differences are to be expected and it is likely that the proportion of women among full professors will continue to grow over the next decade.

Figure 4 shows the raw numbers and cumulative growth among full professors by gender. The number of women at rank of full professor has doubled from 22,416 in 1993 to 44,183 in 2011. In the same time span, the number of male full professors has decreased by 6,211.

AAU institutions represent one in five tenure-line professorial faculty and have lower proportions of women. Of these tenure-line professorial faculty members, roughly 20 percent of them are at AAU institutions. As shown in Figure 5, the exact percentage slightly declined from 21.6 percent in 1993 to 20.6 percent in 2011.

Figure 5. Distribution of tenure-line professorial faculty at AAU and non-AAU institutions

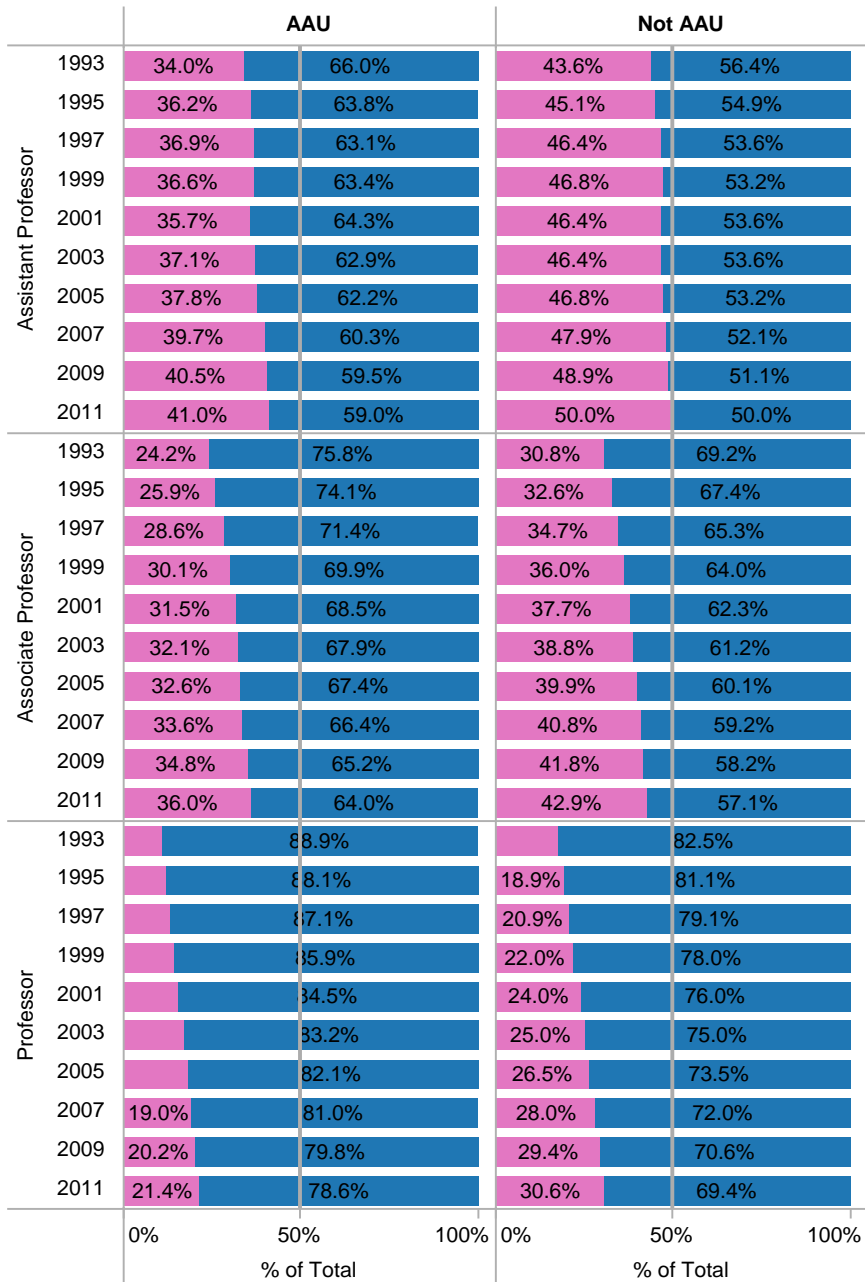


Half of assistant professors are women, but they remain underrepresented among full professors. The gender distribution among assistant professors has become nearly even but women remain largely underrepresented at the rank of full professor (see Figure 3). More specifically, women accounted for less than one-third (28.2%) of the total population of

Like the population as a whole, the proportion of women in tenure-line professorial positions at AAU institutions has been on a slow but steady increase. But AAU institutions have a lower proportion of women than their non-AAU counterparts. In 2011, 41.0% of assistant professors, 36.0% of associate professors, and 21.4% of full professors at AAU institutions were women, compared to 50.0%, 42.9% and 30.6% respectively at non-AAU institutions (see Figure 6). This difference



Figure 6. Gender distribution of tenure-line professorial faculty at AAU and non-AAU institutions



is likely due to the higher proportion of STEM fields at AAU institutions (see Figure 15).

The distribution of the proportion of women by rank at individual institutions in 2011 is shown in Figure 7; each institution is represented by a short line.

AAU Institutions by Discipline

The data collection on *Faculty Profile by CIP*, which is only available for AAUDE institutions, provides faculty demographic data at the discipline level. We examined the data from 35 AAUDE institutions in four two-year time periods between 2004 to 2012. The processes used to select institutions and to define STEM disciplines are detailed in the methodology section (p. 8).

Patterns within this sample of AAUDE institutions mirror national trends.

Figure 8 shows the gender distribution of tenure-line professorial faculty at these institutions. Women consist of just over one-third of this population, which is consistent with the pattern identified with IPEDS HR data. The proportion of women in tenure-line professorial positions grew from 34 percent to 37 percent between 2004 and 2012 among these 35 institutions.

The proportion of women in faculty positions is growing in both STEM and non-STEM fields.

Figure 9 shows the same information separately for STEM and non-STEM disciplines. The proportion of women in non-STEM fields is roughly twice as high as those in STEM fields (44% and 23% respectively in 2011).

In STEM disciplines, women have gained roughly one percentage point in the total proportion of faculty during each two-year span.

The number of women in faculty positions is growing more slowly in STEM than non-STEM fields.

Figure 10 depicts the change in the raw number of and gain in tenure-line professorial faculty by gender and field between 2004-06 and 2010-12. The number of women in these positions has grown, but they are making more substantial gains in non-STEM disciplines. Women represented 54 percent of the growth in STEM disciplines (1507 of 2778) and 79 percent of growth in non-STEM disciplines (2457 of 3092).

Figure 11 shows the distribution of tenure-line professorial faculty by

Figure 7. Percent women among tenure-line professorial faculty at AAU institutions in 2011

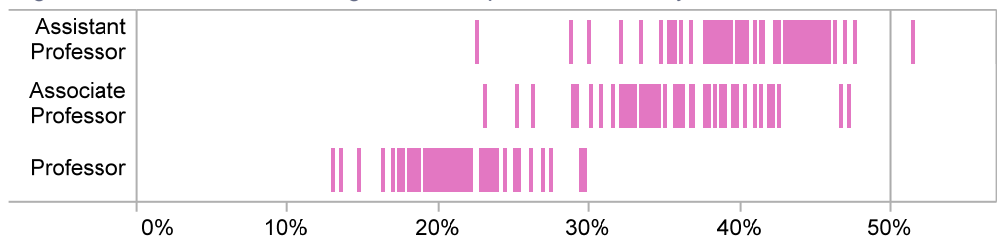


Figure 8. Gender distribution of tenure-line professorial faculty at select AAUDE institutions

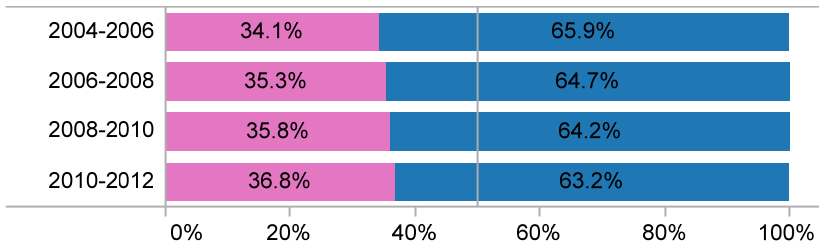


Figure 9. Gender distribution of tenure-line professorial faculty at select AAUDE institutions in STEM and non-STEM disciplines

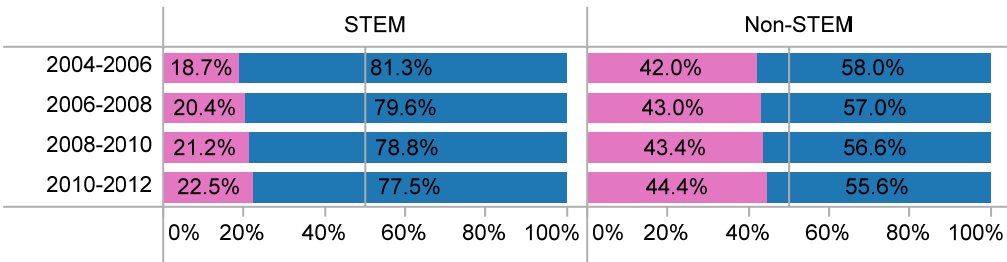


Figure 10. Number and change in number of tenure-line professorial faculty by gender at select AAUDE institutions in STEM and non-STEM disciplines

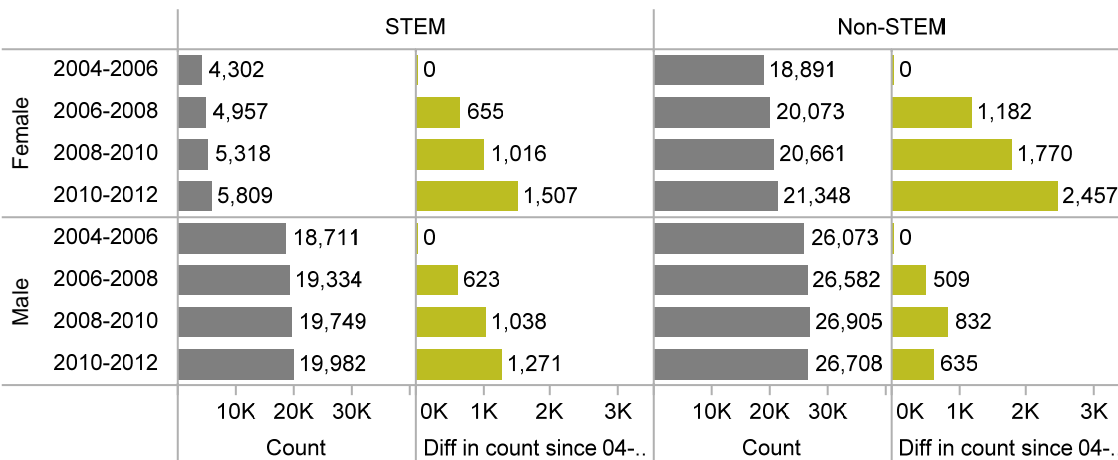


Figure 11. Gender distribution of tenure-line professorial faculty by rank at select AAUDE institutions in STEM and non-STEM disciplines

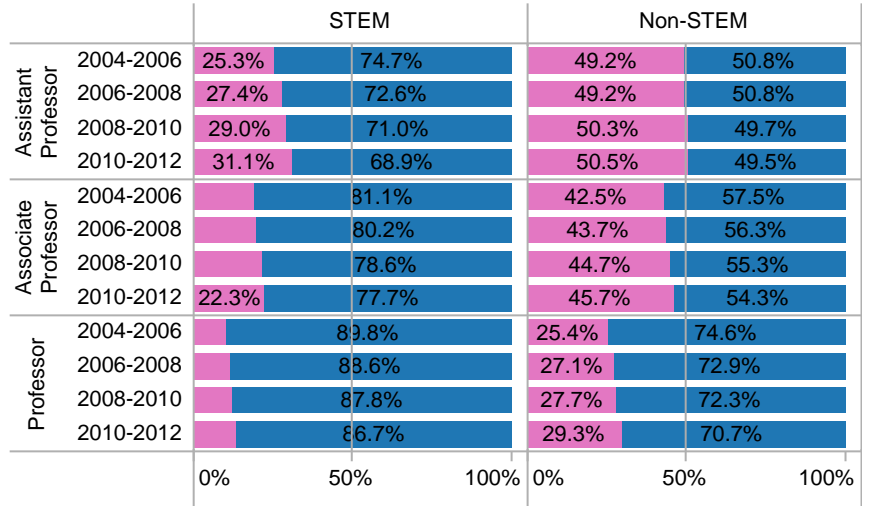


Figure 12. Proportion of women in tenure-line professorial faculty in STEM fields at individual public and private AAUDE institutions

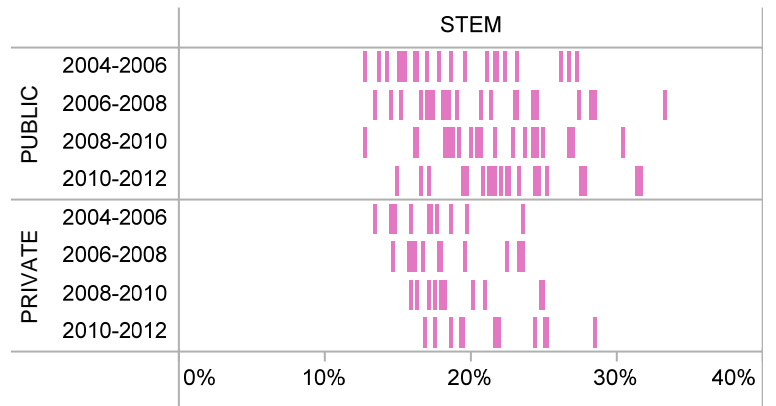


Figure 13. Distribution of discipline of tenure-line professorial faculty at select AAUDE institutions

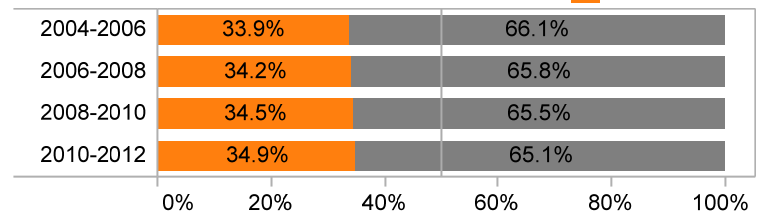
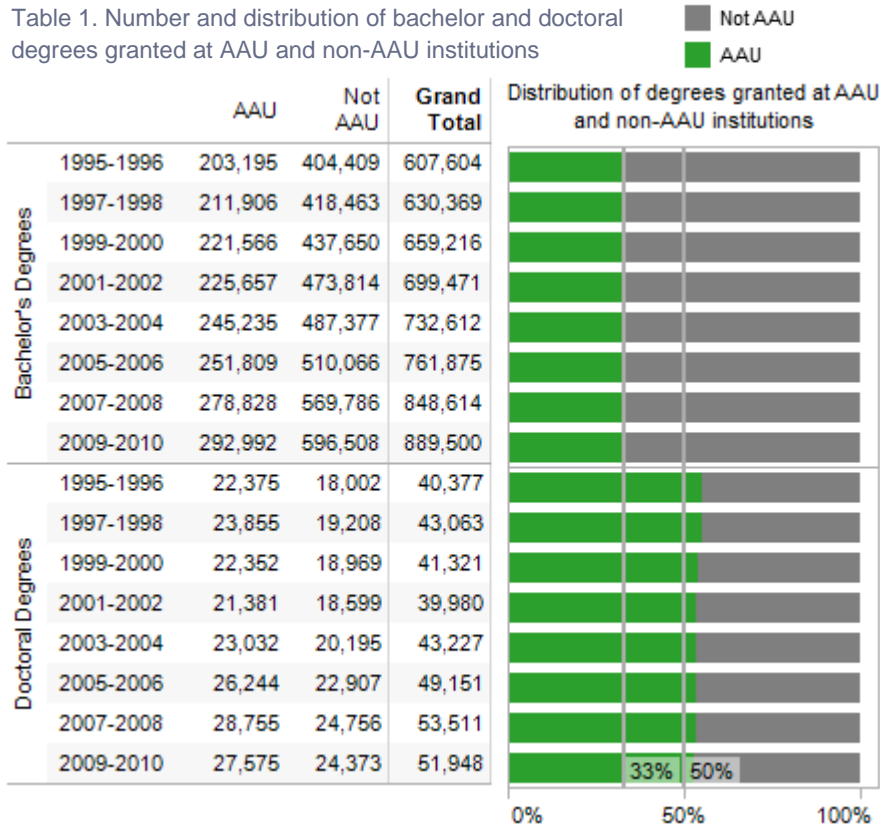




Table 1. Number and distribution of bachelor and doctoral degrees granted at AAU and non-AAU institutions



rank in STEM and non-STEM disciplines. The pattern is consistent with other findings such that: there are more women among assistant professors than among associate and full professors; women are slowly becoming a larger proportion of the faculty population; and women are more highly represented in non-STEM fields.

The proportion of women in STEM fields varies across AAUDE institutions.

Figure 12 shows the proportion of women in STEM fields at individual institutions; each institution is represented by a short line. In 2010-12, this value ranged between 14.8 and 31.5 percent. These patterns are fairly consistent across public and private institutions and when viewed by rank.

Roughly one-third of faculty positions are in STEM fields.

Figure 13 shows that the proportion of faculty in STEM fields at these institutions is just over one-third of tenure-line positions and it has grown only slightly between 2004 and 2012.

Degrees Granted

This final set of analyses uses IPEDS Completions data for bachelors and research doctoral degrees granted at all doctoral-research institutions and 67 additional institutions. In 2009-10, this covers 899,500 bachelor degrees and 51,948 doctoral degrees from 324 institutions. As noted in the methodology section, this is a smaller population of institutions than was used for faculty members.

AAU represents one-third of bachelor degrees and one-half of doctorates. Table 1 shows the number of bachelor and doctoral degrees granted at AAU and non-AAU institutions and the distribution across institution type. AAU institutions are responsible for almost exactly one-third of all bachelor degrees and just over 50 percent of doctoral degrees granted among this population of institutions.

We chose to focus only on years after 2003-2004 to avoid the complexities caused by the change in CIP codes in 2000. See the methodology section for more details.

STEM disciplines represent one-quarter of bachelor degrees and nearly half of doctoral degrees.

Figure 14 shows the proportion of degrees that are in STEM fields at all institutions. Across time, a steady 24 to 25 percent of bachelor degrees are in STEM fields. Over time, a growing proportion of doctoral degrees are in STEM fields. In recent years, the percentage has

Figure 14. Bachelor and doctoral degrees granted in STEM and non-STEM disciplines

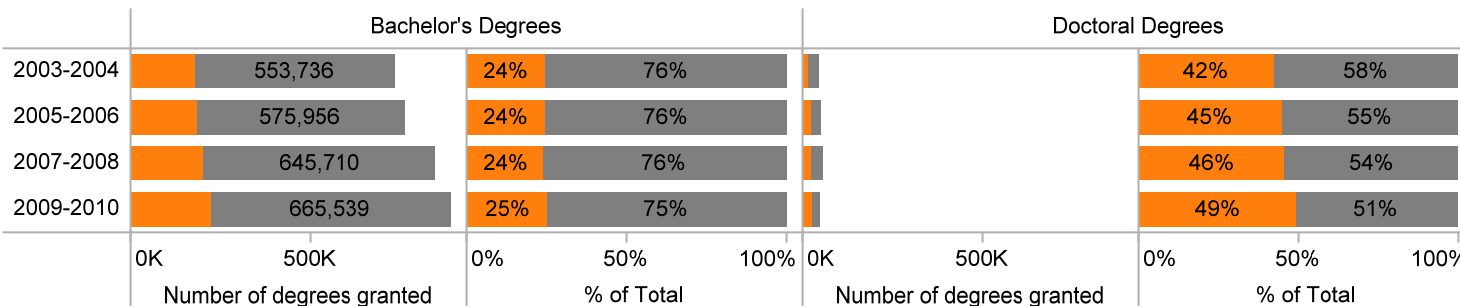


Figure 15. Bachelor and doctoral degrees granted in STEM and non-STEM disciplines at AAU and non-AAU institutions

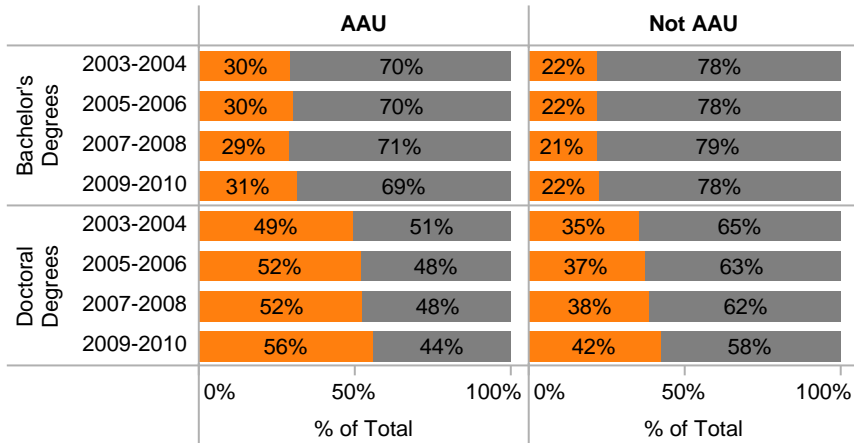
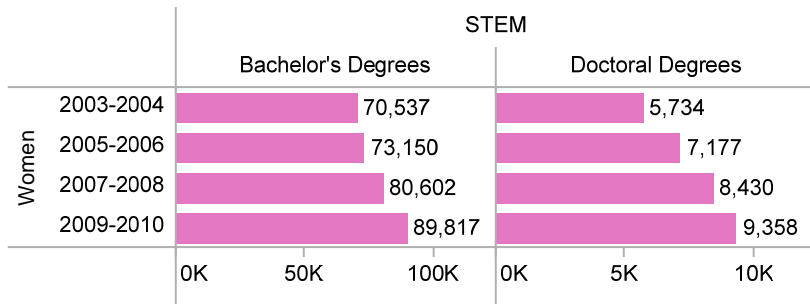


Figure 16. Number of bachelor and doctoral degrees granted in STEM disciplines to women



been between 42 and 49 percent. Figure 15 shows that AAU institutions grant proportionally more STEM degrees than non-AAU institutions by approximately 9 percentage points in bachelor degrees and 14 percentage points in doctoral degrees.

The number of women receiving degrees in STEM disciplines is growing
As shown in Figure 16, the number of women receiving bachelor degrees in STEM fields increased by 27 percent

from 70,537 in 2003-04 to 89,817 in 2009-10. In this same period, the number of women receiving doctoral degrees in STEM disciplines increased by 63 percent from 5,734 to 9,358.

The proportion of women in STEM fields is flat among bachelor degree recipients, but growing among doctoral recipients
Though the number of women in STEM fields has increased, the proportion has remained fairly stable at 40 percent of

Figure 17. Number and distribution of bachelor degrees granted by gender

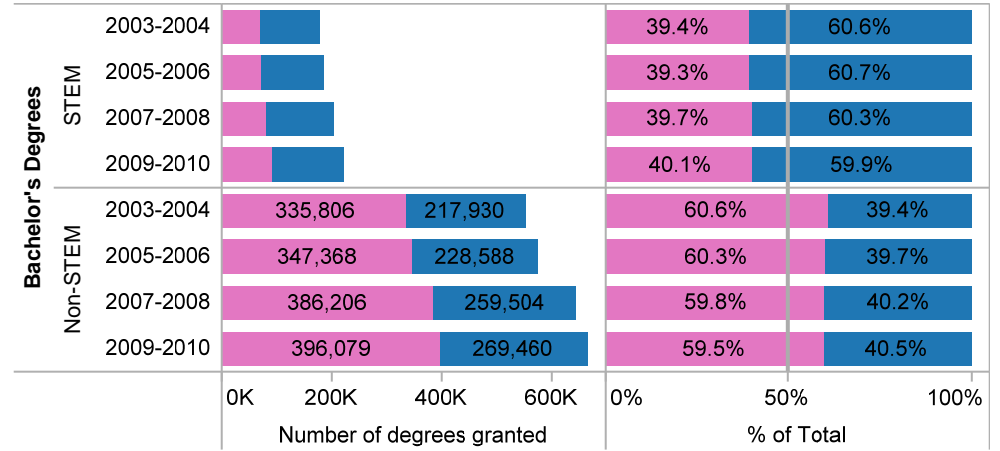
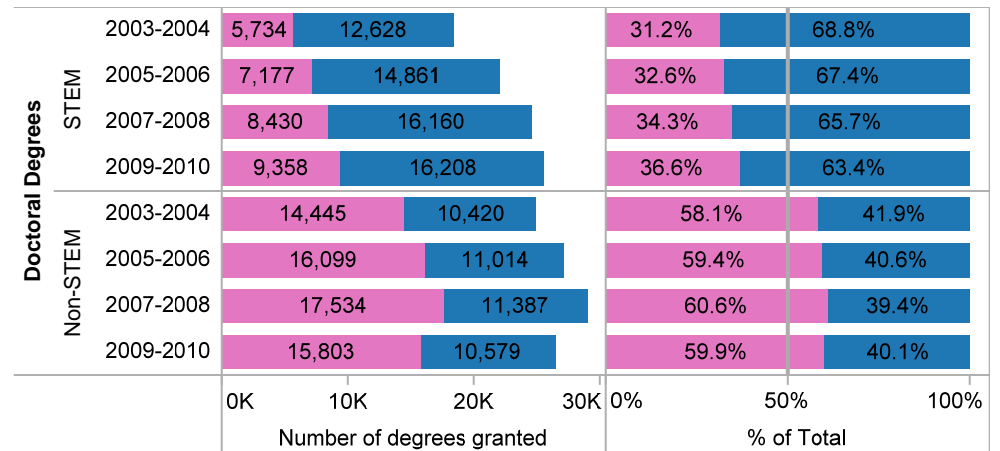


Figure 18. Number and distribution of doctoral degrees granted by gender



bachelor degrees granted (see Figure 17). In contrast, women are overrepresented in non-STEM fields and receive 60 percent of bachelor degrees in those areas.

Both the number and the proportion of women who receive doctoral degrees in STEM fields have increased since 2003-04. As mentioned earlier, this number increased by 63 percent, and the propor-



Data Sources and Methodology

The populations analyzed were selected largely based on available data. Thus, the populations of institutions evaluated are not consistent throughout the report.

IPEDS HR (Fall Staff)

The source data for Figures 1-8 are from IPEDS HR (Fall Staff) for all degree-granting institutions in the U.S. We selected this population because tenured faculty positions exist at all levels of higher education, from community colleges to research institutions.

As of February 2013, the AAUDE data warehouse does not include these data by gender, thus we could not use it as a source. Instead we downloaded these data from the IPEDS Data Center (<http://nces.ed.gov/ipeds/datacenter>) for all degree-granting institutions in the U.S. for every odd year from 1993 through 2011. The resulting data were stored in an Excel spreadsheet.

In 2011, these data covered 1869 institutions with 388,370 faculty members who are tenured or tenure-track (tenure-line) and in the professorial ranks of assistant, associate or full professor. To maximize the homogeneity of the population, our analyses include only tenure-line faculty in professorial ranks.

Faculty Profile by CIP

The source data for Figures 9-13 are from an AAUDE item called Faculty Profile by CIP for 35 AAUDE institutions. These data were retrieved from the AAUDE data warehouse.

AAUDE owns Faculty Profile by CIP data, which are only available for AAUDE institutions. Because providing data is optional, not all institutions provide data every year.

Since these data began being collected in 2002-03, a total of 57 institutions have provided data. In order to ensure a consistent population of institutions over time, these analyses are limited to the 35 AAUDE institutions that submitted data in at least one year in each of four two-year time periods (2004-05/2005-06; 2006-07/2007-08; 2008-09/2009-10; 2010-11/2011-12).

Those institutions were: Arizona, Buffalo, Colorado, *Columbia*, *Cornell*, *Duke*, *Emory*, Florida, *Harvard*, Illinois, Iowa, Kansas, Maryland, Michigan, Michigan State, Minnesota, *MIT*, Nebraska, North Carolina, *Northwestern*, Ohio State, Oregon, *Princeton*, Purdue, Rutgers, *Stanford*, Texas A&M, UC Berkeley, UC Davis, UC Irvine, UC San Diego, UC Santa Barbara, UCLA, *Washington University*, and *Yale*. (Private institutions are in *italics*.)

With a few exceptions, we used data from 2005-06, 2007-08, 2009-2010 (2008-09 for Texas A&M), and 2011-12 (2010-11 for Arizona, Colorado, and North Carolina).

IPEDS Completions

The source data for Figures 14-17 are from IPEDS Completions for all doctoral-research institutions and 67 additional institutions. The selection of institutions is due to current limitations to the AAUDE data warehouse, from which these data were retrieved.

The population of institutions included for these analyses are 324 doctoral/research institutions (extensive and intensive) and 67 others that have been identified as part of a peer group by an AAUDE institution. These additional institutions are generally *branch campuses*, mostly in the Midwest or Colorado, the elite colleges that are part of the *Consortium on Financing in Higher Education* (COFHE), and *state colleges in Colorado*.

Our ideal population for these analyses would be all degree-granting four-year institutions in the U.S. This population would be smaller than that used in the IPEDS HR analyses, but though degree-recipients graduates may work at any level of institution (IPEDS HR), they would only receive bachelor and doctoral degrees at four-year institutions (IPEDS Completions).

We have plans to modify the rules on which institutions have IPEDS data in the AAUDE data warehouse to include all institutions; this will take place later in 2013. After that, we recommend that these analyses be repeated with the population of all four-year public and private not-for-profit institutions when the data are available in the data warehouse.

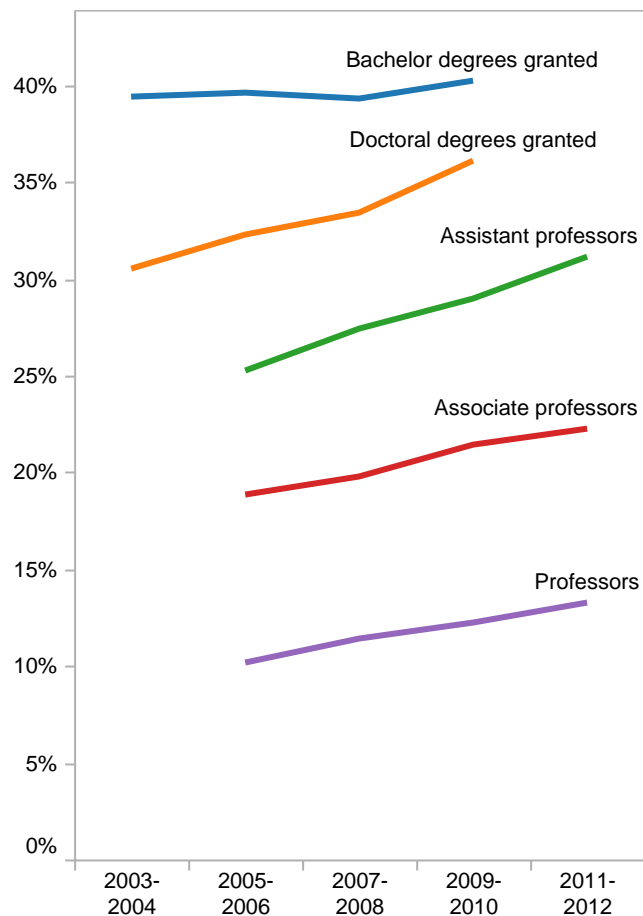
In the new IPEDS classification of degree types, doctoral degree counts *do not include* professional practice doctorates.

Disciplines

For both Faculty Profile by CIP and IPEDS Completions data, we used the 2012 *STEM Designated Degree Program List* that is part of the U.S. Student and Exchange Visitor Information System from U.S. Immigration and Customs Enforcement (ICE), to determine whether a discipline was STEM or non-STEM. The entire list, which includes 454 six-digit CIP codes, can be found at <http://www.ice.gov/doclib/sevis/pdf/stem-list.pdf>. Though there are a few CIP codes that seem to belong in the STEM category, we relied on the official list and did not make exceptions.

The CIP codes identifying STEM disciplines is based on the 2000 CIP codes. In order to ensure consistency in the trends and avoid complexity, we evaluated discipline-level data starting with 2003. ■

Figure 19. Change in proportion of women in STEM fields by academic population



tion grew from 31 to 37 percent (see Figure 18). As with bachelor degrees, women steadily represent more than 50 percent of doctoral degrees in non-STEM fields.

The Pipeline

In order to obtain the ultimate academic position of tenured full professor, women must make their way through the pipeline of bachelor degree, doctoral degree, and then up the ladder of faculty rank. Figure 19 shows a growing number of women are moving through the STEM pipeline in academia, but the movement has been quite slow.

The proportion of women among bachelor recipients – the beginning of the pipeline – has been flat, but has shown gains in each subsequent population along the pipeline. These trends seem poised to continue albeit slowly.

Conclusion

Though their proportion in all academic populations in STEM fields remains well below 50 percent, women are making small steps toward being more fully represented. Both the proportion and number of women receiving doctoral degrees and in faculty positions in STEM disciplines has grown over time. That said, this

movement has been slow and is considerably different than in non-STEM fields.

Further research could be done to better understand these overall patterns, to understand the antecedent events leading to the choice to pursue a career in a STEM discipline, to identify the barriers to increasing the proportion of women in these fields, to identify and understand differences across institutions, as well as to understand other faculty populations besides tenure-line professorial faculty. This final topic will require an in-depth investigation of the differences in how institutions define and report on different populations of their faculty, which may result in recommendations for more standardized coding.

The availability of faculty demographic data in the form of Faculty Profile by CIP is invaluable in understanding these patterns among AAUDE institutions. Because IPEDS HR information is available by discipline, Faculty Profile by CIP is a unique resource that covers a significant subset of faculty in higher education. We encourage all AAUDE institutions to participate in this exchange item and provide historical data. ■



AAU Data Exchange
PMB 407832
2301 Vanderbilt Place
Nashville, TN 37240-7832

Phone: (615) 290-5577
E-mail: aaude@vanderbilt.edu
Web: <http://www.aaude.org>

The Association of American Universities Data Exchange (AAUDE) is a public service organization whose purpose is to improve the quality and usability of information about higher education. Our membership is comprised of AAU institutions that support this purpose and participate in the exchange of data/information to support decision-making at their institution.

The data exchanged and reports prepared by AAUDE include both public and confidential topics. Faculty Profile by CIP data are confidential and will not be available for analysis beyond AAUDE membership. Because this report provides these data in summarized form, it can be shared publicly.

These data are exchanged among member institutions on the basis of mutual confidentiality and on the expectation that those who do not provide data will not use them.