

Understanding the Gender Gap in STEM Fields Entrepreneurship

By Margaret E. Blume-Kohout, MBK Analytics, LLC, Albuquerque, NM 87109-3367, 83 pages.
Under contract number SBAHQ-13-M-0203

Purpose

While it is generally understood that a gender gap exists in science, technology, engineering, and math (STEM) fields, less research has been done on women entrepreneurs in the STEM fields. This report expands on the limited literature specific to women entrepreneurs within STEM fields. In addition, it aims to identify any significant factors or trends that may prove useful to those interested in policies directed at increasing participation of women entrepreneurs in STEM fields.

Background

Recognizing that STEM fields contribute to high-quality job growth and economic innovation, Congress reauthorized the America Competes Act¹ in 2010, increasing funding for STEM education and research. In addition, the U.S. Census Bureau's 2011 American Community Survey reports significant reductions in earnings gaps for STEM workers relative to all workers.² These results were consistent across gender and race/ethnicity. Finally, beyond potential economic contributions, male and female STEM PhDs who engage in entrepreneurial ventures are significantly more likely to report high levels of job satisfaction.³ As such, STEM fields contribute to a wide spectrum of economic growth opportunities.

Small businesses drive a significant portion of the STEM economy.

Small businesses in the United States (firms with fewer than 500 employees) contribute significantly

to vital arteries in the STEM and U.S. economy: research and development (R&D), patent production and job creation.

- In 2010, small businesses paid for and performed over 18 percent of U.S. industry R&D, which totaled over \$40 billion.⁴

- Small businesses also performed a disproportionate share of U.S. industrial R&D in the manufacture of computer and electronic products, components, and instruments. In 2012, manufacturers of computer and electronic products contributed a value-added of over \$272 billion to U.S. GDP.⁵

- In 2010, small businesses held 37 percent of U.S. industry patents.⁶

- In addition to R&D investments, small businesses also employed 382,000 R&D scientists, engineers, and technicians, representing 31 percent of the industrial research workforce.⁷

Gender differences in STEM entrepreneurship expose issues unique to female entrepreneurs in STEM fields while also echoing general gender gap issues in entrepreneurship and in STEM fields.

The gender gap persists for women-owned businesses. While women-owned businesses contribute significantly to the small business economy, they continue to be smaller, less profitable, and more short-lived than their male-owned counterparts.

1. America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act, Public Law No: 110-69, Aug. 9, 2007.

2. U.S. Census Bureau, *Disparities in STEM Employment by Sex, Race, and Hispanic Origin*, September 2013.

3. 2010 Survey of Doctorate Recipients.

4. National Science Foundation and National Center for Science and Engineering Statistics, 2013.

5. Bureau of Economic Analysis, 2014.

6. National Center for Science and Engineering Statistics, 2013.

7. Pontus Braunerhjelm, 2011. "Entrepreneurship, innovation and economic growth: interdependencies, irregularities and regularities." In *Handbook of Research on Innovation and Entrepreneurship*, David B. Audretsch et al, eds. Northampton, MA: Edward Elgar.

The gender gap persists for women in STEM fields. Women have increased their representation in STEM graduate enrollment, but that increase has been uneven across STEM fields. While women have achieved parity for PhDs in biological and medical sciences, their enrollment continues to lag in some of the most entrepreneurial fields, such as bioengineering, mechanical, and civil engineering and materials science. Figures 1 and 2 show gender distribution in top entrepreneurial STEM fields.

According to the U.S. Census Bureau, since the 1970s women have increased their representation in STEM occupations, but that increase has been uneven across STEM fields. In 2011, women constituted 26 percent of STEM workers but remained significantly underrepresented in computer (27 percent women) and engineering occupations (13 percent women). The two fields represent approximately 82 percent of all STEM occupations (Figure 3). This uneven representation persists across field specializations as well. For example, women mechanical engineers represent only 6 percent of that workforce.

The gender gap persists for women-owned STEM businesses. Recent research indicates some incentives for STEM entrepreneurship may differ from incentives for non-STEM entrepreneurship.⁸ Beyond that, female entrepreneurs in STEM further differ from their male counterparts. Figure 4 shows gender distribution by key STEM fields and type of entrepreneurial activity.

In addition, in high-technology industries, women are more likely to start firms that provide research and consulting services and are less likely to start firms in semiconductor and aerospace manufacturing, navigational instruments or communications equipment,⁹ which may correlate with lower reported rates of R&D activities for women STEM PhDs. High-tech women-owned businesses may also be less likely to locate in geographic regions where they can take advantage of regional clustering of highly skilled labor and knowledge spillovers.

8. T. Taylor Aldridge and David Audretsch, 2011. "The Bayh-Dole Act and scientist entrepreneurship." *Research Policy* no. 40:1058-1067.

9. Heike Mayer, 2006. "Economic trends and location patterns of women high-tech entrepreneurs." *Frontiers of Entrepreneurship Research* 26 (11), <http://digitalknowledge.babson.edu/fer/vol26/iss11/>.

Figure 1. According to the 2010 Survey of Doctorate Recipients, engineering dominates the top five fields for STEM PhD entrepreneurship, with entrepreneurship rates between 9 and 12 percent relative to other occupational choices such as academia.

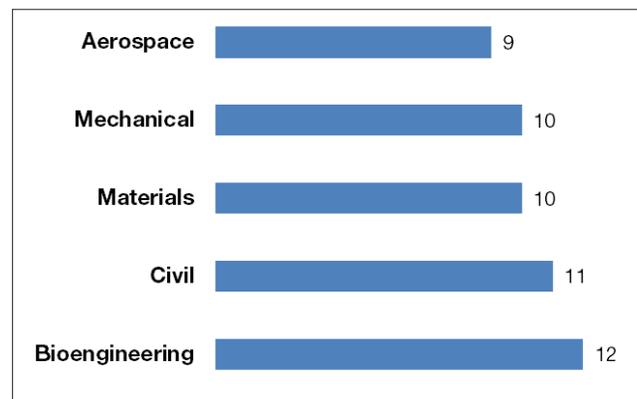


Figure 2. In 2012, according to the U.S. Department of Education, women continued to lag in entrepreneurially inclined engineering PhD fields, earning between 30 and 15 percent of these PhDs.

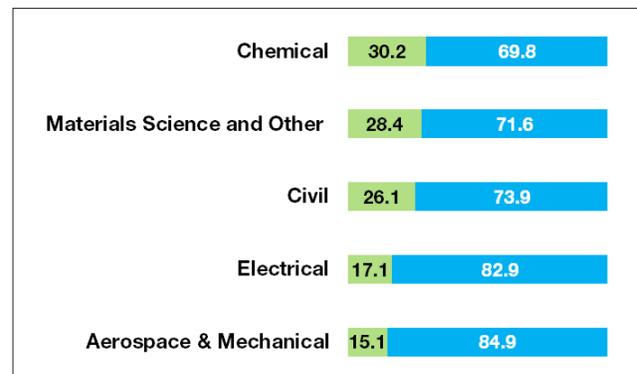


Figure 3. The U.S. Census American Community Survey reports that in 2011, Computer and Engineering represent 82 percent of STEM occupations.

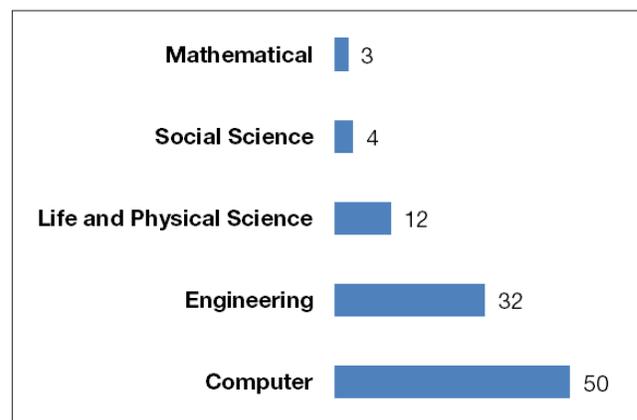
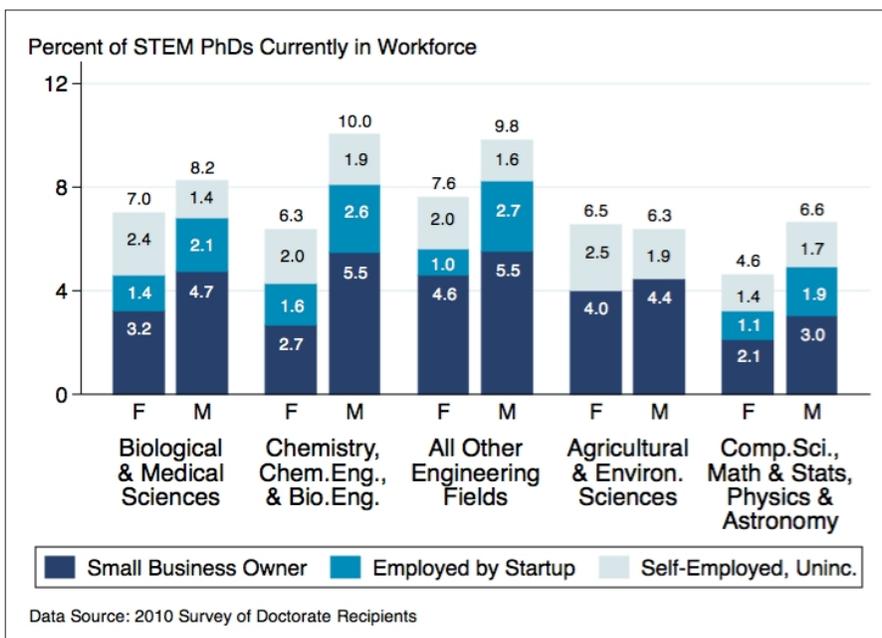


Figure 4. Female STEM PhDs engage in less entrepreneurial activity than their male counterparts but gender gaps vary according to type of activity (small business owner, self-employed, employed by startup) and specific STEM fields.



Overall Findings

The key findings of this report suggest an effective strategy for addressing the gender gap in STEM fields' entrepreneurship should be multifaceted in its approach. Figure 5 shows gender distribution in two key STEM entrepreneurship areas. Across all STEM fields, female PhDs have lower rates of patenting and entrepreneurship than do male PhDs. This difference is most pronounced in physics, astronomy and the computer sciences, in which women earned only 1 in 5 PhDs conferred by U.S. institutions in 2012, and in which women are disproportionately trained and employed by less research-intensive departments.

Overall findings and therefore policy implications vary widely across individual STEM fields and include gender differences in graduate training environments, employment sector, typical work activities, professional seniority, and the impact of patenting activity on subsequent entrepreneurship.

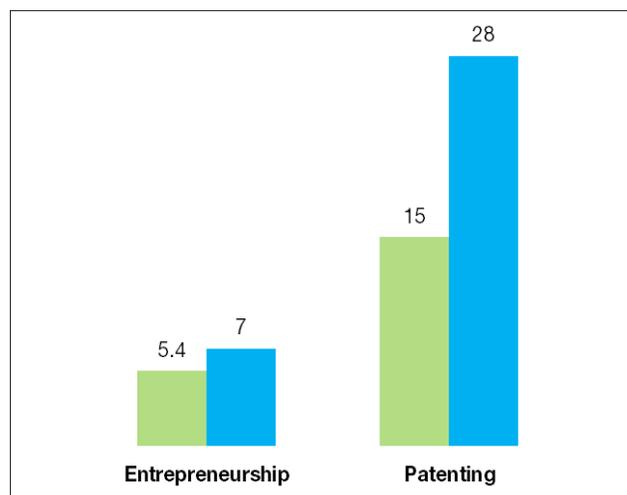
The results identify four broad areas that matter for women entrepreneurs in STEM.

The ratio of women to men in STEM PhD programs matters.

- While gender parity exists in some STEM field PhD programs, significant enrollment gaps exist for some of the most entrepreneurial STEM fields, such as engineering.

- The graduate degree gap is echoed in female faculty representation across entrepreneurial and patent generating fields. In some fields, junior faculty ratios reflect a potential trend toward narrowing the gender gap.
- This study finds female to male ratios among student bodies and faculty matter for female enrollment choices in STEM programs.

Figure 5. On average, results from the 2010 Survey of Doctorate Recipients underscore the gender gap in STEM entrepreneurship and patenting, with women STEM PhDs engaging in both activities at lower rates (5.4 percent versus 7 percent, and 15 percent versus 28 percent, respectively).



Industry R&D funding and postdocs matter.

- Industry funded R&D and postdoctorals increase the likelihood of STEM entrepreneurship for STEM PhD women, while volume of R&D matters for STEM PhD men.
- Female STEM PhDs who attend programs at universities with relatively higher patenting volume and higher shares of R&D funded by industry or other non-federal sources are significantly more likely to participate in patenting and entrepreneurship.
- Female STEM PhDs whose first postdoctoral employment was in (or funded by) industry are equally likely as men to participate in patenting and entrepreneurship.
- In the highly entrepreneurial, women-underrepresented engineering fields, industry supports a significantly greater share of total R&D, 8.3 percent of all engineering research at U.S. universities which totals about \$857 million. Female graduate students in chemical and mechanical engineering disproportionately enroll in programs with no industry-funded R&D.

Gender differences in job satisfaction matter.

- In terms of job satisfaction, female STEM PhDs value availability of health insurance benefits significantly more than male STEM PhDs. As of 2010, entrepreneurial ventures were less likely to offer these benefits, but recent changes in access to health insurance coverage may change this landscape.
- Having a spouse or partner who works full-time in non-STEM fields increases female STEM PhD's propensity towards small business ownership, perhaps because that situation may provide an alternative source for health insurance.
- Female STEM PhDs who start their own businesses or join entrepreneurial ventures are less likely than male STEM PhDs to do so for family-related reasons, but more often do so to improve their working conditions. Female STEM PhDs value the independence of self-employment more than their male counterparts.

Parenthood matters in the short run.

- Arrival of young children at home significantly and substantially decreases women's near-term patenting and entrepreneurship, with no similar effect for men.

Policy Recommendations

This report examines multiple data sources in order to help explain persistent and systematic differences in STEM entrepreneurship between highly educated men and women across STEM fields. The results identify three broad areas for policy and practice.

Faculty mentors

- In the STEM fields with lowest female representation among U.S.-earned PhDs—aerospace, mechanical, and electrical engineering—as well as in computer science, math and statistics, female graduate students disproportionately enroll in programs with relatively higher shares of female faculty. This tendency also correlates with female students' disproportionate enrollment in lower-ranked and less research-intensive programs.
- Interventions in larger research-intensive institutions that help to provide female students with a more intimate group of students and female faculty mentors may improve these students' subsequent innovative activity and participation in entrepreneurial ventures.

Funding and training opportunities

- Within STEM fields, PhD-granting programs in which private sector sources fund a higher percentage of full-time graduate students tend also to have a significantly lower representation of female students. In some STEM PhD programs, particularly those in materials science and chemical engineering, female students prove disproportionately less likely than their male classmates to receive their primary funding from these sources.
- These findings as well as previous literature in support of this “imprinting” effect may provide inspiration for additional industry R&D funding and postdoctoral opportunities aimed at women in underrepresented STEM fields.

Further research on occupational environments

- New options and incentives for small business owners to acquire health insurance under the Affordable Care Act legislation may provide research opportunities to investigate whether any observed changes in this gender-specific source of job dissatisfaction positively correlates with women's participation in STEM entrepreneurship.
- Further comparative research regarding the relationship between parenting responsibilities for young children and types of academic activities (teaching versus research focused) and

entrepreneurial ventures may further illuminate the finding regarding short-run decreases in patenting and entrepreneurial activities for women STEM PhDs with young children.

Scope and Methodology

This study employs data from several nationally representative surveys conducted by the National Science Foundation and the U.S. Department of Education, which collect data from individuals who earned PhDs from U.S. institutions, from their graduate departments and programs, and from the PhD-granting institutions that house those programs.

Additional data sources include National Research Council doctoral program rankings and patent records from the U.S. Patent and Trademark Office. Descriptive summary tables and graphical representations are accompanied by multivariate econometric estimations to better distill and describe the correlates of STEM PhDs' behavior.

This report was peer reviewed consistent with Advocacy's data quality guidelines. More information on this process can be obtained by contacting the director of economic research by email at advocacy@sba.gov or by phone at (202) 205-6533.

Additional Information

This report is available on the Office of Advocacy's research webpage at <http://www.sba.gov/advocacy>. To be informed of Advocacy's future research, visit the office's email subscription webpage at <http://www.sba.gov/content/connect-us-0>. By subscribing to the Small Business Regulation & Research category, you can choose to receive email notices of new Advocacy research, news releases, regulatory communications, publications, or the latest issue of *The Small Business Advocate* newsletter.