LinkedIn Economic Graph

Measuring gender gaps in the U.S. STEM workforce

March 2023

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Economic Graph White Paper
March 2023

Women continue to be underrepresented in Science, Technology, Engineering, and Mathematics (STEM) education and careers. In this paper, we analyze millions of LinkedIn profiles in the United States to examine the transition from obtaining a STEM degree to securing STEM employment. A significant gender gap exists in both the rate of holding STEM skills and in STEM employment. Our paper also reveals that the greatest expansion in the gender gap occurs between obtaining a STEM degree and working in STEM one year after graduation. We found that during this timeframe, the gender gap in STEM widens by ten percentage points. Nevertheless, we also observe an improvement in the gender representation of new STEM employees across graduation cohorts.

Introduction

Science, Technology, Engineering, and Mathematics (STEM) employment is a crucial aspect of a robust, resilient economy (Idin, 2018). With high earning potential and a stable career path, STEM jobs also offer many opportunities (Langdon et al., 2011; Melguizo & Wolniak, 2012). However, women and underrepresented groups in the United States are less likely to work in STEM (Baird et al., 2017), with disparities emerging in the educational process (Rodriguez-Solorio, 2022). These gaps persist and grow along the entire education and employment pipeline (Arcidiacono et al., 2016; Sovero et al., 2021). While previous research has primarily focused on gender and race gaps during the education process, particularly in college, leaks from the pipeline before employment could result in inefficiencies, given that the primary goal of education is to prepare individuals for the workforce.

To understand the transition from obtaining a STEM degree to securing STEM employment, we analyze the LinkedIn profiles of all STEM degree holders in the United States who graduated in 2016 or later. While acknowledging that gender is a spectrum, we restrict our analysis to binary classification of male and female due to data limitations. We examine STEM participation during college and the first five years following graduation, using a proprietary definition of STEM work based on STEM skills. Additional details regarding our definition of STEM work are provided at the end of this paper.

Overall STEM estimates

Based on our analysis of LinkedIn data, we estimate that 19.4% of the membership in the United States are employed in STEM occupations. This estimate is consistent with other non-traditional approaches to estimating STEM in the overall United States economy (Rothwell, 2013 at 20% and Anderson et al., 2021 at 19.8%) and higher than traditional estimates that are not skills-based (e.g., the U.S. Bureau of Labor Statistics, 2022 estimated 6.2%). Our use of a skills-based approach may contribute to the higher estimates compared to the BLS, but it is also possible that the LinkedIn membership in the

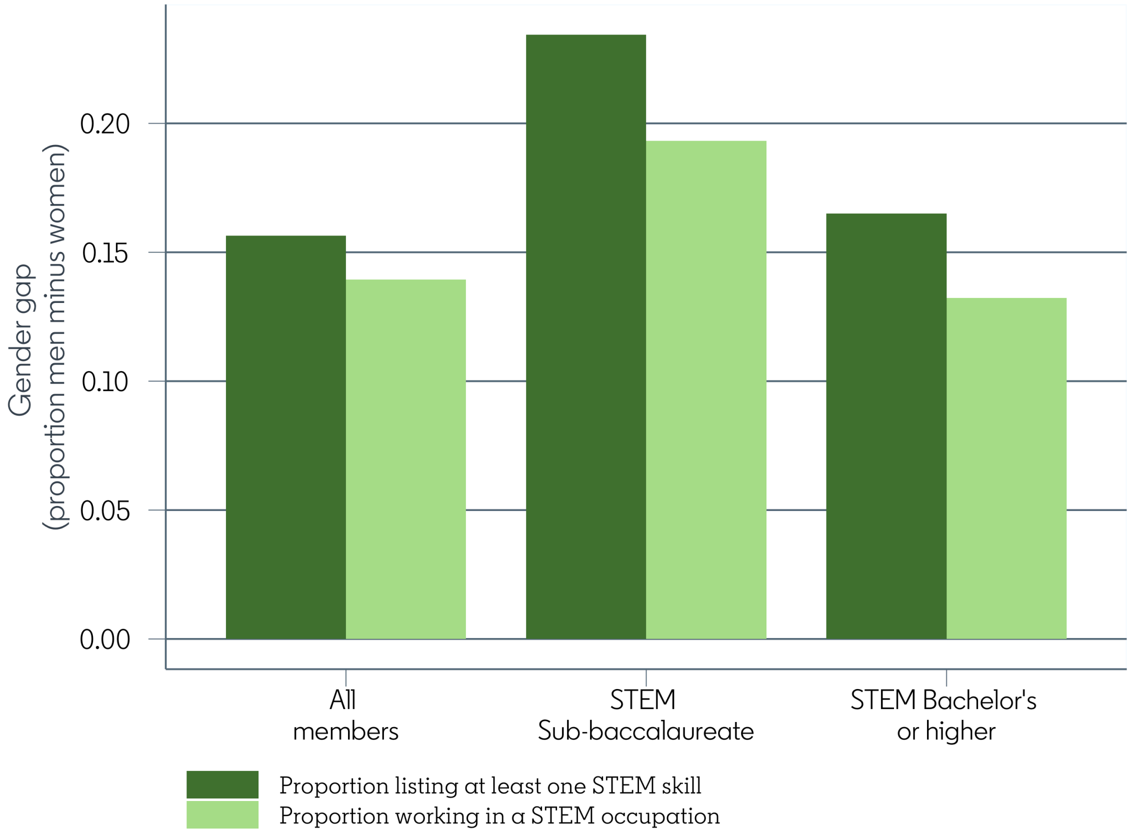
Table 1

Gender gaps in STEM skills and STEM employment

Population	Men	Women
Proportion of members with at least one STEM skill on profile		
All members	29.5%	13.8%
Sub-baccalaureate STEM degree holders	51.5%	28.0%
Bachelor's or higher STEM degree holders	60.3%	43.8%
Proportion of members working in a STEM occupation		
All members	25.9%	11.9%
Sub-baccalaureate STEM degree holders	41.8%	22.5%
Bachelor's or higher STEM degree holders	47.4%	34.2%

Figure 1

Gender gaps in the proportion of members with STEM skills or working in STEM occupations



United States is more likely to participate in STEM occupations on average than the overall U.S. population. We are unable to identify the specific reasons for this difference in our study.

Table 1 presents the proportion of LinkedIn members with STEM skills and STEM occupations. Our analysis reveals significant gender gaps in both STEM skills and employment. Specifically, our findings indicate that 29.5% of men who list skills on LinkedIn possess at least one STEM skill, compared to only 13.8% of women. STEM degree holders have STEM skills at higher rates, but the gender gap still exists. For employment, we estimate that, while 19.4% of U.S. members work in STEM, 25.9% of men and only 11.9% of women work in STEM. We find similar disparities by gender among sub-baccalaureate and bachelor's degree or higher STEM degree holders.

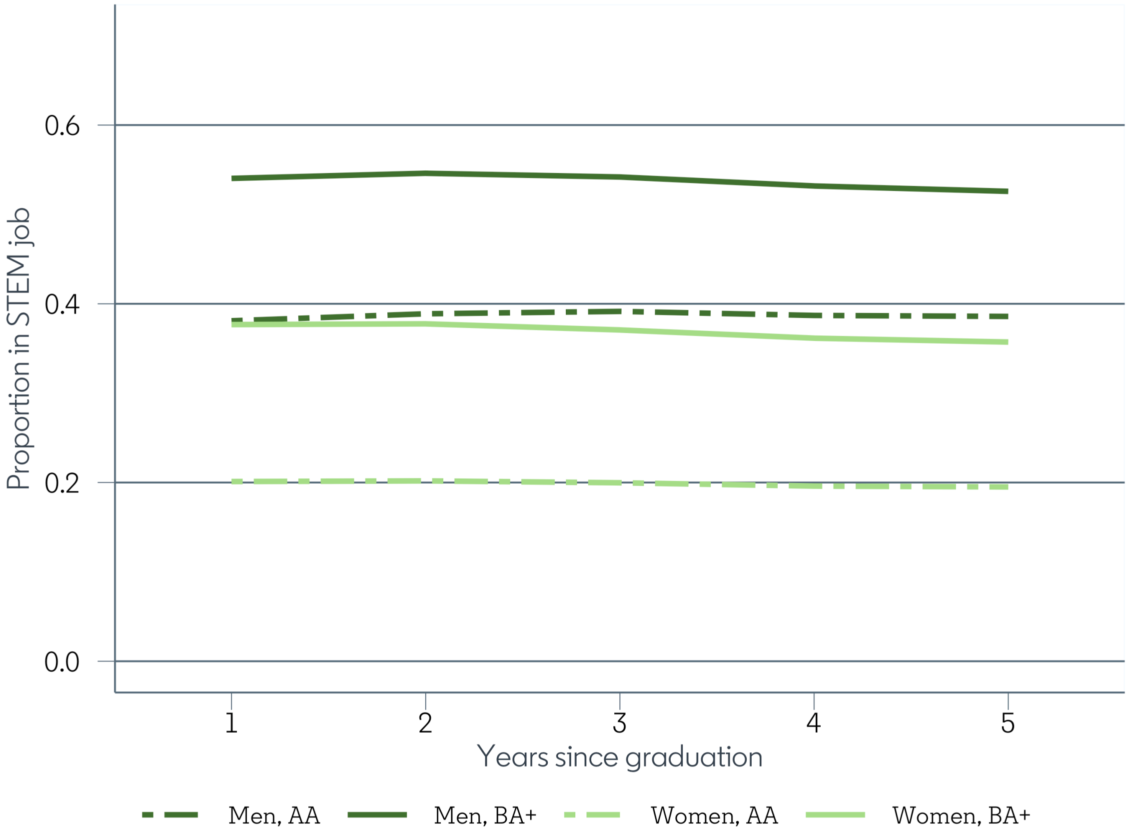
Figure 1 shows the gender gap in these outcomes. The gender gaps are slightly larger for STEM skill rates than for STEM employment. The gaps are largest for sub-baccalaureate workers. Thus, despite women making gains in STEM education (NCSES, 2022), with women now earning more total postsecondary degrees than men in the U.S. and more STEM degrees as well (Fry et al., 2021), this does not translate into elimination of STEM employment—or skills--gaps.

Our estimates are largely consistent with those in the literature, although differences in sample and STEM occupation classification must be noted. For instance, Baird et al. (2017) found that 49.1% of U.S. men with a STEM bachelor's degree or higher were working in a STEM job. Our estimate of 47.4% is very close. Likewise for women, Baird and colleagues found that 29.7% of women with bachelor's degrees or higher were in a STEM job, compared to the 34.2% in our sample. As a result, the estimated gender gap is also fairly similar between studies, with Baird et al. (2017) reporting a 19.4% difference, and our study finding a 13.2% difference.

There are differences between our sample and those in the literature, such as the fact that our analysis is based on LinkedIn members. Additionally, our skills-based approach may help explain some of the reasons our gap is somewhat narrower (see Anderson et al., 2021). We also find that the transition from a STEM degree to a STEM occupation is lower for sub-baccalaureate workers compared to those with a bachelor's or higher, and the gender gap in this transition is slightly larger at 19.3 percentage points.

Figure 2

Proportion of STEM graduates in STEM employment for the 2016 graduation cohort, by years after graduation



Note: Each group is limited only to those with STEM degrees earned in 2016

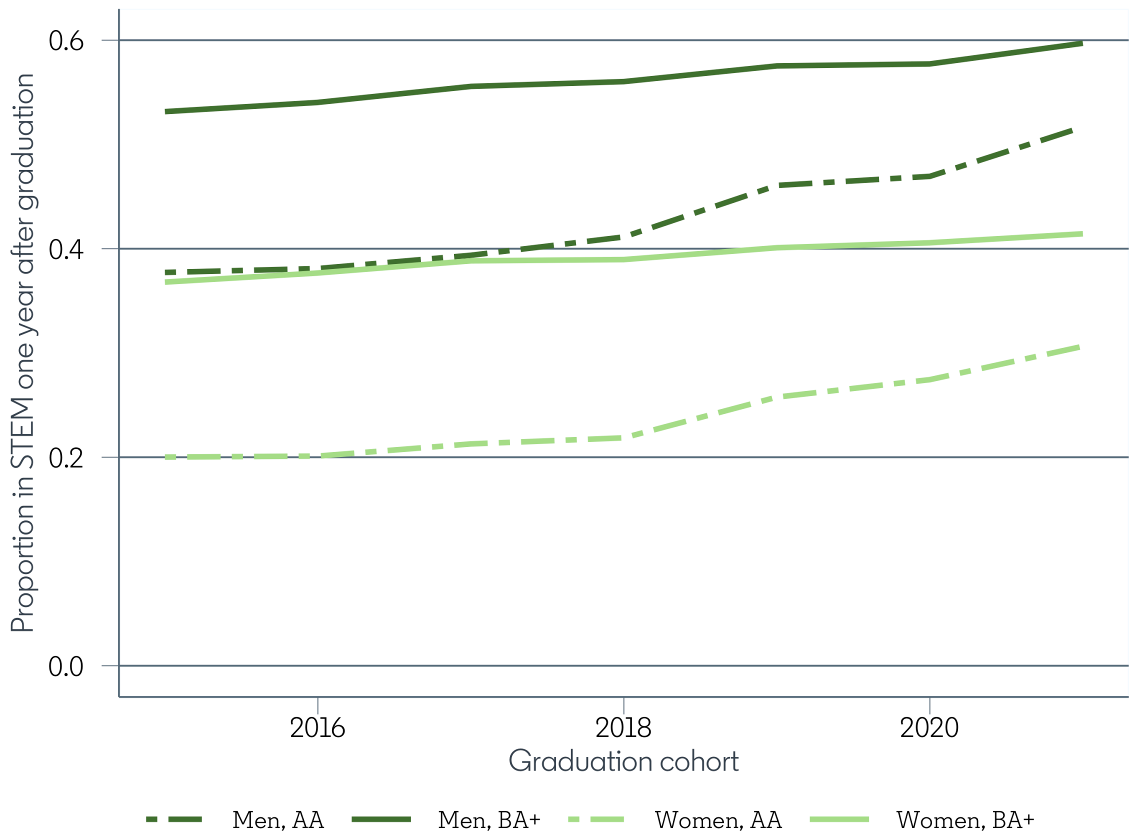
Trends in STEM retention

In order to focus on retention in the STEM pipeline, we narrowed our sample to those with a STEM college degree earned since 2016 and the first five years after graduation for the next figures. Figure 2 displays the proportion of STEM graduates in STEM employment by years after graduation, revealing several noteworthy patterns. First, there appears to be a slight decrease in the proportion of workers who work in a STEM job over time for all groups, which may be due to the challenges of breaking into STEM occupations and/or changes in career preferences or opportunities. This phenomenon may be particularly challenging for workers with lower levels of educational attainment or from historically underrepresented groups, who may face additional barriers to entering and advancing in STEM fields.

These differences between groups persist over time, as observed by the sizeable gaps between them. Workers with a STEM bachelor's degree or higher are more likely to be employed in a STEM job than those with an associate's degree in STEM, with a gap of over ten percentage points that remains relatively stable over time. Women

Figure 3

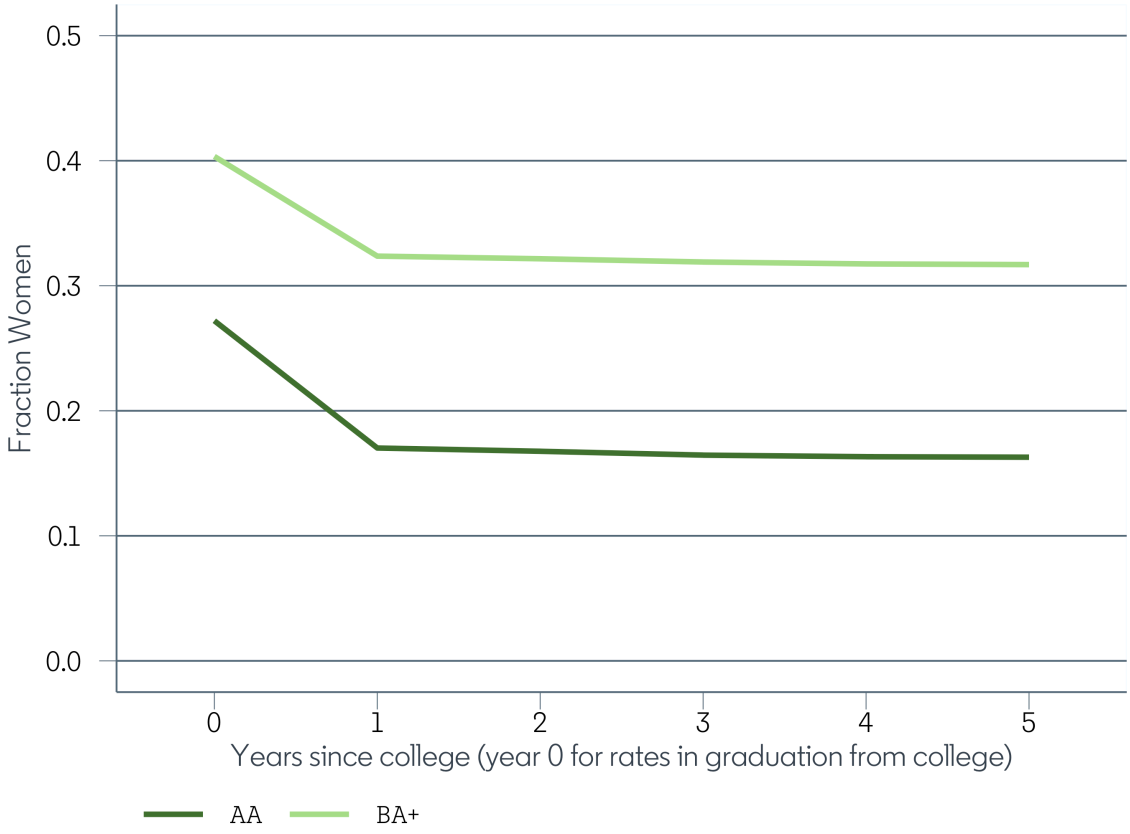
Proportion of STEM graduates in STEM employment one year after graduation, by graduation cohort



Note: Each group is limited only to those with STEM degrees earned in 2016

Figure 4

Proportion of STEM that are women among STEM degree holders, by time since graduation



Note: Each group is limited only to those with STEM degrees earned in 2016

with STEM degrees are consistently less likely to work in STEM than men, and this gender gap slightly widens over time. In fact, women with a bachelor's degree in STEM are less likely to work in STEM than men with an associate's degree in STEM, at all points within the first five years after graduation. Baird et al. 2017 had a similar finding, where they showed that women with bachelor's degrees in STEM were less likely to work in STEM after graduation than men with non-STEM bachelor's degrees. The gender gap in STEM employment ends up near the 15-20 percentage point difference shown in Figure 1.

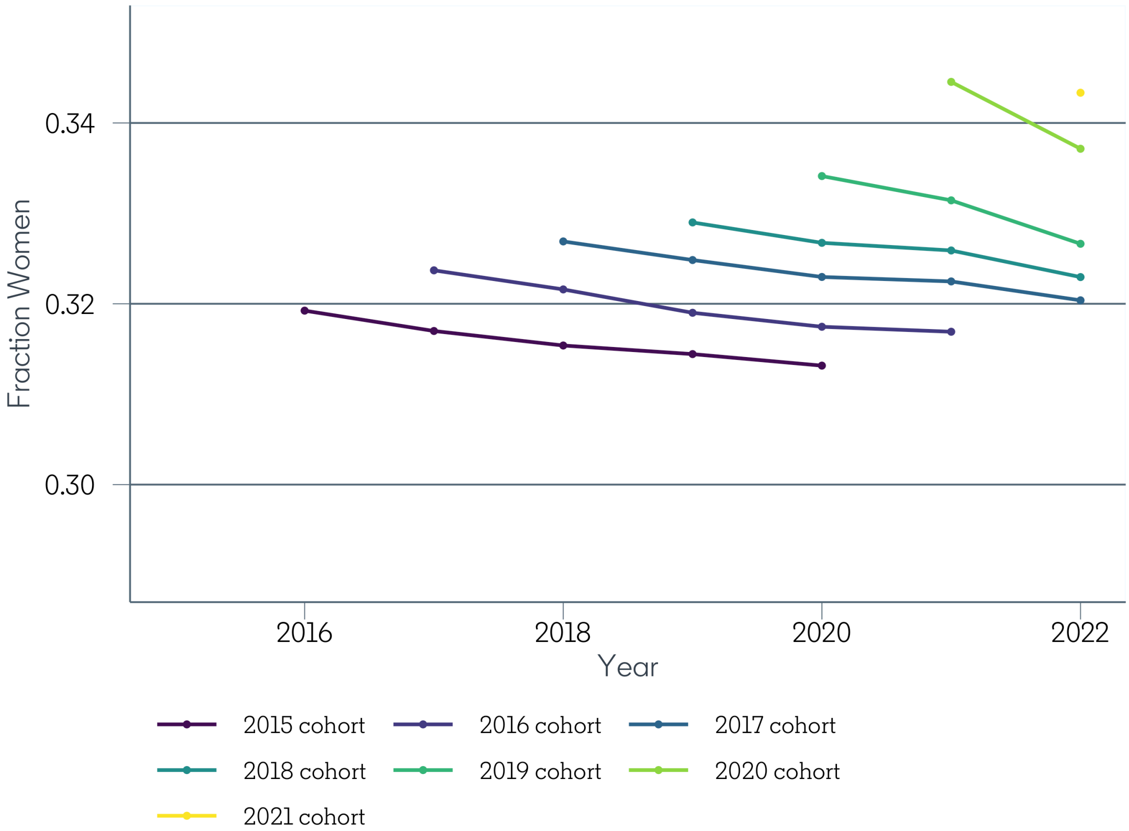
In addition to viewing the trend over time after graduation, we can observe the change in retention across graduation cohorts. Figure 3 presents these results, focusing on the proportion in a STEM job one year after graduation. For each of the four groups, there is a relatively steady increase across cohorts, with more recent graduation cohorts being more likely to be working in a STEM job one year after graduation. This is particularly true for sub-baccalaureate STEM graduates, with graduates from the early pandemic cohorts seeing a larger increase over prior cohorts.

Figure 4 illustrates the proportion of women in STEM jobs among STEM graduates. The graph shows a slight decline in the representation of women between years 1 and 5 after graduation, but the drop is relatively small compared to the sharp initial decline observed between graduation and one year after graduation. Thus, a significant portion of the attrition leading to the under-representation of women in STEM occurs within the first year after graduation. This pattern holds for both associate degree holders and bachelor's degree or higher members. The observed drop-off aligns with the gender gaps displayed in Figure 1: a larger proportion of women obtain STEM degrees (and possess STEM skills, hence the parity with men), but do not work in STEM occupations even one year later, as depicted in Figure 4. As a result, this contributes to the persistent measured gap in STEM employment shown in Figure 1.
Figure 5 focuses on individuals with a STEM bachelor's degree or higher and shows the proportion of women in STEM across cohorts and time since graduation. There are two simultaneous trends shown by these data that operate in opposite directions.

First, as suggested in Figure 3, there is a slight downward trend over time within cohorts, with a decrease in the share of women in STEM jobs for each additional year elapsed since graduation (an average annual decrease of 0.22

Figure 5

Proportion of STEM workforce that are women, by graduation cohort and time since graduation



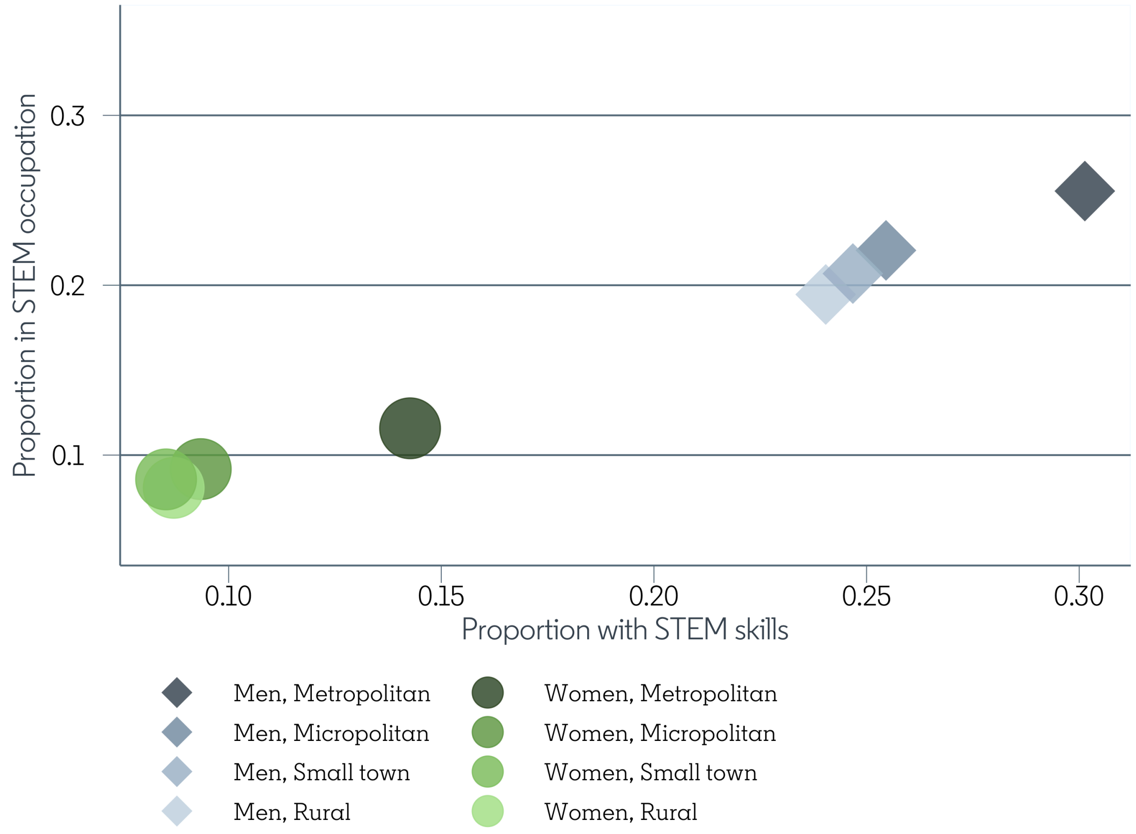
percentage points). On the other hand, there is also an increase in the share of women in STEM jobs for most subsequent graduation cohorts, which is more than 50 percent larger than the within-cohort decrease (an average increase of 0.36 percentage points per cohort in the first year after graduation). This trend is encouraging and represents progress towards increased representation of women in STEM. However, we note that the 2021 cohort saw a very slight decrease in the proportion of women in the first year compared to the 2020 cohort, instead of the continual increase in representation seen across prior cohorts. This may reflect the strong demand for STEM skills in the tech industry, which is more heavily comprised of graduates from more male-dominated majors such as engineering and computer science than other STEM majors.

Trends patterns by rurality

Figure 6 presents the averages of STEM skills and STEM employment across all workers, including college graduates and non-graduates, as well as younger and older workers. This is a breakdown of the "All members" rows in Table 1 and Figure 1. As previously noted, women are less likely than men to list STEM skills or to work in STEM jobs, regardless of their urban-rural residence. However, our analysis also reveals a strong relationship between urbanicity and STEM skills and employment, with members in urban areas being more likely to list STEM skills and to work in

Figure 6

Proportion of STEM skills and employment, by gender and rurality



STEM jobs. This relationship is particularly pronounced for STEM skills, with a sharper gradient by rurality. Nonetheless, the gender gap in STEM skills and employment remains wider than the urban-rural differences. For instance, women living in metropolitan areas are less likely to list STEM skills and work in STEM jobs than men living in rural areas. This suggests that factors beyond individual skill levels may affect whether individuals are able to obtain STEM jobs in urban versus rural areas. We also note that the urban-rural differences within gender are remarkably similar, with the largest difference being between micropolitan and metropolitan members for each gender.

Conclusion

STEM is a critical component of any economy, providing opportunities for career advancement and higher wages, as well as driving economic growth. However, despite the importance of a strong STEM workforce, women and underrepresented groups remain underrepresented in STEM fields. Analyzing LinkedIn data in the United States, we uncover several key findings that shed light on the gender gaps in STEM. Our analysis reveals significant and persistent gender gaps in both the listing of STEM skills and employment in STEM occupations. Additionally, we find a rural-urban divide in STEM skills and employment, with urban areas having higher rates of members listing STEM skills and working in STEM occupations. However, the differences in urbanicity are considerably smaller than the gender gaps we observe. These findings highlight the importance of addressing gender disparities in STEM skills and employment, as well as the potential impact of rural-urban differences on the STEM workforce.

While both men and women with STEM degrees are slightly less likely to end up in STEM positions as time passes after graduation, the gender gap persists and even slowly widens. However, the most significant drop-off in STEM employment occurs within the first year after graduation, and this drop-off is much more pronounced for women than men. Therefore, it is crucial for policymakers and researchers to focus on understanding the reasons for this drop-off, as well as the mechanisms and potential interventions that could encourage more women to transition from STEM education to STEM employment and address any structural barriers they may face.

Finally, we see some reasons to be encouraged. Across graduation cohorts, there is an increase in the transition from STEM graduation to STEM employment for both men and women, sub-baccalaureate graduates and bachelor's or higher. In other words, there is less leakage from the STEM pipeline at that critical juncture. Additionally, we see that there is a slow increase in women's representation in STEM after graduation across cohorts. These hint towards more efficient and equitable STEM workforce over time.

This work has limitations and should be followed-up with additional research. First, while we present the observed trends in U.S. LinkedIn membership data, this may not necessarily reflect only true changes in the underlying U.S. economy. That is, we cannot say whether the observed changes and differences capture the true increases in the population, changes in the demand for STEM (such as more jobs, changes in the composition of the LinkedIn membership, or other factors. Future analysis should evaluate the sensitivity of some of the primary findings of this paper to these potential confounders. Future research can also investigate such questions as the reasons for the disparity between men and women's transitions into STEM employment, such as college field of study, local labor conditions, and job search behavior; the transitions in and out of STEM employment for non-degree holders; and international comparisons.

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Methodology

A fuller description of the methodology is described in Baird et al. (2023). Overall, we use three steps which build in each other: define STEM degree holders, define STEM skills based on this, and define STEM occupations based on this.

Classifying STEM Degrees

We classify degrees as STEM or non-STEM using the U.S. Department of Homeland Security's STEM Designated Degree Program list of majors. The list uses Classification of Instructional Programs (CIP) codes. DHS bases their list on the U.S. Department of Education's National Center for Education Sciences definition of STEM fields.

Classifying STEM Skills

We create a new classification of STEM occupations that is based on the occupation using STEM skills. To do so, we first develop a list of STEM skills (most closely related to the classification approach of Rothwell (2013)). We define a STEM skill be meeting two criteria: first, at least 100 members have added the skill (imposed to ensure sufficient data quality), and second, the probability that a STEM graduate adds the skill is at least five times as likely as the probability that a non-STEM graduate adds the skill.

Classifying STEM Occupations

With the derived list of STEM skills, we next classify which occupations are STEM. To do this, we used the LinkedIn Skills Genome, which calculates TF-IDF scores across members within each occupation to determine the most important and unique skills to that occupation. We classified an occupation as STEM if it had at least one STEM skill in its top ten skills. We used the LinkedIn occupational taxonomy of occupation representative IDs, which groups together related occupations and yields a total of 3,194 occupations. Of these, we identified 825 as STEM occupations in the United States, representing 25.8 percent of all occupations.

Classifying Rural-Urban

We use the ZIP Code that the user provides (for those who have it provided). We use the USDA Economic Research Service designation of Rural-Urban Commuting Area Codes at the ZIP Code level, 2010 (the most recent available). More details are provided on the USDA website.[1]

[1] https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes/