NATIONAL WOMEN'S BUSINESS COUNCIL

ADVISORS TO THE PRESIDENT, CONGRESS, AND THE SBA

# An Illuminating Moment:

## Lighting a Pathway for Women STEM Entrepreneurs

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# 1. Executive Summary

We performed this study to understand the representation, participation and characteristics of "Women in STEM"[1], and the policies that impact their success in high-yield and high-growth industries. The box below defines these terms.

| Definitions |
| --- |
| **High-yield industries**<br>STEM industries |
| **STEM industries**<br>Science, technology, engineering, and mathematics industries |
| **High-growth industries**<br>STEM-adjacent industries |
| **STEM-adjacent industries**<br>Architecture Engineering Construction (AEC), infrastructure, supply chain, sustainability and other rapidly growing industries |
| **Women in STEM**<br>Women entrepreneurs in the high-yield and high-growth industries |

## 1-1 Literature Survey

First, we conducted a literature survey to review the existing research on women entrepreneurs' representation in STEM and STEM-adjacent industries, and their success in these industries. We studied how women's business representation in STEM compares to other industries, and researched industries that value the participation of women-owned businesses. We looked at the barriers faced by women-owned STEM businesses and the limitations on female leadership in STEM. We examined the negative practices, policies and programs that hinder women's success and potential policies and programs that can help female STEM entrepreneurs succeed. We reviewed the impact of the COVID-19 pandemic on women entrepreneurs in terms of their

[1] The definitions for these and other terms are also included in a Glossary in Chapter 9.

financial stability and entrepreneurship success. Finally, we researched the potential economic and social value of women's equal participation in STEM businesses, as part of this survey.

### 1-1-1 Women-owned Business Representation

We found that women are underrepresented in the STEM and STEM-adjacent fields. There are gaps in STEM earnings, funding, investment, intellectual property, patenting, and commercialization for female-owned businesses. As compared to high-yield industries, women are better represented in "female-typed" fields such as retail, healthcare, food, and other services. Women's business ownership in the retail, health, beauty, and fitness service sectors compares favorably to male ownership, and their participation in these sectors is increasing over time. It is possible that women's success in these sectors as defined by business ownership and participation is higher.

However, this is not a straightforward story. Women entrepreneurs have better credit risk profiles than male entrepreneurs in all sectors including STEM. There is no significant difference in leverage between female and male firms overall, and for bigger firms, male entrepreneurs are more leveraged. Female-led firms are more profitable than male firms after controlling for individual characteristics and other determinants of firm performance. Women businesses owners represent a high percentage of entrepreneurs offering innovative products, and women-owned startups generate more revenues. This implies that the story in terms of their representation in sectors is mixed.

### 1-1-2 Factors that Impact Women in STEM Representation

In the STEM fields, female entrepreneurs face a number of barriers which are factors mentioned in the literature, that lead to the low representation of Women in STEM. These include enrollment, training, positions, resources, licensing, funding, networking, and government assistance. Negative factors that hinder women STEM entrepreneurs' growth include:

- Discrimination in training, promotion and licensing support on the part of academic institutions,
- Risk-aversion by banks, and
- Biased business plan evaluations by investors.

We found positive factors from the literature that are conducive to women STEM entrepreneurs' growth such as:

- Gender-balanced learning environments,
- Industry specific associations that provide mentoring support,
- Financing by female venture capitalists or angel investors
- Non-traditional funding sources such as crowd source platforms and "pitch" competitions for veteran women, and
- Online connections with commercializing or licensing entities.

### 1-1-3 Impact of the Pandemic on Women Entrepreneurs

The COVID-19 pandemic impacted women entrepreneurs adversely in some ways. Women and minority-owned businesses were at the most risk, least likely to obtain government assistance, and less likely to survive the pandemic. Gender differences in credit availability and assets for women, especially women of color and lower-income women, lowered their capacity to withstand financial shocks.

However, there were also positive findings for female entrepreneurs during the pandemic. Early-stage women businesses reported that the pandemic provided them with new opportunities, and that they adopted new technologies. In 2020, women reached the highest monthly rate of new entrepreneurs in 24 years. The second round of government assistance provided through the Paycheck Protection Program (PPP) was delivered through community institutions that are more accessible than traditional sources to underserved populations. This could have helped women entrepreneurs obtain more government assistance in the second round, and could have assisted them in forming new businesses.

The above impacts on women during the pandemic are not STEM-specific. However, the gaps in traditional credit access, emergency government assistance, and childcare obligations could hinder the success of Women in STEM, including the success of demographically diverse female-owned businesses in STEM. The delivery of government access through community organizations and provision of temporary childcare resources during unanticipated shocks, and the closing of longstanding gaps in credit access, are necessary to avoid unfavorable entrepreneurial outcomes for these businesses. In addition, encouraging women to continue exploring new opportunities and technologies in face of economy-wide shocks will enhance their ability to withstand these events better in the future as entrepreneurs.

## 1-2 Data Analysis

Second, we conducted a demographic analysis of STEM businesses using United States (U.S.) Census Bureau (Census) data. We accessed the Annual Business Survey[i] (ABS) that provides information on economic and demographic characteristics of employer businesses and business owners by sex, ethnicity, race, and veteran status. For non-employer businesses that are businesses without employees, we collected data from the Non-employer Statistics by Demographics series[ii] (NES-D) that assigns demographic characteristics such as sex, ethnicity, race, veteran status, owner age, and U.S. citizenship to business owners.

The business owner demographic data that we obtained from the ABS and the NES-D was based on the 2017 North American Industry Classification System (NAICS). We identified the NAICS codes that fall under the STEM fields by using the high-yield industries definition mentioned in the glossary, top industries for STEM employment identified in a TechAlliance site[iii], previous studies on Research and Development (R&D) intensive industries, and the STEM workforce in the Defense Industrial Base.

We used these NAICS codes to gather 2019 ABS and NES-D data. We focused on 2019 data because the NES-D series has information only up to 2019, and we wanted to get a complete picture of ownership in the STEM fields, including for employer and non-employer businesses.

The 2019 ABS data only provides information up to three-digit NAICS codes, so, there were instances where the STEM NAICS we identified, for example NAICS 541, covered STEM industries such as "Scientific research and development services", but also STEM-adjacent industries such as "Architectural, engineering, and related services". The 2020 ABS data provides information on four-digit NAICS and offers greater insights into the granularity of the industry data at the four-digit level. So, we were able to analyze the 2020 data for employer business ownership in greater detail, with a breakdown between STEM and STEM-adjacent industries. However, we were unable to do the same for non-employer business ownership data because as was mentioned before, the NES-D data is available only through 2019.

### 1-2-1 Findings from the Data Analysis

We found the following from our data analysis of all STEM firms:

- Male STEM entrepreneurs outnumber female STEM entrepreneurs. There are 733,880 more male STEM entrepreneurs than female STEM entrepreneurs.
- There is greater STEM entrepreneurship gender disparity amongst employer firms versus nonemployer firms. The difference between the number of male-male-owned and female-owned STEM employer firms is close to 600,000 firms, whereas, the difference between the number of male-owned and female-owned STEM nonemployer firms is less than 200,000 firms.
- Female STEM firms as a percent of all STEM firms in a state, range from approximately 33% to 52% across states. In Utah female STEM firms are 32.8 percent of all STEM firms in the state, whereas in Maine they are 52% of all STEM firms.
- STEM businesses are concentrated in the Professional, scientific, and technical services sector, and male-owned firms in this sector outnumber female-owned firms overall, and in the employer and nonemployer categories. There are 841,469 more male-owned firms than female-owned firms in this sector. Total male-owned firms are approximately one and a half times female-owned firms for this category
- White male-owned firms dominate the STEM industry
- There are more female-owned firms than male-owned STEM firms for the Black or African American, and American Indian and Alaska Native racial groups
- STEM firms owned by Hispanic women outnumber the number of firms owned by Hispanic men
- The vast majority of STEM business owners within the U.S. are U.S. citizens
- The combined receipts of female-owned firms in certain sectors such as Data processing, hosting, and related services, Hospitals, and Electrical equipment, appliance and component manufacturing, are lower than the combined receipts

of male-owned firms. Female-owned firms have combined receipts of $1 billion to less than $5 billion for each of these sectors. The combined receipts of male-owned firms for each of these sectors are equal to or greater than $5 billion.

We found the following about STEM employer firms from our data analysis:

- Female-owned STEM employer firms as a percent of all STEM employer firms in a state range from 0.4% to 89% across states. In Alabama, female STEM employer firms are 0.4% of all STEM employer firms in the state. In Maine, they are 89% of all STEM employer firms.
- Within veteran employer STEM businesses, the number of male-owned businesses is more than 15 times the number of female-owned businesses. In 2019, women veterans were only approximately 10% of the veteran population[iv]. This large difference in male-owned versus female-owned veteran employer STEM businesses, could to some extent reflect the difference in the number of female versus male veterans.
- There is a greater number of employer firms in the STEM-adjacent fields as compared to the STEM fields. In 2020, there were 1,012,845 STEM-adjacent employer firms compared to 900,215 STEM employer firms.
- Female-owned employer firms are underrepresented in both the STEM and STEM-adjacent fields. In 2020, female-owned STEM employer firms were 27% of classifiable STEM employer firms. Female-owned STEM-adjacent employer firms were 11% of classifiable STEM-adjacent employer firms.

We found the following about STEM nonemployer firms from our analysis:

- Nonemployer women-owned STEM firms outnumber the male-owned non-employer firm owners in the under 25, 25-34, and 35-44 owner age groups. This is in light of the fact that, there are approximately two million more nonemployer women-owned STEM firms than employer women-owned STEM firms.
- The percent of female non-employer firms as a percent of all nonemployer firms in some southern states (Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas and Louisiana) is above average.

## 1-3 Policy Review and Solutions

Next, we conducted a review of existing policies and programs that impact female entrepreneurship in STEM. These include federal executive orders (EOs) and legislation, federal agency programs, state level initiatives, institutional and private support. We looked at how these policies and programs are resources for female STEM entrepreneurship. They act as resources in the following areas:

- Procurement and Contracting
- Education and Workforce Development
- Diverse Faculty Hiring, Promotion and Entrepreneurship
- Patenting, Licensing, and Commercialization
- Grant Funding

- Other Funding and Financing
- Networking and Mentoring
- Taxes and Payment Assistance

The existing policies and programs don't address the challenges that women STEM entrepreneurs face entirely. We developed policy solutions to further address these challenges based on our findings from the literature search, data analysis and policy review. Table 1-1 below summarizes these policy recommendations and groups them by the entities that can provide these solutions.

**Table 1-1: Women in STEM Policy Solutions by Entity**

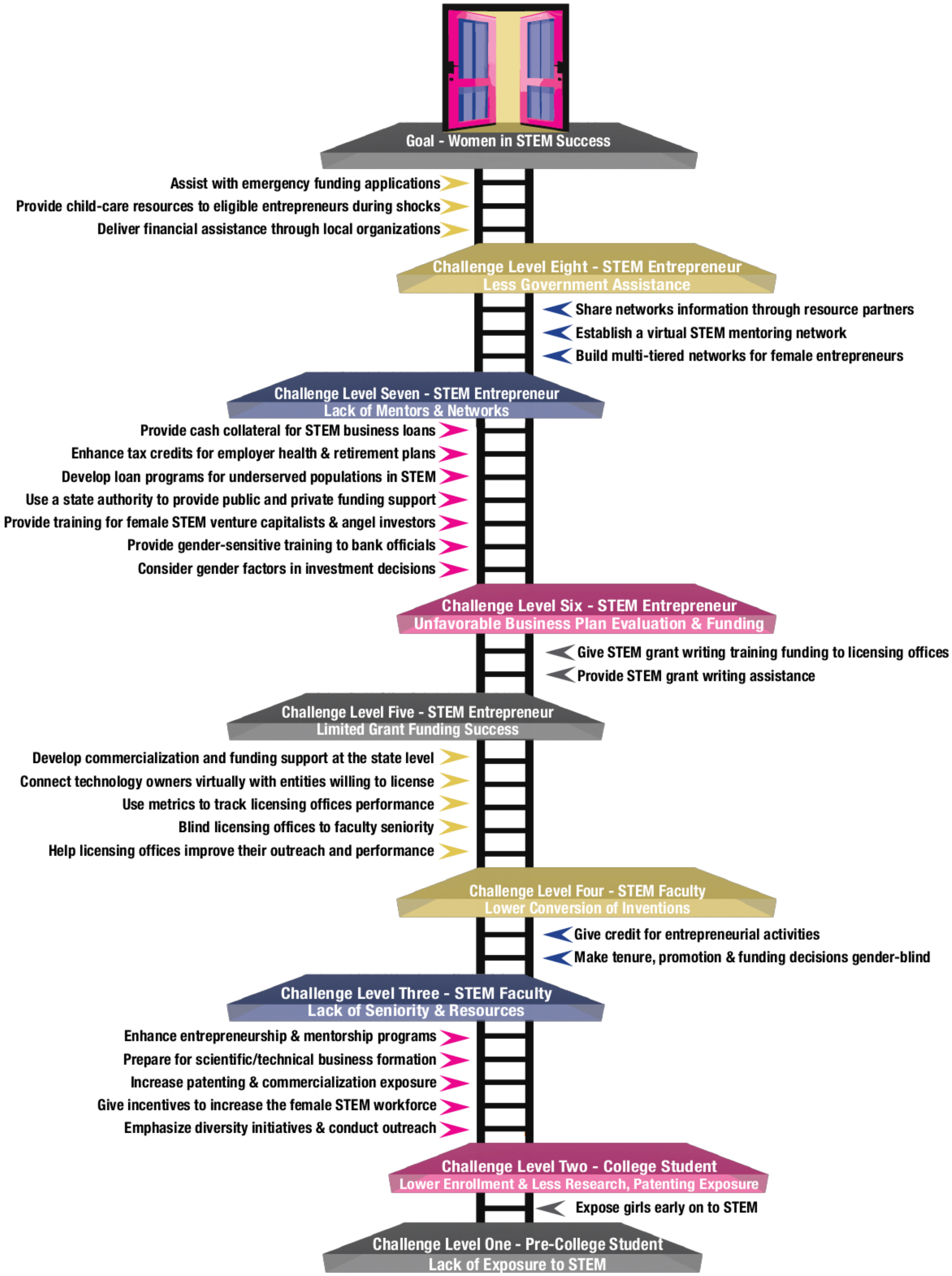
| Entities | Policy Solution/s |
|---|---|
| **Academic Institutions and Schools** | 1. Provide STEM exposure through K-12 female outreach.<br>2. Include commercialization and patenting in academic programs.<br>3. Enhance college entrepreneurship and mentorship programs with emphasis on STEM and diversity initiatives.<br>4. Teach to prepare for business formation in the Professional, scientific, and technical sector.<br>5. Use AI and other tools to foster "gender-blind" tenure, promotion, funding, and licensing decisions and give credit for entrepreneurship.<br>6. Help licensing offices improve their gender outreach, metrics, and performance. |
| **Lending Institutions** | 1. Provide gender-sensitive training on STEM-related business plan evaluation, and funding to bank officials.<br>2. Introduce gender-factored investing for STEM businesses that considers gender factors in investment decisions. |
| **Federal Government** | 1. Deliver emergency assistance to female STEM entrepreneurs through local organizations.<br>2. Provide temporary child care resources to eligible entrepreneurs for stability in emergencies.<br>3. Provide emergency funding training and application assistance to female STEM businesses. |
| **Federal Agencies** | 1. Develop loans with favorable terms for underserved populations in STEM.<br>2. Provide curriculum training to increase pool of potential women venture capitalists and angel investors that will fund STEM businesses.<br>3. Provide STEM grant writing assistance to female entrepreneurs. |

**Table 1-1 (Continued): Women in STEM Policy Solutions by Entity**

| Entities | Policy Solution/s |
|---|---|
| | 4. Give funding to university licensing offices to assist female faculty with grant writing.<br>5. Build multi-tiered networks for female STEM entrepreneurs.<br>6. Establish a virtual national mentoring network.<br>7. Inform female STEM entrepreneurs about these networks through agency resource partners.<br>8. Enhance IRS tax credits for employer retirement and health plans. |
| **State and Local Governments** | 1. Provide educational incentives to institutions to increase the female STEM workforce.<br>2. Offer cash collateral for STEM business loans, through a financing authority.<br>3. Provide sources of commercialization and funding support at the state level through an innovation authority.<br>4. Develop an online marketplace that connects new technology owners with entities willing to commercialize, license or distribute a technology. |

Figure 1-1 shown below, depicts the policy solutions in Table 1-1 in a different fashion. It breaks the solutions by the stage (from pre-college to college to business), of a female STEM entrepreneurs' journey to success. The figure shows the challenges at each stage and the policy solutions that will help the entrepreneurs go from one stage to another, and ultimately reach success. Each challenge level is shown in in the form of a platform, and each policy is shown as the rung of a ladder that brings these entrepreneurs' closer to the next challenge level, on the pathway to success.

**Figure 1-1: Women in STEM Pathway to Success**



## 1-4 Benefits of Increased Representation of Women in STEM

Our data analysis showed that male-owned STEM firms outnumbered female-owned STEM firms by more than 700,000 firms in 2019. Through our literature search, we found that if women entrepreneurs were to participate in high-yield industries at a comparable rate to their male counterparts, they would positively impact the national economy and increase family resiliency. They would bring about greater social innovation, because research shows that women's inventions frequently address social problems related to health, poverty and education. Saksena et al. (2022) in a U.S. Patent and Trademark Office (USPTO) study find that if f the gender disparity in patenting was removed, commercialized patents could increase by 24%, and gross domestic product (GDP) per capita could go up by 2.7%. Women entrepreneurs would also emphasize building better relationships with customers and vendors.

# 2. Introduction

The *Infrastructure Investment and Jobs Act* or *Bipartisan Infrastructure Law* (BIL) of 2021, includes billions of dollars for infrastructure expansion and clean energy expenditures. The *CHIPS and Science Act* of 2022 invests billions of dollars in semiconductor manufacturing and supply chain resilience. The *Inflation Reduction Act* (IRA) of 2022 includes tax credits and funding for clean energy projects. These expenditures are expected to result in a large number of manufacturing, clean energy and infrastructure projects that impact high-yield and high-growth industries. High-yield industries are also anticipated to grow quickly due to technological and commercial advancements. The Acts include funding goals for disadvantaged communities[2]. This should result in increased entrepreneurship opportunities for underserved businesses owned by minority, women, and veteran entrepreneurs.

The National Women's Business Council (NWBC) wants women to seize these opportunities, and be well positioned to take advantage of future STEM-related initiatives. In addition, NWBC recognizes that women have been "hidden figures' historically, and have not received full credit for their collaborative work in STEM. The Council would like them front and center in this major moment in STEM, in order to create an equitable future.

However, the Council finds that even though there is more business formation in high-yield and high-growth industries, female-owned businesses encounter many obstacles in starting and growing their businesses in these sectors. These barriers include limited access to entrepreneurial learning, resources, capital and networks, among others. Also, businesses in high-growth sectors, such as AEC do not receive support comparable to STEM industries. With the new initiatives for STEM and STEM-adjacent industries mentioned above, the aim of the Women in STEM research is to remove barriers and change the business landscape for firms in these fields.

NWBC aims to understand business owner characteristics in these industries, policies that support or hinder entrepreneurship in these fields, and the impact on female business owners. The Council's aim is that the outcomes of this research will help in understanding female representation in these industries as a whole and by demographic breakdown, and lead to policy recommendations for overcoming barriers and enhancing women business owners' ability to be successful.

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[2] Disadvantaged communities are either geographic or share a common condition. These could be individuals living in geographic proximity or be geographically dispersed but experience common conditions. These communities could experience environmental, climate, socio-economic or other burdens. https://www.energy.gov/justice/justice40-initiative#:~:text=Generally%2C%20a%20census%20tract%20that,will%20be%20marked%20as%20disadvantaged

In order to accomplish this, we performed a literature survey of previous research on these topics and a data analysis of the most recent data on female STEM firms. The literature review examines the representation of women entrepreneurs in these industries, the specific barriers that they face, the best practices to help them overcome these barriers and a few other areas of interest to NWBC. This helped us develop policy solutions for Women in STEM at every stage of their journey. In the data analysis, we analyzed the latest Census data on Women in STEM employer and nonemployer businesses to understand the gender gap in STEM overall, and by geography, sector, race, ethnicity, age, veteran, and citizenship status. As a result of the survey and analysis, we made policy inferences for enhancing the success of women in STEM-related activities.

The remainder of this report is organized as follows:

- Chapter 3 is the Literature Review
- Chapter 4 describes the Data Sets and Analysis
- Chapter 5 is a graphical presentation of Women in STEM Entrepreneurship Trends
- Chapter 6 is a Policy and Solutions Review
- Chapter 7 presents a Preliminary Methodology for the next, more detailed stage of the study
- Chapter 8 is our Conclusion
- Chapter 9 is a Glossary that defines specific terms used in this report
- Chapter 10 is a list of References
- Appendices are included at the end of the report

# 3. Literature Review

We conducted a literature survey to understand the following:

- The underrepresentation of women business owners in STEM,
- How the representation of female entrepreneurs compares across industries,
- The barriers women entrepreneurs face in the STEM fields,
- Negative and positive practices, policies, and programs that impact female entrepreneurship, and possible future policies to enhance entrepreneurship
- Improvements in the status of female STEM entrepreneurs over time.
- The impact of the COVID-19 pandemic on women entrepreneurs,
- The economic and social value female STEM entrepreneurs would bring to society, if they participated at the same rate as men in STEM.

We developed keywords to find literature related to the items above and searched for articles, books, reports, interviews, and news available online or in hardcopy. Some of the keywords we used were: STEM, technology (tech), women entrepreneurs, women-owned business, gender differences, leadership, funding, financing, credit, capital, gaps, barriers, research, commercialization, patents, licenses, entrepreneur demographics, infrastructure, sustainability, construction, policies, programs, partnerships, networks, mentors, pandemic impacts, etc.

Our search encompassed STEM-specific sources or sources with applications to STEM or STEM-adjacent industries. We also searched for and examined sources at the intersection of women-owned businesses and STEM. In total we initially selected and reviewed 34 sources. Subsequently, we searched for policy initiatives applicable to Women in STEM, and other articles referenced in the sources from our initial search. NWBC members also shared pertinent references with us. All of this broadened the selection of sources. Overall, we reviewed 111 sources. The results of our review are described below.

## 3-1 Gender Disparity in STEM

A decade's research from 2012 through 2022 on women's representation in STEM entrepreneurship has established that there is gender disparity in STEM, and that women are underrepresented in these industries. There have been changes in their status over this time period, but it is important to understand the historical context to see how their underrepresentation has persisted. Colyvas et al. (2012) find gender disparity in medical research. Blume-Kohout (2014) in a report developed for the Small Business Administration's (SBA) Office of Advocacy finds a gender gap in entrepreneurial behavior in STEM fields. Turrentine (2015) in an American Society For Engineering Education (ASEE) conference paper noted the gender gap in academic engineering commercialization. Anid et al. (2016) recognized female participation and the leadership gap in the tech industry. Liautaud (2026) documents the under-representation of women in the STEM fields in Europe and the U.S. Smith et al. (2017)

find differences in academic commercialization patterns by men and women. Williams-Baron et al. (2018) find women's underrepresentation in STEM industries.

More recent work finds few women entrepreneurs in the STEM industry (Kuschel et al. 2020). Pogessi et al. (2020) study academic and non-academic women STEM entrepreneurs in the U.S., United Kingdom (UK), and Germany. Academic women entrepreneurs when compared to non-academic women are motivated more by their research than by profit, are more risk-averse, and are more influenced by external forces to start a business. Overall, only a small number of women fund and run STEM firms and academic women have low rates of university entrepreneurship activities. Barron and Ruiz (2021) find gender differences in STEM studies enrollment and entrepreneurship. Kovaleva et al. (2023) study the underrepresentation of women in the STEM fields, with a focus on Finland. The authors conducted surveys of women interested in tech careers, and interviews with women entrepreneurs about entrepreneurship in the tech sector. Only one-third of the respondents felt that there were no meaningful differences between men and women becoming entrepreneurs.

In addition to gender disparity in the STEM fields, recent articles find gender differences in STEM-adjacent industries. Grabowski (2019) finds that women are a small percent of the construction industry. They make up only 9.1 percent of this industry. Davies (2020) examines the worldwide gender differences in the renewable energy sector. Davies mentions a finding from an International Renewable Energy Agency (IRENA) report related to shares of women in STEM, non-STEM and administrative jobs in renewable energy (IRENA 2019). Women's average share of jobs in the renewable energy sector is only 32%. The IRENA report findings are based on a global online gender survey conducted in 2018.

In addition to differences in representation, there is a gender gap in STEM earnings between male-owned and female-owned businesses. Pogessi et al. (2020) find that the STEM earnings gap is related to business size and motivation of women business owners. Female-owned businesses face higher financing costs than men which in turn affects the motivation of women business owners. Women businesses in general face higher costs due to reasons such as lack of social networks and investor attitudes (Pogessi et al. 2015). Such barriers lead to a lack of motivation which in turn lowers the growth of individual women-owned businesses. Anid et al. (2016) describe funding gaps for women owners. Kuschel et al. (2020) find investor bias in funding them.

Davies (2020) writes about gender differences in renewable sector funding. "Women solar energy entrepreneurs, interviewed by the IEA, faced the common challenge of convincing financial institutions to provide finance, as well as creating networks and partnerships for their businesses. In emerging economies, women are often less financially independent than men, on average being less likely to own or actively use a bank account. On the demand side, female entrepreneurs generally have less knowledge of available business opportunities, credit facilities and bank services. Women are often at a disadvantage by having less capital to invest or collateral against which to borrow.

On the supply side, an Asia Foundation study found that bank managers often lack confidence in business plans put forward by women, which they deem riskier by default."

There are entrepreneurship and patenting gaps for women-owned businesses. Colyvas et al. (2012) define technology transfer, as "the movement of academic discoveries to industry through patents and licenses for commercial development (Ding et al. 2006)." According to the authors "Technology transfer begins when faculty disclose a research finding or invention with commercial potential to the university's technology licensing office (Bercovitz and Feldman 2008). The invention may then move forward to patenting, a step that often depends on a company's expressed interest in licensing the invention. Revenue is realized when the license is signed and reaches different milestones, signaling commercial success." The authors analyze cross-sectional faculty data from three prominent U.S. university medical schools between 1991 and 1998, and look at faculty disclosure activity during this time period. They also track the success of these inventions until 2002. They find lesser rates of disclosing by women and that these gender effects are highly influenced by employment and resource characteristics.

Blume-Kohout (2014) finds that "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." She suggests "that the gender gap in STEM fields entrepreneurship may be partly attributable to differences in mentoring and commercial exposure female graduate students and postdocs receive." Turrentine (2015) finds a gender gap in academic commercialization due to a "leaky pipeline". Based on 2011 data, as women move up the pipeline from engineering Ph.D., to professor, to involvement in academic commercialization, their numbers decline from 23% to 12%.

Smith et al. (2017) mention the variety of activities under commercialization. "Extant literature has mainly focused on the formation of academic spin-off companies, pre-commercialisation activity such as academic publishing, and patents and licensing. Other forms include consultancy, commercial research collaborations, as well as media contents, e.g. educational videos and industrial scholarships." The authors attempt to characterize circumstances when women in STEM disciplines try and subsequently either fail or succeed in commercializing their research. They analyze several studies for the US from 2004 to 2012, and for Europe in 2012 and 2014. They find that women STEM academics have fewer patents and invention disclosures, launch fewer start-up companies and receive less angel and venture capital funding than do the male STEM academics who make the effort.

Williams-Baron et al. (2018) examine entrepreneurship in an Institute for Women's Policy Research (IWPR) publication. They use the 2014 and 2015 Annual Survey of Entrepreneurs (ASE), and the 1997, 2002, 2007, and 2012 releases of the Survey of

Business Owners (SBO), from the Census, to examine entrepreneurship. They document the growth rates of men and women entrepreneurship, and find women's under-representation in STEM industries.

Pogessi et al. (2020) find low rates of entrepreneurship activities by academic women. They find a gender gap among UK academics. "Abreu and Grinevich (2017) show that the gender gap among UK academics is still relevant, being equal to 6.1% for patenting, 6.8% for consultancy work, 3.9% for licensing and 3.2% for spinouts."

Woolley (2021) discusses National Science Foundation (NSF) data on education in STEM fields for men and women, since the entrepreneurs in both genders tend to have intensive backgrounds in the field and shows data arguing that doctoral degrees in the field between genders were almost equal as of 2015. She argues that academic spinoff firms in STEM fields are started after academics reach full professorship status, with women under-represented at this stage and over-represented in post-doctoral, part-time status, etc., and being promoted more slowly. She mentions discouragement of women patenting and developing intellectual property.

Muir et al. (2022) mention a USPTO finding about the women inventor rate, which is the share of women among all U.S. inventor-patentees. This rate grew from 12.1% in 2016 to 12.8% in 2019 which demonstrates lack of parity given that women make up nearly half of the workforce. The article also mentions an Institute for Women's Policy Research (IWPR) report. This report found that in 2019 only 21.9% of patents had at least one female inventor, which is only slightly higher than in 2016 and at this rate women will not reach patenting parity in the 21st century.

## 3-2 Women-owned Business Representation Comparison

The above articles establish fairly conclusively that women-owned businesses are underrepresented in the STEM fields. This leads to the following question - What is the level of representation of women business owners in high-yield industries when compared to all industries? Loscocco and Robinson (1991) wrote that women-owned businesses tend to concentrate in female-typed fields such as retail. Woolley (2021) cites statistics that women, relative to their founding 40% of all new business firms, found only 3% of the tech firms. These studies show that women business owners' representation in STEM related industries is lower than in other industries.

Liu and Parilla (2020) find that women-owned businesses are concentrated in food services and retail. Childers (2023) looks at women entrepreneurs in Utah and finds them in low-tech goods and services businesses, such as healthcare, event planning, food, and artisan goods. Guidant Financial (Guidant) performs surveys of small business owners every year. Guidant finds that the top industries for women-owned businesses are retail, health, and food and restaurant services. Among women-owned businesses surveyed over the last few years[v], retail went from 16% in 2020 to 22.32% in 2022 to 26% in 2023; health, beauty, and fitness services went from 13% in 2022 to

16.07% in 2022 to 17% in 2023: and food and restaurant went from 10% in 2020 to 11.61% in 2022 to 14% in 2023.

Also, the 2023 Guidant Financial Survey finds that "Women entrepreneurs are trailblazers in the business world, showing an especially significant influence and ownership in two trending industries — retail and health, beauty, and fitness services. In fact, women business owners are more than twice as likely to own businesses within these sectors compared to their male counterparts." Since women's business ownership in these sectors compares favorably to male ownership and their participation in these sectors is increasing over time, it is possible that women's success in these sectors in the form of ownership and participation is higher.

However, there is more to this story. Morazzoni and Sy (2022) study 4928 new US firms in different sectors, that started their operations in 2004 and were followed until 2011. They examine the credit risk profiles of female and male entrepreneurs and find that overall, female entrepreneurs are not rated riskier than male ones. Among successful loan applicants, the average Dunn and Bradstreet risk score of male applicants is 2.62, whereas for female entrepreneurs it is 2.44 (these scores are on a scale of 1 to 5, with a lower number representing lower risk). For rejected loan applications, the average score of male entrepreneurs is 3.22, while for female entrepreneurs it is 2.87. So, female-led firms have better credit risk profiles amongst both accepted and rejected loan applicants. A comparison of female and male entrepreneurs leverage (ratio between total business debt and fixed assets), shows that there is no statistically significant difference in leverage across genders for the full sample of firms. However, focusing on relatively bigger firms, male entrepreneurs are more leveraged. Based on standard profitability measures (ratio of profits and assets or profit margin measured by the ratio of profits and revenues) female-led firms are more profitable compared to male ones, after controlling for individual characteristics and other determinants of firm performance.

Elam et al. (2021/2022) in a Global Entrepreneurship Monitor (GEM) report find that women in the U.S. represent over 40% of entrepreneurs offering innovative products in local, national, and international markets. From the US Census, in 2018 women-owned businesses reported a combined total of $1.8 trillion in sales, shipments, receipts, or revenues with an annual payroll of $388.1 billion.[vi] Abouzahr, Krentz, Harthorne, and Taplett (2018) find that women-owned start-ups generate more revenue than male owned, which could imply higher quality business plans. So, while we can say that women are better represented in non-STEM sectors like retail and health, they have better credit risk profiles, are not highly leveraged and are more profitable in all sectors including STEM. They represent a high percentage of entrepreneurs offering innovative products, may have higher quality business plans and generate high sales. This implies that it is a mixed story.

## 3-3 Barriers to Women in STEM

There are several factors behind women-owned businesses low representation in the STEM fields. In order to understand these factors, it is important to first understand the cultural context in which women choose to own businesses. In this section we start with the research that looks at the cultural reasons behind women's decision to own businesses. Then we mention the research that explores the barriers specific to STEM. Next, we outline some of the studies that explore barriers in other industries, but have applications for the STEM or high-yield industries.

Gibson (2008) analyzes the differences in cultural values that impact the business ownership decision of women in different U.S. subcultures. The study uses the four cultural dimensions developed by Hofstede (1980, 2003, 2007) to assess the cultural values of White, non-Hispanic, Asian, Hispanic, and African American subcultures that influence their business ownership. The four dimensions are as follows:

- *Power distance*, that measures the degree to which a culture tolerates and/or accepts social inequalities
- *Individualism* is a measure of the degree to which a culture encourages individual achievement and ability over group achievement and relationships
- *Masculinity* measures the degree to which a culture encourages competitiveness, assertiveness, ambition, wealth accumulation, and gender role distinction
- *Uncertainty avoidance* is the degree to which a culture tolerates or deals with uncertainty and ambiguity.

Gibson applies Hofstede's values for the U.S. to White, non-Hispanic culture. For the African American culture, the Hofstede dimensions are the same as U.S. values for power distance and masculinity. For the dimensions of individualism and uncertainty avoidance, the cultural values are different and are assessed qualitatively. For the Hispanic culture, she applies the average Hofstede values for all Latin American countries. She analyzes Mexico separately. She divides Asian culture into smaller groups. The Hofstede values for China, South, Korea, and Japan are analyzed together and the Hofstede value for India is analyzed separately.

Gibson (2008) makes the following findings about these cultures. For the White, non-Hispanic culture, power distance is moderately low, individualism is high, masculinity is moderately high, and uncertainty avoidance is moderate. The combination of these values has encouraged White non-Hispanic women to engage in entrepreneurship, and become more competitive, assertive and risk tolerant over time. However, gender roles remain distinct leading to conflicts between work and family. So, to maintain work-life balance, many highly educated White non-Hispanic women choose business ownership, keep their business operations small and in the service sector. It is likely that for women in this subculture, business ownership is not for supporting the family financially, but for developing a flexible career.

The Hofstede values for the African American culture show that power distance is moderately low, individualism is high but slightly lower than for the U.S. as a whole, masculinity is moderately high, and uncertainty avoidance is somewhat higher but not significantly higher than for the U.S. This combination of moderately low power distance, high individualism, moderately high masculinity, and moderate uncertainty avoidance encourages African American women to own businesses. The Center for Women's Business Research (2007) finds that between 1997 and 2006, firms owned by African American women grew 147%. This shows that Black women are taking advantage of the opportunities available to them. Strong family and community ties among African Americans make it likely that Black women choose businesses where they can help other African American women take advantage of these opportunities. It is likely that Black women choose business ownership to balance work and family, and to contribute financially to the family.

For the Hispanic subculture, the Hofstede values for Latin American countries show that power distance is moderately high, individualism is significantly low, masculinity is moderate, and uncertainty avoidance is significantly high. For Mexico, power distance is significantly higher, individualism is somewhat higher, masculinity is significantly higher and uncertainty avoidance is significantly high. The combination of these values of high power distance, low individualism, moderate to high masculinity, and significantly high uncertainty avoidance, could impact business ownership by Hispanic women adversely. The family is of primary importance and gender roles are distinct in Hispanic culture, especially in Mexican culture. So, Hispanic women choose to own businesses largely to contribute financially to the family and to balance work and family. Hispanic men perceive no conflict between work and family whereas Hispanic women find specific examples of this conflict. So, cultural values regarding gender roles increases the potential for conflict in Hispanic women.

The Hofstede values for the Asian countries of China, Japan, and South Korea show high power distance with higher values for China. Individualism in China and South Korea is significantly low, whereas in Japan it is more moderate. Japan has high masculinity, China has moderately high masculinity and South Korea has moderately low masculinity. Japan and South Korea have high uncertainty avoidance, whereas China has relatively low uncertainty avoidance. Given the moderately high power distance, low individualism, moderate masculinity (except for Japan), and high uncertainty avoidance (except for China), Far East Asian culture is similar to Hispanic culture. This culture also emphasizes strong extended family ties and relationships, honesty, loyalty, work ethic, and education. Hence, Far East Asian women are likely to be well-educated. They are likely to choose business ownership to support their families and to balance work and family. The high uncertainty avoidance, and the strong sense of responsibility and honor in these cultures, leads to fear of failure as a significant motivating factor for women business owners. In a 2006 report, SBA's Office of Advocacy found that between 1997-2000, Asian-American women-owned businesses had a 77% survival rate, the highest of all ethnic groups.

For India, that Gibson analyzed separately, power distance is high, individualism is moderate, masculinity is moderate, and uncertainty avoidance is moderately low. This combination of values suggests that Indian women choose business ownership to balance work and family. The moderate levels of individualism and masculinity indicate that business ownership is either to financially support the family, achieve personal goals, or both. The moderately low uncertainty avoidance shows a tolerance for risks and a reason for business ownership by Indian women.

Gibson's study of the differences in cultural values that impact women's business ownership decision implies that "despite cultural differences, women are likely to own businesses to balance work and family obligations." However, there are qualifications to the cultural analysis done by Gibson. The study was done 15 years ago, no data using surveys or other means was collected, and it largely interpretative. So, while it provides some understanding of why women in different subcultures in the U.S. become business owners, more research using current data on women-owned businesses from different U.S. subcultures needs to be done, to understand the present cultural landscape.

Colyvas et al. (2012) mention the lack of secure faculty positions, and less monetary, research and licensing support for women in academia. This acts as barrier for academic women because it adversely impacts the rates of invention disclosure by academic women. Turrentine (2015) points towards resource discrimination, adverse organizational climate, and sexual harassment in academia as restricting women's success in STEM. Anid et al. (2016) point towards lack of training, funding, and networks for women entrepreneurs in tech, especially Black women, who are held back because of the lack of Black women venture capitalists.

Williams-Baron et al. (2018) in the IWPR publication that utilizes 2014 and 2015 ASE data and 1997, 2002, 2007, and 2012 SBO data, mention factors that contribute to women's lower likelihood of holding intellectual property. This is a barrier for women STEM firms because intellectual property and revenue are highly correlated. "Women-owned firms with patents pending hold shares of sales and receipts that are 13 times higher than their share of the population of business owners…" The IWPR publication explores the relationship between female business representation and intellectual property. "To explore the relationship between women's representation as business owners within industries and the share of firms in each industry holding intellectual property, IWPR calculated the correlation coefficient between these two variables. The analysis yielded a correlation coefficient of -0.27, which indicates a statistically significant negative but weak relationship between the two variables. This suggests that factors in addition to women's under-representation in STEM are likely to be contributing to women's lower likelihood of holding intellectual property."

Williams-Baron et. al find that factors that deter success for women entrepreneurs in the STEM fields are because of the nature of the work: the higher the risk of the work, the higher the need for funding to obtain intellectual property and patents that are necessary for success, and the higher the concentration of men in the field, leading to reduced networking opportunities and increased discrimination for women entrepreneurs.

Davies (2020) is focused on the renewable energy sector, but highlights gender differences and barriers in STEM. Davies identifies key barriers from the IRENA (2019) report that is based on IRENA's 2018 online global survey. Davies mentions that there are barriers related to STEM hiring, mentoring, networking, and working conditions. "There is an enduring perception that women are less suited to technical fields. In emerging economies, notably in rural contexts, there is little or no technical training for women or it is often discouraged altogether. In general, fewer women than men will choose to go into STEM fields, though providing girls with better information on career opportunities and female role models can help to increase numbers. This may also translate into gender biased hiring practices or misperceptions that women are ill suited to roles, for instance seeing physical strength as a barrier to installation work. The IRENA report also lists lack of mentoring opportunities and access to informal networks, unequal pay, and inflexible working hours, as some of the barriers to career progression." Davies also mentions that women have less knowledge about business opportunities, credit facilities and bank services. They have less access to credit and capital due to risk aversion by banks.

Kuschel et al. (2020) find that underrepresentation in STEM educational programs, employment, and leadership positions are barriers to women STEM entrepreneurs. The authors emphasize the factors deterring entry into STEM fields, arguing that "Traditionally, women have been underrepresented in STEM educational programs as well as in STEM employment and leadership positions (Mavriplis et al. 2010). This may be one reason why few women entrepreneurs are present in STEM industries (Coleman and Robb 2016). In addition to the low levels of women earning STEM degrees, it seems that women are either opting out or pushed out in various stages of their career development. This is illustrated with the metaphor of the 'leaky pipeline', pointing to the fact that the number of women decreases as career levels advance (Blickenstaff 2005), both in education and in the labor market."

Similarly, Pogessi et al. (2020) find that financing and networking barriers for Women in STEM, along with family obligations and behavioral issues restrict women's business growth. Kovaleva et al. (2023) find the lack of social acceptance and role models to be major factors holding back women entrepreneurs in STEM.

In addition to these specific barriers in STEM industries, other studies find factors that contribute to women's low entrepreneurial representation in STEM-adjacent fields and in business in general. Verwey (2007) studies the political and cultural environments that inhibit women entrepreneurs in construction. Women enter the construction industry due to positive motives, where most cite the love for construction and the challenges, the desire of success, independence, and financial security as motivating factors. However, systematic barriers such as limited access to education, funding resources, and gender discrimination due to cultural beliefs fuels a lack of further motivation. Verwey also points out the gaps in communication and education that arise due to the lack of access to mentorship, and other networks for women.

Aldrich (2014) finds limited opportunities for women entrepreneurs to move into leadership roles in new businesses started with men. If they find a business with their husbands, the opportunities for leadership are even more limited. The continuation of domestic gender roles into entrepreneurial partnerships restricts women's success in business. Mr. Aldrich and his graduate student Tiantian Yang, conducted this study at the University of North Carolina. They studied entrepreneurial teams composed of both men and women. Their representative sample included 880 entrepreneurs, on 362 mixed-sex startup teams. Most of the teams were married couples, and the researchers found that the assumptions of domestic roles characteristic of gender stereotypes carry over into the entrepreneurial partnerships. The stereotypes deprive women of the power to lead the teams in general. "Our explanation for more pronounced gender inequality in spousal teams is that when husband and wife work together, they carry with them the cultural expectations for the male breadwinner and the female homemaker roles into the business setting," says Yang. "And the more children there are at home, the more it amplifies the expectation that the woman will also take on the role of leader of the household." They specifically recommend templates and formal operating agreements at the start of these businesses, to reduce this inequality.

Grabowski (2019) finds that a change in women's leadership roles due to adverse comments and questions in the construction sector can limit their success. "As a woman working in a male-dominated field, you will encounter comments and questions that will grate on your nerves. The most important thing is to not allow these comments to change who we are as leaders and colleagues and to ultimately alter what we are trying to accomplish.

Davies (2020) finds that women are underrepresented in financial leadership roles and this leads to lack of access to credit for women entrepreneurs in the renewable energy sector.

To conclude, in spite of cultural differences women start businesses to balance work and family life. They encounter a number of barriers in their entrepreneurship journey. For academic STEM women entrepreneurs the lack of employment security and resources impact their rate of invention disclosure. An adverse organizational climate and sexual harassment in academia further impacts their success. There are other factors that impact all female STEM businesses. Reduced funding and networking opportunities for women businesses reduce their chances to hold intellectual property, which leads to lower revenues. In the STEM-adjacent fields, women face limited access to communication, education, funding, and gender discrimination due to cultural beliefs. This leads to less motivation and limits their success. Finally, women entrepreneurs don't find many leadership opportunities when they start businesses with male entrepreneurs. They also face challenges in existing leadership roles in the form of comments and questions. The Council wants women entrepreneurs to take advantage of

STEM and STEM-adjacent initiatives and envisions an equitable future for these businesses. In order to realize these goals, we need to find policy solutions that address these barriers and provide a pathway for the success of Women in STEM.

## 3-4 Negative Policies, Practices, and Programs

There are specific practices, policies, and programs that negatively impact women's entrepreneurship in the STEM fields. These exist both in the academic and non-academic realms.

### 3-4-1 Lower Conversion of Disclosures for Women Entrepreneurs

Colyvas et al. (2012) find that academic institutions employment and resource allocation policies do not favor women. Women faculty's likelihood of reporting inventions to university licensing offices is similar to men, but they end up reporting less due to their lack of seniority and security in faculty positions and less monetary support for research efforts. Entrepreneurial opportunities are more available for those with the status and resources to engage in scientific advancement and commercial development. Even when they report inventions to licensing offices, their lesser rank and resources compared to male faculty influence the ultimate outcome. The likelihood of their disclosures being converted to patents and licenses by these offices is lower than their male counterparts. Smith et al. (2017) see hierarchical academic structures and lack of women on advisory boards as impacting their commercialization success.

Muir et al. (2022) find that women faced discrimination during the invention disclosure and patenting processes. The technology transfer offices (TTOs) had a propensity to work with established faculty, that were Caucasian males. They were left out of patenting and licensing decisions and were not considered similarly to their male counterparts when they were the sole inventors. Future policies could help rectify this situation by first reforming faculty tenure and promotion decisions and second, by helping TTOs aim for more inclusive innovation.

### 3-4-2 Less Funding for Women Entrepreneurs

Banks and other investors funding practices also limit the success of women STEM entrepreneurs. Kuschel et al. (2020) find that investors ask different questions to male and female entrepreneurs that impact funding outcomes. "Although both male and female entrepreneurs deliver pitches in the lexicon of promotion, investors tend to ask male entrepreneurs promotion questions (such as, how do you intend to acquire customers? What does your revenue forecast look like?), and ask female entrepreneurs prevention questions (such as, what does customer retention look like? Are you operating at breakeven?)." Some investors such as public funds, venture capitalists and angel investors might consider the possibility of pregnancy for the leader of a women-led startup, which could lower the leaders' priority of the startup temporarily (Kuschel and Lepley, 2016). This might lead them to not fund female startups.

Davies (2020) describes how the banking sector evaluates women entrepreneurs' business plans differently from men entrepreneurs, with female entrepreneurs' plans considered to be riskier. Davies refers to an Asia Foundation study (Muti and Warren, 2017) that looks at the difficulty women face in getting bank loans to find or grow a business. The study analyzed access to finance for women in Bangladesh. It interviewed 300 women entrepreneurs from six districts and bank managers. "Interviews with bank managers reveal that many banks are under the impression that despite the business being licensed to a woman, it is actually being operated by a male family member. They also believe the business initiatives explored by women entrepreneurs are less diversified with a limited number of clientele, increasing the risk of default (this is not evidence-based). Because of these constraints, the study found women do not find the service delivery environment easily accessible: nearly 19 percent of women entrepreneurs surveyed have not opened a bank account, and only 48 percent have applied for a loan from a commercial bank."

Muir et al. (2022) mention an analysis of National Institutes of Health (NIH) funding over a ten-year period. This analysis found that "female applicants across all grant types apply for fewer grants, ask for less money, and received an average of $40,000 less on first-time research awards compared to their male counterparts"(Oliveira et al., 2019 The study also notes the decline in venture funding for women-led startups from 2.8% in 2019 to 2.3% in 2020. This has happened even though the number of women-owned firms has grown at five times the national average. Changes in the lending policies of institutions to ensure equitable evaluation of funding requests, and curriculum development for more female venture capitalists and angel investors could help ameliorate this situation.

### 3-4-3 Women Entrepreneurs' Choices

Muir et al. (2022) find that women's participation in inventions and commercialization is limited because they spend more time on housework than their male counterparts. They also lack knowledge about intellectual property, commercialization, and entrepreneurship. Institutional training in these areas is not marketed in a fashion to engage them, and is not offered at a time and place of their convenience. By offering more of these training programs and increasing their access to female faculty, institutions could increase female participation in inventions and commercialization activities.

Muir et al (2022) survey results show that fewer female respondents were aware of or participated in entrepreneurial training programs. This could be because of their institutions not offering these training programs, or their lack of awareness of these programs, or unconscious biases that lead them to not self-associate as entrepreneurs and therefore not engage with these programs. The article notes that these biases could exist because women tend to be more risk-averse than men, and entrepreneurship is seen as a high-risk activity. Women are also motivated to see their research applied to help people, and entrepreneurial endeavors are seen as “going to the dark side” or “selling your soul”.

In regards to funding, as noted above, female applicants apply for less grant funding (Oliveira et al. 2019). In addition, their grant submission rates as entry-level faculty are significantly lower. Women apply for a very small percentage (13% to 15%) of Phase I Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) awards (NWBC 2020). More research and analysis could clarify the reasons for why female entrepreneurs apply for less funding. However, the provision of grant writing assistance could help close these gaps.

### 3-4-4 Government Assistance for Women Entrepreneurs

In terms of government assistance programs, women-owned businesses tend to receive fewer resources than male-owned businesses. Liu and Parilla (2020) find that less assistance was provided to minority and women-owned businesses from pandemic relief programs. Wiersch and Misera (2021) find that women-owned businesses were less likely to receive emergency funding during COVID-19. This is explored in greater detail in the Section 3-7. However, policymakers could address this gap in assistance by providing emergency funding application assistance.

### 3-4-5 Policy Implications of Women’s Entrepreneurship Research

Foss et al. (2019) explored the policy implications of empirical research on women’s entrepreneurship over 30 years. They find that policy implications in this research are “underplayed”, and when they are included, the emphasis is on women and the actors around them, rather than the whole entrepreneurial ecosystem. They mention the nine components of the entrepreneurial ecosystem as suggested by Mazzarol (2014). These include the following:

- *Government Policy* which is the first and most important component of the ecosystem
- *Regulatory framework and infrastructure* that is created and influenced by policy
- *Funding and financing* that is the availability of financial capital
- *Culture* that refers to societal norms
- *Mentors, advisers, and support systems* to help entrepreneurs
- *Universities as catalysts* encouraging entrepreneurial development
- *Education and training programs* for entrepreneurs and established firms
- *Human capital and workforce element* to develop a skilled workforce
- *Local and global markets* to provide growing businesses with access to large domestic and international markets

Foss et al. explain that these nine components can be further classified as “hard” ecosystem components (funding and finance and universities); “soft” ecosystem components (education and training, mentors and advisors, human capital and workforce, access to markets); "compliance" ecosystem components (policy, regulatory frameworks); and the "culture" ecosystem component.

Foss et al. analyzed 165 articles over 30 years and found that 117 included policy implications. Of these 117 articles, 75 had explicit policy implications whereas 42 had implicit policy implications. They also examined the remaining 48 non-policy papers to see if they had implications to Mazzarol's seven ecosystem elements outside of the policy and regulatory components. Their most important finding was that a third (42 out of 117) did not address policy implications explicitly. So, the article finds that the policy component of the entrepreneurial ecosystem is "underplayed".

Their second finding is that policy implications (part of the "compliance" component) do not address specific targets such as, government functions or legislative changes. The third finding is that for the "soft" ecosystem components of education and training, recommendations target women entrepreneurs, and other actors close to them such as educators, governments, bankers. This can highlight women's perceived deficits and support the argument that "women need to be fixed". A fourth finding is that researchers writing about policy implications do not address contextual components such as legislation, regulation, taxes or welfare. They concentrate on training for the women and the actors mentioned and don't touch on other areas of policy within the ecosystem. Another finding was that most of the recommendation were related to overcoming discrimination or equal access to resources, and the ultimate aim was higher economic growth.

The findings have important implications for the entire entrepreneurial ecosystem. First, Foss et al. reinforce the view that policy is the most important ecosystem component. Second, they show that policy recommendations will not be effective without addressing other interconnected ecosystem elements. Third, policymakers need to adopt a holistic approach and develop an ecosystem strategy that recognizes the interdependencies between the different actors in the "hard", "soft", "compliance", and "culture" components of the entrepreneurial ecosystem. Policy solutions for women STEM entrepreneurs need to take account of these findings, avoid the policymaking biases mentioned above, and address how multiple layers of the entrepreneurial ecosystem within the STEM industry operate.

## 3-5 Positive Policies, Practices, and Programs

There are both existing and potential practices, policies, and programs that can positively impact women entrepreneurs in STEM. Some of these include existing female behavioral practices by women entrepreneurs and their families, yet others are potential policies and programs by investors, government agencies, and private entities.

### 3-5-1 Positive Practices by Women Entrepreneurs

Colyvas et al. (2012) find that women medical school faculty members have the same likelihood of reporting inventions as their male counterparts. Smith et al. (2017) mention that patenting performance is often connected to publishing activity. Women are found to be less productive on this measure because they publish less than their male counterparts. However, even though women publish less, their publications are more impactful than men over career years, and have consistently higher citations than the publications by men (Long 1992). Policies that support women in their publications and inventions will increase the likelihood of female STEM entrepreneurship.

Gibson (2008) looks at cultural differences across U.S. subcultures and as mentioned above finds that women are likely to own businesses to balance work and family obligations across cultures. She also notes that an empirical study that finds that innovativeness does not appear to vary across cultures, but cultural differences from the U.S. appear to impact the risk-propensity, internal controls and energy levels of entrepreneurs (Thomas and Mueller 2000). This implies that as cultural diffusion occurs in women of later generations of immigrants, their propensity to take advantage of educational and career opportunities and to take risks will increase, leading to the creation of more businesses. Policymakers could encourage this cultural diffusion by conducting more culturally sensitive outreach to immigrant women.

### 3-5-2 Positive Funding Practices for Women Entrepreneurs

Anid et al. (2016) find that funding staff that understand investments and the private sector are beneficial to "Women in Tech'. In addition, women financing women has a positive impact on resources flowing to women. Maury and Stutsman (2019) find that non-traditional funding sources, such as, group-funding or crowd-source platforms, business plan competitions and community funding initiatives are beneficial for women-owned veteran STEM businesses.

Stengel (2020) finds that government programs such as the SBIR and STTR programs, provide a five times higher chance of funding for STEM female founders, and this funding is provided without giving up equity or the need to pay back the funds. Joshi et al. (2018) find that there is a positive association between the diversity of the workforce at agencies and the likelihood of women technology entrepreneurs obtaining Phase II SBIR/STTR awards. They performed an empirical analysis of 52,126 Phase I SBIR/STTR awards by 11 federal agencies between 2001 to 2011. They find that agency workforce diversity and Phase II funding for Phase I grantees is positively related. However, minority and women technology entrepreneurs are less likely to receive these awards, compared to their non-minority and male counterparts. Federal agencies that value workforce ethnic diversity or use gender homophily, impact the likelihood of women technology entrepreneurs obtaining Phase II funding positively.

There are other articles that are not specifically devoted towards STEM funding but describe funding practices that are beneficial to women entrepreneurs. Garaizar (2016) finds that providing educational programs, networks, training, and events for women angel investors that in turn invest in women-owned businesses is a positive practice. Davies (2020) finds that the Organization for Economic Co-operation and Development (OECD) Clean Energy Finance and Investment Mobilisation (CEFIM) program considers gender in the broader social, legal, and institutional context, identifies policy gaps and creates a positive environment for renewable energy & energy efficiency investment. The consideration of gender in investment decisions by lending institutions could help close the gaps in investing.

### 3-5-3 Positive Networking Practices for Women Entrepreneurs

Verwey (2007) finds that construction associations such as the National Association of Women in Construction (NAWIC) in the U.S. and South Africa Women in Construction (SAWIC) in South Africa (SA) provide important mentoring and networking support for women entrepreneurs. Maury and Stutsman (2019) find that networking in a variety of venues such as industry-specific conferences, customer-focused sessions, women-in-business programs and small business development center (SBDC) events is beneficial to women-owned veteran STEM businesses. Ehdaie and Spring (2022) describe the Department of State's Providing Opportunities for Women's Economic Rise (POWER) program that reduces entry barriers in the digital economy for women, and helps them develop professional networks and partnerships. These can serve as an example for other entities and help them develop networking programs.

### 3-5-4 Mentors and Role Models for Women Entrepreneurs

Liautaud (2016) emphasizes how mentoring programs allow women to learn directly from success stories and personal interactions. Kleschenko (2020) is part of a series of interviews launched by WIPO GREEN in 2020, to ask female innovators and green entrepreneurs about their inventions and business development, and their experiences in the technology and innovation arena. These online interviews introduce important role models to women entrepreneurs interested in the green space. The 2023 article by Kovaleva et al. states the importance of role models and support for entry-level opportunities as important factors for women's success in tech. Muir et al. (2022) survey results show the significant interest in role models and mentors on the part of female faculty and specific interest in mentors of the same gender and ethnicity. Colleges and universities could increase their mentorship programs and make them more diverse.

### 3-5-5 Positive Targeted Programs for Women Entrepreneurs

Other programs that have a positive impact on Women in STEM include targeted programs such as, the Veteran Women Igniting the Spirit of Entrepreneurship (V-WISE) program (Maury and Stutsman 2019). This program provides entrepreneurship and small business management training to women veteran businesses. Programs like WIPO GREEN that connect new technology owners with commercializing, licensing or distributing entities online also have a positive impact. Elda and Ruiz (2021) talk about entrepreneurial learning and self-efficacy taught in a supportive and gender-balance environment leading to positive outcomes for women student STEM entrepreneurs.

The Women in Apprenticeship and Nontraditional Occupations (WANTO)[vii] grant program by the Woman's Bureau in the Employment and Training Administration (ETA) at the Department of Labor (DOL), helps women enter and lead in industries where they are underrepresented. It helps community-based organizations recruit, train, and retain more women in industries such as manufacturing, infrastructure, cybersecurity, and healthcare.

Another initiative that is an Act rather than a program and targets underrepresented populations is the *CHIPS and Science Act*. This Act gives agencies and institutions "the mission and the tools to combat sexual and gender-based harassment in the sciences, a demonstrated barrier to participation in STEM for too many Americans". The Act is structured to support services that bolster women's participation in STEM industries.

## 3-6 Improvements in the Status of Women in STEM

There are studies that show some improvements in the status of women entrepreneurs in STEM. Maury and Stutsman (2019) find that female veterans are two times as likely to pursue STEM-related occupations than non-veteran women. The study notes women veterans' success, in opening and growing STEM businesses.

The number of science and engineering degrees earned by women over the ten-year time period 2011 to 2021, jumped 63% for associate degrees, 34% for bachelor's degrees, 45% for master's degrees, and 18% for doctorate degrees. The STEM workforce gradually diversified over the same time period, with greater representation of women and underrepresented minorities. From 2011 to 2021, the number of women in the STEM workforce increased 31%, which is 16% more than the male growth rate during the same time period. In 2021, women make up about 35% of the STEM labor force which is a three-percentage point increase from 2011 (NSF 2023). Given the greater representation in the STEM workforce, it is possible that women's entrepreneurial representation in STEM is positively impacted over time.

Saksena et al. (2022) in the USPTO study find that the number of counties with women inventor-patentees grew by 32%, from 1990 through 2019. There was substantial growth in female inventor-patentees between 1990 and 2019 by technology hub (where a technology hub is a county with the most women inventor-patentees in a technology field). For example, Monroe, New York (NY), the technology hub for physics, saw a growth of 4,288% in the number of female inventor-patentees in this time period. Santa Clara, California (CA), the technology hub for electricity, saw a growth of 7,054% in the number of female inventor-patentees in the same time period.

Elam et al. (2021/2022) GEM report finds that North American women are 78% more likely than men to begin a business within information, computers, and technology (ICT) related fields (8.9% for women compared to 5.0% for men in ICT). It is likely that this is due to increases in STEM education targeted towards women.

## 3-7 Impact of the COVID-19 Pandemic

Next, we reviewed articles that studied the positive and negative impacts of the COVID-19 pandemic on women entrepreneurs. We wanted to know how a shock such as the pandemic has the potential to impact the already underrepresented status of Women in

STEM in general, as well as the demographically diverse STEM women entrepreneurs in particular. We also investigated if the pandemic presented new opportunities for female STEM entrepreneurs.

### 3-7-1 Negative Impacts of the Pandemic on Women Entrepreneurs

Fallon (2020) shows that women business owners were behind male-owned businesses in funding, confidence, and market saturation, how the pandemic exacerbated these challenges, and why more government assistance was needed for the survival of these businesses. She outlines specific steps for women-owned businesses to make it through the pandemic. These findings are applicable to Women in STEM, since they face the same challenges and more government assistance is needed for these businesses to survive pandemics or other shocks in the future.

Liu and Parilla (2020) in a Brookings study reviewed two small business crises in the U.S. The first was the immediate impact on small businesses due to the pandemic. The second crisis they identified was the long-standing structural racial and gender disparities in business ownership. They showed how these two (2) crises intersected and were "mutually reinforcing". They examined the Census 2016 Annual Survey of Entrepreneurs (ASE) and American Community Survey (ACS) data to calculate the "disparity ratio" – "the ratio of business ownership share to population share" and the sales revenues of minority- and women-owned business enterprises (MWBEs).

Liu and Parilla find that the disparity ratio stood at 50% for people of color, and 65% for women. They also find that MWBEs have smaller sales revenues. For example, for firms between ten (10) to 249 employees, they find that the gross receipts of Latino- or Hispanic-owned businesses were 58.2% of their non-Latino or Hispanic-owned counterparts, those of female-owned businesses were 57% of male-owned businesses, Black-owned businesses' revenues were at 46.4% of White-owned businesses and Asian American-owned businesses' gross receipts stood at 53.2% of White-owned firms. For businesses that had greater than 250 employees, Black businesses' gross receipts were 21% of White-owned firms.

They stipulated that the COVID-19 pandemic had the potential to disproportionately impact MWBEs, because the pandemic was putting the food services, retail, and accommodation industries at immediate risk and MWBEs were most represented in industries at immediate risk. In these immediate-risk industries 39% were female-owned or equally female- and male-owned, and 20% were Asian American or Black-owned.

Liu and Parilla (2020) mention that the COVID-19 small business relief program – the Paycheck Protection Program (PPP) was delivered through mainstream financial institutions that might be "less relevant to underbanked and unbanked MWBEs". They cited statistics based on 2018 data from the Small Business Credit Survey (SBCS) that showed that "Large banks approve about 60% of loans sought by white small business owners, 50% of loans sought by Latino or Hispanic small business owners, and 29% of loans sought by Black small business owners". Instead, they argue that small business relief funds and technical assistance provided at the local level through local lenders, community-based organizations, and entrepreneurs can better help MWBEs take advantage of the national stimulus. This study is not STEM-specific, but the funding challenges for MWBEs in this study are similar to the funding barriers faced by Women in STEM, and the local assistance solutions offered by the study may be applicable also to female-owned STEM businesses including demographically diverse women STEM businesses.

Fernandez and Tranfaglia (2021) use data from the Federal Reserve's (Fed's) 2020 Survey of Household Economics and Decisionmaking (SHED) and find that women were more likely to be in credit card debt, applied for credit at lesser rates than men, and were denied or approved for less credit than they applied for. These gender differences were noticeably unchanged from 2019, in spite of the economic stimulus, benefits, and assistance provided during the COVID-19 pandemic. They find that credit access varies across gender, race, ethnicity, and other factors.

The gender differences in credit availability were more pronounced for non-White and lower-income women, and women living with their children in 2020. Credit card ownership was higher for individuals who were White, non-Hispanic, and had higher family incomes. Even among these individuals with a credit card, women were more likely to have credit card debt in 2020. Non-White adults were more likely to carry unpaid credit card debt. The difference between non-White men and women who carry debt was nearly one and a half times the difference between White, non-Hispanic men and women. This could lead to compounding effects for the non-White female sector of the population

Credit card debt was also strongly correlated with the presence of children. Survey respondents with children carried more credit card debt, and this was more pronounced for female respondents. There was a difference in the success rates of credit applications between men and women in 2020. Women with at least one child were more likely to be denied credit than women with no children. Women with children were denied or approved for less credit, compared to men with children. Women were also more likely not to submit a credit application.

Kent and Addo (2022) find that women are more likely to have student debt than men. Young Black women are the most likely to carry student loan debt. Men are able to pay their student loan debts at a faster rate than women and people of color due to higher incomes.

These differences in debt and credit availability could lead women to use credit products with higher long-term fees. It could also impact their ability to use more complex financial products and accumulate wealth in the future. Again, this article is not STEM-specific, but points to the lack of credit availability and the capacity to accumulate wealth for women, which possibly impacts their entry and expansion in STEM related entrepreneurship. In addition, understanding how the gender gaps in credit availability and behavior change with race, ethnicity, parental status, and income is useful for future tailoring of credit related policies for different demographic groups.

Wiersch and Misera (2021) use the Fed's 2020 SBCS to show that women-owned businesses, confronted more financial and operational challenges during the pandemic than men-owned businesses and were less likely to receive financing. Black women-owned businesses suffered worst outcomes when applying for traditional financing and emergency funding. These differences between male- and female-owned businesses focus on employer businesses, but were also observed for nonemployer firms.

Women-owned businesses tend to be five or less years old, and have lesser annual revenues and number of employees than men-owned firms. Smaller, newer firms tend to be less profitable, have more financial challenges and are less likely to be approved for financing. In addition, women-owned firms are concentrated in the health-care and education sectors, which were harder-hit than other sectors during the pandemic. Furthermore, these firms are more likely led by people of color, leading to greater financing and other challenges that were exacerbated during the pandemic. Finally, women-owned firms are more likely to be nonemployer firms.

Women-owned businesses experienced temporary closures and reduced operations during the pandemic, and reported declines in revenues and number of employees. They faced significant operational and financial challenges and were not in very good financial condition. Federal assistance in the form of the PPP and the SBA's Economic Injury Disaster Loan (EIDL) program did not reach women-owned firms at a similar level to men-owned firms. Amongst PPP applicants, women-owned firms were more likely to be denied funding and less likely to receive the total amount they applied for. The same was true for traditional financing applications.

Wiersch and Misera (2021) find that analyzing these differences by race and ethnicity, reveal that Hispanic and Asian women-owned firms faced greater challenges than their male-owned counterparts and also compared to White female-owned businesses. Black women-owned businesses faced more financial challenges than any other firms, were the most likely to report that their business was not in a good financial condition, were least likely to receive all of the PPP funding that they applied for, and were less likely to receive traditional financing as well. Racial and gender differences in being given emergency and traditional funding during COVID-19 impacted entrepreneurial efforts among these groups. The longstanding gaps in traditional credit access and emergency government assistance should be addressed for Women in STEM including demographically diverse female-owned businesses in STEM. This is necessary to avoid unfavorable entrepreneurial outcomes for these businesses, due to unanticipated shocks to the economy in the future.

Lloro (2021) uses the 2020 SHED survey to show how the pandemic disrupted childcare or in-person schooling for parents, and how it impacted the work of women. The evidence overall is mixed. One fourth of all mothers reported not working or working less due to childcare and schooling disruptions in 2020. In a separate question, one fifth of mothers said that childcare or family obligations led them to not work in 2020, which was unchanged from 2019.

Lloro also examines this by race and ethnicity. Thirty percent of Hispanic women and 19% of White women said that they were not working or working less due to childcare or schooling disruptions, yet the percent of White and Hispanic women reporting childcare or family responsibilities as a reason for not working was the same as 2019. Overall, 36% of Black mothers did not work or worked less because of disrupted childcare or in-person schooling and for lower-income Black mothers this was over 40%. One in four Black mothers said that childcare or family obligations caused them to not work, compared to the 13% that said that in 2019. The decline in labor force participation was also much more pronounced for Black mothers as compared to Black women without children based on findings by Federal Reserve Bank of Dallas researchers. White or Hispanic women did not see such pronounced differences between mothers and women without children. These results imply that childcare disruptions had a disproportionate impact on Black mothers' employment during the pandemic. The article does not explain the reasons behind this disproportionate impact. However, a Fuller Project study finds that even before the pandemic "Black mothers were more likely to live in child care deserts, struggle to access affordable child care and have lower workplace flexibility" (Washington 2021). The pandemic likely made affordable child care further out of reach, disproportionately affecting Black mothers who have greater caregiving and financial responsibilities than other parent groups.

Lloro (2021) finds that mothers that were unable to work due to childcare and schooling constraints experienced financial fragility and reported an inability to pay bills on time. This was because these mothers faced financial fragility before the pandemic and the childcare and schooling constraints increased their fragility. The article relates the inability to find childcare to work-life balance and gender role issues impacting women-owned businesses during the pandemic. These same findings could apply to Women in STEM. Financial fragilities due to lack of childcare or family obligations probably impacted entrepreneurship success in the STEM fields as well during the pandemic. Pandemic stimulus measures did not entirely alleviate these financial barriers for women with children, which are long standing. Policies and programs designed to provide affordable, quality childcare on a consistent basis, are needed to ensure mothers' financial well-being and entrepreneurial success in the long run.

Hernández (2021) examined the financial vulnerabilities that single mothers had going into the COVID-19 pandemic compared to single fathers and women without children. She discusses the effects of COVID-19 given disproportionate female employment in the service sector and in-person industries. Single mothers, especially women of color, had very little assets that provided support during the pandemic, which led to greater adversity and exacerbated inequalities. The study finds that single women without children were nine times wealthier than single mothers. Single fathers did not experience a wealth penalty. Their wealth was not very different from single men without children. In addition, single fathers were eight times wealthier than single mothers in 2019. Single mothers had lower wealth than all other single groups.

Hernández notes the racial and ethnic wealth gaps in the U.S., and the fact that Black and Hispanic women are more likely to be single mothers than White women. She mentions that for these reasons it is important to understand the financial standing of single women of color. She finds that White mothers were about eleven times wealthier than single Black or Hispanic mothers, and single White women without children were seven to eight times wealthier than Black and Hispanic women without children. The article also compared women of the same race and ethnicity and finds that single women without children had greater wealth than mothers of all races. However, these differences were not statistically significant for single women of color and the racial gap with White single women remained.

Working mothers had higher unemployment rates than fathers during the COVID-19 recession despite having similar rates in early 2020. Mothers experienced larger decreases in labor force participation rates than women without children. This could have led to mothers having no income to save, drawing down assets and accumulating more debt. This diminishes wealth and reduces their ability to invest in the future, such as starting a new business.

Single unemployed mothers had greater financial instability than other single groups. Amongst single unemployed mothers, 23% of White mothers, 49% of Black mothers and 34% of Hispanic mothers reported not being able to pay bills on time. as compared to their White counterparts. Single unemployed mothers of each race and ethnicity reported similar percentages of being financially worse off compared to the previous year. So, while all single mothers were worse off financially than the past, single unemployed mothers of color experienced greater financial instability.

Hernández mentions that before the COVID-19 recession there was a greater number of women compared to men in the nonfarm civilian workforce, the share of college-educated women in the workforce was larger and the annual growth rate of women-owned businesses was more than twice of all businesses. However, single women and women of color had very little wealth. Single women confronted a number of issues when the pandemic started. These included childcare disruptions, unemployment with no savings, and health-related impacts. The author recommends improved access to quality, affordable childcare to help working mothers, especially in times of stress. Additionally, the author recommends policies such as paid family and medical leave to close the racial employment and income gaps. Finally, the article suggests that society could focus wealth-building and recovery efforts on single mothers, especially mothers of color.

Hernández (2021) provides context around the financial stability of single mothers, especially women of color and how the pandemic impacted this further. Affordable childcare policies and policies such as paid family and medical leave, could these groups build wealth and savings in normal times. They could also help them stay in the workforce in the face of unanticipated shocks, experience greater financial stability, and increase their ability to invest in the future including in new businesses. Beck (2018) mentions that many women start freelance businesses to take care of their homes and earn income. Other reasons for starting new businesses include a spirit of entrepreneurship, greater freedom, innovation and execution. By providing them with better childcare, family and medical leave policies, we could ensure that women are starting businesses not just due to necessity, but also to realize their entrepreneurship and innovation goals. These policies could also benefit single mothers and mothers of color in the STEM workforce, make them more financially stable overall and in unanticipated times, and help them start new STEM businesses.

### 3-7-2 Positive Findings about Female Workforce and Entrepreneurship during the Pandemic Years

Goldin (2022) finds that the impact of the pandemic on labor force participation rates was related to education. "For college graduates, labor force participation rates by spring 2021 were about the same as they were in 2018, and that is true for both men and women. In fact, men had slightly larger decreases than did women. For the non-college graduate group, decreases were considerably greater and the differences between men and women are not large…". Since there are high education levels among Women in STEM the effect of the pandemic was possibly limited. In addition, it could vary depending on the degree of remote working. For example, women in healthcare, which requires in-person work, may have been more impacted than women in technology-related fields.

Furman et al. (2021 study) find that the percent change in employment between parents of young children and other parents was not higher during COVID-19. For women with a bachelor's degree the percent change in employment between mothers of young children and women without them, remained the same during the pandemic as in previous times. For mothers without a bachelor's degree, there was a larger decline in employment compared to women without young children. This is to some extent a different finding than the one mentioned above, which mentions that single working mothers had higher unemployment rates during the COVID-19 pandemic leading to greater financial instability (Hernández 2021). However, it is important to note that Hernández focused on single mothers, and did not distinguish these mothers by educational level. Since Women in STEM tend to have higher education levels, it is possible that the percent change in employment between mothers and other women in STEM was not higher during the pandemic, compared to previous years.

To the extent that female-owned businesses were able the access other sources of funding during the pandemic, it allowed them to build equity and to focus on establishing themselves in post-pandemic recovery.

The first round of PPP funding was delivered through mainstream financial institutions such as banks, which were not very accessible to underrepresented populations. However, the second round of PPP utilized Community Financial Institutions (CFIs) such as, Community Development Financial Institutions (CDFIs), Minority Depository Institutions (MDIs), Certified Development Companies (CDCs), and Microloan Intermediaries to deliver assistance. CDFIs help populations, such as women and minorities, that find it difficult to obtain loans through traditional sources of funding[viii]. CDFIs provide support to businesses within the communities they serve, to help them succeed, and 47% of CDFI clients are women[ix]. The targeting of underrepresented populations in the second round of PPP funding conceivably helped them take advantage of the national stimulus and recover post-pandemic. This targeting was not STEM-specific, but the funding challenges faced by Women in STEM are similar to other underrepresented groups, and the second round of pandemic funding could have helped women-owned STEM businesses with post-pandemic recovery.

Despite gaps in funding during the pandemic within the United States in 2021, 21.5% of early-stage women entrepreneurs reported that the pandemic provided them with new opportunities (Elam et al. 2021/2022). This coupled with the finding in the report that North American women are 78% more likely than men to start a business in the ICT fields, could imply that early-stage women entrepreneurs in these STEM-related fields found new opportunities during the pandemic. In addition, during the same time period, close to 20% of early-stage female entrepreneurs adopted new digital technologies. These women owners were 84% more likely than men owners to adopt new digital technologies.

Fairlie and Desai (2021) find that in 2020 the monthly rate of new entrepreneurs was .30 percent among women, and .48 percent among men. These were large increases for both men and women from the previous year. Women reached their highest monthly rate in 24 years. This monthly rate increased for all racial groups from 2019. It also increased greatly for all age groups. The increases in this rate happened as the economy experienced shutdowns, layoffs and re-openings. While this finding is not STEM-specific, the favorable entrepreneurship climate for start-ups could have helped female STEM founders as well.

## 3-8 Potential Economic and Social Value of Women's Equal Participation

Our research showed that Women in STEM are underrepresented, and that there are barriers and negative policies, programs, and practices hindering their success. We found that even though COVID-19 exacerbated these existing disadvantages, female entrepreneurs were able to find new opportunities and adopt new technologies during the pandemic. We also found that there are positive policies, practices, and programs that can improve their position, and that there were some improvements in the status of STEM women entrepreneurs in the past couple decades. The next topic we investigated was the potential economic and social value that women-owned businesses can create if they participated in STEM fields at the same rate as their male counterparts.

Turrentine (2015) finds that inventions by women address important social problems in health, poverty, and education. So, if the STEM academic commercialization activity gap were closed, society would help women “impact applied research, socially focused innovation, and the economy through patenting, licensing, and spinning off inventions into companies”. If women’s underrepresentation in STEM businesses was removed, they would create economic and social value by solving disease, inequality, and knowledge related challenges. Furstenthal et al. (2022) discuss women entrepreneurs’ investments in new technology including banking, genome editing, AI, and others. These inventions could lead to the development of software, products, and services to improve women’s health.

Pogessi et al. (2020) find that women entrepreneurs in the STEM fields are more interested in building better relationships with customers and workers. This has the potential to create long term economic and social benefits for society.

Muir et al. (2022) mention that countries that involve diverse inventors in the innovation lifecycle maximize their GDP and prosperity. An analysis of more than a million inventors found that U.S. innovation would quadruple if women, people of color, and people from low-income families invented at the same rate as other groups that do not face discrimination and structural barriers (Bell et al. 2019).

Saksena et al. (2022) in the USPTO study find that the persistent underrepresentation of women in patenting impacts American innovation and prosperity negatively. According to some economists if this gender disparity in patenting was removed, commercialized patents could increase by 24%, and GDP per capita could go up by 2.7%. In addition, gender equality in patenting could improve the quantity and quality of innovation, address technology gaps, enhance communication, and increase team productivity.

More generally, there are positive benefits to communities, states, and countries of increasing female entrepreneurship. Nathan Shinabarger (2017) argues that illiteracy is the common aspect of criminality, and increasing women’s entrepreneurship can increase family resiliency, strength, and literacy. Childers (2023) points out positive benefits from women’s entrepreneurship in Utah. Providing economic opportunities through female entrepreneurship can help avoid depopulation of rural areas or high vulnerability to economic downturns. Vanderveldt in an interview mentions that women channel 90% of their income into their families and communities, which creates a multiplier effect. Businesses founded by women generate two times more per dollar invested than firms founded by men. If the gender disparity in entrepreneurship were removed, global GDP could go up by 3 to 5% (Lesonsky 2022).

# 4. Data Sets and Analysis

This chapter describes the data sets we accessed to perform this research, displays the data in the form of tables, and presents the findings based on our data analysis.

## 4-1 Data Sets

We developed data sets for our research from the ABS and NES-D Census datasets using the following steps. First, we identified the NAICS codes for STEM sectors based on the 2017 NAICS codes pertaining to STEM, because the data from the datasets is for NAICS codes from this year. We used the high-yield industry definition mentioned in the glossary, researched the top industries for STEM employment, read articles on the STEM workforce in the Defense Industrial Base (National Research Council 2012) and R&D intensive (Crane et al. 2021) industries, to identify these codes. We did not include undervalued industries[3] in which women are overrepresented.

Next, we looked for the latest year with the most complete information available on all STEM businesses, including employer and nonemployer businesses. The most recent year for which data was available from both ABS and NES-D is 2019[4x]. Each ABS provides data for the previous year. So, the 2019 employer data is from the 2020 ABS. We downloaded demographic data on STEM businesses using the identified NAICS codes, from 2019. Appendix A provides a listing of the identified three-digit NAICS codes that we used to gather 2019 STEM employer and nonemployer data.

We developed data sets and tables from the downloaded data, using single and multi-level demographic factors. For example, we developed a data set to study gender differences in STEM industries. Yet another data set and table combined the gender information with race to understand the nuances between genders and races in STEM. Some of the STEM specific demographic data was not available, because the estimates did not meet the Census reporting standards and were unreported, or because the estimates were withheld to avoid disclosing data for individual companies, but were included in higher-level totals.

The 2019 ABS data only provides information up to three-digit NAICS, so some of the STEM NAICS we identified for example NAICS 541 covered STEM industries such as "Scientific research and development services", but also STEM-adjacent industries such as "Architectural, engineering, and related services".

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[3] The definition for the term undervalued industries is included in a Glossary in Chapter 9.

[4] The latest NES-D release includes demographic statistics of both employer and nonemployer businesses. It combines results from the 2019 ABS and the 2019 NES-D.

In order to look at these industries at a greater level of detail we accessed 2020 ABS data (2021 data is preliminary and not final), which is available at the four-digit NAICS code level. We identified NAICS codes for STEM-adjacent industries such as AEC, infrastructure, supply chain, and sustainability using different sites related to these industries[xi][xii]. We downloaded 2020 data for both STEM and STEM-adjacent industries and developed data sets to analyze STEM employer business data. We could not do the same for STEM nonemployer data, because the NES-D data is not available beyond 2020. Appendix B lists the four-digit NAICS codes that we used to gather 2020 STEM and STEM-adjacent employer data from the ABS.

## 4-2 Data Analysis

As mentioned above we developed tables to conduct a demographic analysis of the STEM data we downloaded from the ABS and NES-D. The demographic analysis examined demographic characteristics such as racial, ethnic, age, veteran status and business characteristics such as location to describe entrepreneurship in STEM and STEM-adjacent industries. We performed the analysis using Excel spreadsheets and by using R software[5] . Below are the tables that we developed and the analyses based on these tables. The standard errors for the estimates in the tables are in Appendix C.

### 4-2-1 STEM Entrepreneurship by Gender

We examined female-owned, male-owned, and equally male- and female-owned businesses in the STEM fields. Table 4-1A shows the number of STEM entrepreneurs, according to our definition, by gender composition of ownership. There are 733,880 fewer female-owned STEM firms than male-owned firms. Overall, most STEM businesses are nonemployer firms. Nonemployer STEM firms are close to 78% of all STEM firms. The table indicates that there are more nonemployer than employer firms for both men and women. However, in the case of equally male/female-owned businesses a majority are employer firms.

This table shows that more men participate in STEM entrepreneurship than women. There is a difference close to 600,000 between the number of female-owned and male-owned STEM employer firms. This is in comparison to non-employer firms where the difference in the number of male and female-owned firms is less than 200,0000 firms. This implies that a large part of the gender disparity in STEM entrepreneurship could be because of female employer firm representation, and policies and programs focused on this segment of female-owned STEM firms might bear more fruit**.**

This is in light of the fact that there are fewer women-owned employer firms in general, as compared to woman-owned nonemployer firms. The NWBC 2022 report[xiii] mentions

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[5] https://www.r-project.org/

that there were 1.2 million female-owned employer businesses in 2019. Women owned 41.1%[xiv] of the nonemployer businesses (approximately 27.1 million[xv]) in 2019. This translates to approximately 11.1 million female-owned nonemployer businesses in 2019.

**Table 4-1A: Total Number of STEM Firms by Owner Sex (2019)**

| | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable |
|---|---|---|---|---|---|
| **Total** | 6,678,411 | 2,797,342 | 3,531,222 | 197,834 | 6,526,398 |
| **Employer** | 1,475,795 | 356,826 | 926,606 | 139,529 | 1,422,961 |
| **Nonemployer** | 5,202,600 | 2,440,500 | 2,604,600 | 57,400 | 5,102,500 |

Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900NESD01

Notes applicable for all tables in this chapter are grouped together and included in endnotes[xvi].

### 4-2-2 STEM Entrepreneurship by Geographical Location

Table 4-1B examines STEM entrepreneurship for women across the U.S. for nonemployer and employer firms. We calculated female-owned STEM firms as a percent of all STEM firms in each state. This percent ranges from close to 33% to 52%. For example, Utah has the lowest rate of female STEM entrepreneurship at 32.8%. Maine, at 52%, has the highest percentage of female STEM entrepreneurship. Other states such as Mississippi and Vermont are at 47% and 49% respectively. The District of Columbia is at 47%. Averaging this percent across states, shows that on average, female-owned STEM firms are 43% of all STEM firms in a state.

Female-owned nonemployer STEM entrepreneurs as a percent of all nonemployer STEM firms in a state, is in the range of 38-55% across all states. Taking an average of this percent across states, we found that on average, female-owned nonemployer STEM firms are 48% of all STEM nonemployer firms in a state.

Female-owned STEM employer firms as a percent of all STEM employer firms in a state, ranges from 0.4% to 89% across the U.S. In Alabama, women run 0.4% of STEM employer firms whereas, in Maine that number is 89%. Once again, taking an average of these percentages across states, we found that on average female-owned STEM employer firms are 24% of all STEM employer firms in a state.

# Table 4-1B: Total Number of Female-Owned STEM Firms by State (2019)

| | Majority Female-owned | | | Total | | | Percent of Female as a Total of Nonemployer and Employer Firms | | |
|---|---|---|---|---|---|---|---|---|---|
| **Geographical Area** | **Nonemployer** | **Employer** | **Total** | **Nonemployer** | **Employer** | **Total** | **Nonemployer** | **Employer** | **Total** |
| Alabama | 26,700 | 43 | 26,743 | 53,920 | 11,117 | 65,037 | 49.5% | 0.4% | 41.1% |
| Alaska | 4,920 | - | 4,920 | 9,600 | 1,679 | 11,279 | 51.3% | - | 43.6% |
| Arizona | 48,910 | 7,559 | 56,469 | 104,530 | 28,626 | 133,156 | 46.8% | 26.4% | 42.4% |
| Arkansas | 17,210 | 2,366 | 19,576 | 32,760 | 9,259 | 42,019 | 52.5% | 25.6% | 46.6% |
| California | 348,900 | 51,303 | 400,203 | 745,490 | 206,825 | 952,315 | 46.8% | 24.8% | 42.0% |
| Colorado | 59,890 | 9,929 | 69,819 | 122,270 | 35,602 | 157,872 | 49.0% | 27.9% | 44.2% |
| Connecticut | 31,130 | 3,031 | 34,161 | 65,540 | 12,903 | 78,443 | 47.5% | 23.5% | 43.5% |
| Delaware | 5,710 | - | 5,710 | 12,610 | 2,934 | 15,544 | 45.3% | - | 36.7% |
| District of Columbia | 10,280 | 1,128 | 11,408 | 19,720 | 4,376 | 24,096 | 52.1% | 25.8% | 47.3% |
| Florida | 229,550 | 33,658 | 263,208 | 452,130 | 117,170 | 569,300 | 50.8% | 28.7% | 46.2% |
| Georgia | 85,410 | 12,963 | 98,373 | 164,590 | 44,592 | 209,182 | 51.9% | 29.1% | 47.0% |
| Hawaii | 11,470 | 885 | 12,355 | 23,130 | 4,269 | 27,399 | 49.6% | 20.7% | 45.1% |
| Idaho | 12,430 | 1,018 | 13,448 | 26,750 | 7,663 | 34,413 | 46.5% | 13.3% | 39.1% |
| Illinois | 82,370 | 15,379 | 97,749 | 173,870 | 57,969 | 231,839 | 47.4% | 26.5% | 42.2% |
| Indiana | 30,320 | 4,669 | 34,989 | 67,080 | 20,228 | 87,308 | 45.2% | 23.1% | 40.1% |
| Iowa | 14,330 | 2,292 | 16,622 | 29,850 | 9,447 | 39,297 | 48.0% | 24.3% | 42.3% |
| Kansas | 15,250 | 2,326 | 17,576 | 33,990 | 9,716 | 43,706 | 44.9% | 23.9% | 40.2% |
| Kentucky | 20,800 | 2,987 | 23,787 | 44,390 | 11,298 | 55,688 | 46.9% | 26.4% | 42.7% |
| Louisiana | 34,690 | 4,116 | 38,806 | 66,590 | 17,442 | 84,032 | 52.1% | 23.6% | 46.2% |
| Maine | 10,620 | 595 | 11,215 | 20,960 | 667 | 21,627 | 50.7% | 89.2% | 51.9% |
| Maryland | 59,010 | 8,158 | 67,168 | 115,430 | 28,096 | 143,526 | 51.1% | 29.0% | 46.8% |
| Massachusetts | 63,170 | 7,853 | 71,023 | 135,600 | 29,985 | 165,585 | 46.6% | 26.2% | 42.9% |
| Michigan | 64,910 | 9,221 | 74,131 | 134,730 | 38,155 | 172,885 | 48.2% | 24.2% | 42.9% |
| Minnesota | 36,500 | 5,929 | 42,429 | 79,020 | 22,338 | 101,358 | 46.2% | 26.5% | 41.9% |
| Mississippi | 18,100 | 718 | 18,818 | 33,140 | 6,641 | 39,781 | 54.6% | 10.8% | 47.3% |

## Table 4-1B (Continued): Total Number of Female-Owned STEM Firms by State (2019)

| | Majority Female-owned | | | Total | | | Percent of Female as a Total of Nonemployer and Employer Firms | | |
|---|---|---|---|---|---|---|---|---|---|
| Geographical Area | Nonemployer | Employer | Total | Nonemployer | Employer | Total | Nonemployer | Employer | Total |
| Missouri | 31,630 | 3,325 | 34,955 | 67,410 | 17,692 | 85,102 | 46.9% | 18.8% | 41.1% |
| Montana | 8,420 | 851 | 9,271 | 17,250 | 4,600 | 21,850 | 48.8% | 18.5% | 42.4% |
| Nebraska | 9,720 | 871 | 10,591 | 20,520 | 6,164 | 26,684 | 47.4% | 14.1% | 39.7% |
| Nevada | 21,170 | 3,247 | 24,417 | 47,520 | 14,109 | 61,629 | 44.5% | 23.0% | 39.6% |
| New Hampshire | 10,640 | 589 | 11,229 | 23,460 | 3,250 | 26,710 | 45.4% | 18.1% | 42.0% |
| New Jersey | 71,360 | 10,778 | 82,138 | 162,160 | 44,949 | 207,109 | 44.0% | 24.0% | 39.7% |
| New Mexico | 13,880 | 1,172 | 15,052 | 26,680 | 5,416 | 32,096 | 52.0% | 21.6% | 46.9% |
| New York | 173,260 | 24,124 | 197,384 | 365,160 | 95,047 | 460,207 | 47.4% | 25.4% | 42.9% |
| North Carolina | 71,420 | 9,507 | 80,927 | 141,590 | 35,740 | 177,330 | 50.4% | 26.6% | 45.6% |
| North Dakota | 3,810 | 339 | 4,149 | 7,840 | 1,704 | 9,544 | 48.6% | 19.9% | 43.5% |
| Ohio | 68,840 | 8,032 | 76,872 | 148,120 | 39,787 | 187,907 | 46.5% | 20.2% | 40.9% |
| Oklahoma | 21,360 | 3,829 | 25,189 | 46,170 | 15,798 | 61,968 | 46.3% | 24.2% | 40.6% |
| Oregon | 35,220 | 5,031 | 40,251 | 70,290 | 18,998 | 89,288 | 50.1% | 26.5% | 45.1% |
| Pennsylvania | 79,110 | 9,941 | 89,051 | 173,190 | 46,917 | 220,107 | 45.7% | 21.2% | 40.5% |
| Rhode Island | 8,320 | 1,097 | 9,417 | 17,410 | 4,308 | 21,718 | 47.8% | 25.5% | 43.4% |
| South Carolina | 31,900 | 3,698 | 35,598 | 64,540 | 16,058 | 80,598 | 49.4% | 23.0% | 44.2% |
| South Dakota | 4,360 | 702 | 5,062 | 9,560 | 1,594 | 11,154 | 45.6% | 44.0% | 45.4% |
| Tennessee | 42,070 | 2,160 | 44,230 | 89,160 | 17,423 | 106,583 | 47.2% | 12.4% | 41.5% |
| Texas | 207,700 | 30,894 | 238,594 | 442,300 | 116,070 | 558,370 | 47.0% | 26.6% | 42.7% |
| Utah | 20,120 | 2,233 | 22,353 | 52,800 | 15,280 | 68,080 | 38.1% | 14.6% | 32.8% |
| Vermont | 6,810 | 522 | 7,332 | 13,310 | 1,686 | 14,996 | 51.2% | 31.0% | 48.9% |
| Virginia | 63,420 | 11,610 | 75,030 | 129,820 | 37,593 | 167,413 | 48.9% | 30.9% | 44.8% |
| Washington | 56,580 | 4,179 | 60,759 | 115,670 | 29,360 | 145,030 | 48.9% | 14.2% | 41.9% |
| West Virginia | 6,510 | 440 | 6,950 | 13,950 | 1,805 | 15,755 | 46.7% | 24.4% | 44.1% |
| Wisconsin | 27,700 | 4,015 | 31,715 | 60,900 | 17,807 | 78,707 | 45.5% | 22.5% | 40.3% |
| Wyoming | 4,110 | 460 | 4,570 | 8,830 | 2,803 | 11,633 | 46.5% | 16.4% | 39.3% |

Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900NESD01

Note: Some cells have no numbers because either the estimate did not meet Census reporting standards and is unreported, or because estimate is withheld to avoid disclosing data for individual companies, but is included in higher-level totals.

### 4-2-3 STEM Entrepreneurship by Sector

Examining total STEM entrepreneurship by sector in Table 4-2 we find that across all genders, most STEM businesses are concentrated in the Professional, scientific, and technical services sector followed by the Ambulatory healthcare services sector. This is also true for employer and nonemployer firms. Hence, a large number of STEM businesses are providing health care, professional, scientific, and technical services.

In the Ambulatory healthcare services sector, there are more female-owned businesses overall compared to male-owned businesses. This is also true for nonemployer firms in this sector. However, in the Professional, scientific, and technical services sector, male-owned firms outnumber female-owned firms overall, and also in the employer and nonemployer categories. Male-owned firms outnumber female-owned firms by 841,469 firms in this category. Total male-owned firms are close to one and a half times female-owned firms, and employer male-owned firms are more than two and a half times employer female-owned firms in this sector. Nonemployer male-owned firms outnumber nonemployer female-owned firms by 517,000 firms. This implies that to alleviate gender disparity in STEM, policies and programs should focus on barriers for women in the professional, scientific, and technical arena.

## Table 4-2: Total Number of STEM Firms by Sector and Owner Sex (2019)

| Sector | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable |
|---|---|---|---|---|---|
| **Total (Employer + Nonemployer)** | | | | | |
| Total for All Sectors | 6,678,411 | 2,797,342 | 3,531,222 | 197,834 | 6,526,398 |
| Ambulatory health care services | 1,705,637 | 949,660 | 678,397 | 46,761 | 1,674,818 |
| Chemical manufacturing | 25,717 | 8,154 | 13,910 | 1,335 | 23,399 |
| Computer and electronic product manufacturing | 18,603 | 2,456 | 13,153 | 1,236 | 16,845 |
| Data processing, hosting, and related services | 56,966 | 22,155 | 30,852 | 1,455 | 54,462 |
| Electrical equipment, appliance, and component manufacturing | 11,447 | 1,807 | 7,889 | 638 | 10,334 |
| Fabricated metal product manufacturing | 90,350 | 9,352 | 70,073 | 7,659 | 87,084 |
| Hospitals | 1,789 | 63 | 361 | S | 424 |
| Machinery manufacturing | 35,061 | 3,532 | 26,146 | 2,984 | 32,662 |
| Management of companies and enterprises | 25,777 | 2,463 | 12,681 | S | 15,144 |
| Miscellaneous manufacturing | 90,721 | 28,162 | 53,925 | 5,443 | 87,530 |
| Professional, scientific, and technical services | 4,595,410 | 1,766,815 | 2,608,284 | 129,020 | 4,504,119 |
| Transportation equipment manufacturing | 20,933 | 2,723 | 15,551 | 1,303 | 19,577 |

## Table 4-2 (Continued): Total Number of STEM Firms by Sector and Owner Sex (2019)

| Sector | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable |
|---|---|---|---|---|---|
| **Employer** | | | | | |
| Total for All Sectors | 1,475,795 | 356,826 | 926,606 | 139,529 | 1,422,961 |
| Ambulatory health care services | 487,637 | 138,660 | 294,397 | 39,761 | 472,818 |
| Chemical manufacturing | 10,217 | 1,554 | 6,310 | 1,035 | 8,899 |
| Computer and electronic product manufacturing | 10,203 | 1,156 | 7,053 | 1,036 | 9,245 |
| Data processing, hosting, and related services | 10,466 | 1,155 | 7,352 | S | 8,507 |
| Electrical equipment, appliance, and component manufacturing | 4,747 | 707 | 2,989 | 488 | 4,184 |
| Fabricated metal product manufacturing | 50,350 | 5,652 | 36,573 | 6,559 | 48,784 |
| Hospitals | 1,781 | 55 | 353 | S | 408 |
| Machinery manufacturing | 20,061 | 1,932 | 14,146 | 2,534 | 18,612 |
| Management of companies and enterprises | 25,769 | 2,455 | 12,673 | | 15,128 |
| Miscellaneous manufacturing | 23,221 | 3,662 | 15,425 | 3,543 | 22,630 |
| Professional, scientific, and technical services | 822,410 | 198,815 | 523,284 | 83,520 | 805,619 |
| Transportation equipment manufacturing | 8,933 | 1,023 | 6,051 | 1,053 | 8,127 |
| **Nonemployer** | | | | | |
| Total for All Sectors | 5,202,600 | 2,440,500 | 2,604,600 | 57,400 | 5,102,500 |
| Ambulatory health care services | 1,218,000 | 811,000 | 384,000 | 7,000 | 1,202,000 |
| Chemical manufacturing | 15,500 | 6,600 | 7,600 | 300 | 14,500 |
| Computer and electronic product manufacturing | 8,400 | 1,300 | 6,100 | 200 | 7,600 |
| Data processing, hosting, and related services | 46,500 | 21,000 | 23,500 | 550 | 45,050 |
| Electrical equipment, appliance, and component manufacturing | 6,700 | 1,100 | 4,900 | 150 | 6,150 |
| Fabricated metal product manufacturing | 40,000 | 3,700 | 33,500 | 1,100 | 38,300 |
| Hospitals | S | S | S | S | S |
| Machinery manufacturing | 15,000 | 1,600 | 12,000 | 450 | 14,050 |
| Management of companies and enterprises | S | S | S | S | S |
| Miscellaneous manufacturing | 67,500 | 24,500 | 38,500 | 1,900 | 64,900 |
| Professional, scientific, and technical services | 3,773,000 | 1,568,000 | 2,085,000 | 45,500 | 3,698,500 |
| Transportation equipment manufacturing | 12,000 | 1,700 | 9,500 | 250 | 11,450 |

Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900NESD01

S- Estimate did not meet Census reporting standards so it is unreported

### 4-2-4 STEM Entrepreneurship by Race and Ethnicity

As seen in Table 4-3A below, by race the majority of STEM firm owners are White. White firm owners are approximately 81% of all STEM firms, close to 85% of employer STEM firms and close to 80% of nonemployer STEM firms. Within the White racial group, the majority of businesses are male-owned. This is also true for employer and nonemployer businesses. There are approximately 800,000 fewer White female-owned businesses than male-owned businesses, overall. White female-owned STEM firms are 41%, whereas White male-owned STEM firms are approximately 56% of all White classifiable STEM firms. Black or African American, and American Indian and Alaska Native are the only racial groups for whom female-owned STEM firms outnumber male-owned STEM firms.

With greater than 600,000 businesses, Asians own the most STEM firms after White firm owners, followed by Black or African American, American Indian and Alaska Native, and Native Hawaiian and Pacific Islander firm owners. Asians own 9% of all STEM firms.

When compared to White firm owners, there are far fewer STEM employer firms owned by other races. Asians own more employer firms compared to other races except White firm owners. Asian firm owners own approximately 10% of these firms.

A majority of STEM firms, regardless of race are nonemployer firms. Excluding White owners, Black or African Americans own more nonemployer firms than other races. Black owners own 10% of these firms.

## Table 4-3A: Total Number of STEM Firms by Owner Race and Sex (2019)

| | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable |
|---|---|---|---|---|---|
| **Total** | 6,659,261 | 2,797,342 | 3,524,912 | 197,834 | 6,520,088 |
| White | 5,372,497 | 2,201,749 | 3,001,238 | 166,505 | 5,369,492 |
| Black or African American | 562,875 | 347,415 | 207,480 | 3,714 | 558,609 |
| American Indian and Alaska Native | 57,491 | 29,931 | 26,984 | 847 | 57,762 |
| Asian | 601,609 | 258,497 | 324,471 | 15,570 | 598,538 |
| Native Hawaiian and Other Pacific Islander | 15,142 | 7,938 | 7,170 | S | 15,108 |
| | | | | | |
| **Employer** | | | | | |
| Total | 1,456,645 | 356,826 | 920,296 | 139,529 | 1,416,651 |
| White | 1,235,681 | 298,183 | 813,522 | 120,505 | 1,232,210 |
| Black or African American | 41,867 | 16,420 | 23,364 | 1,956 | 41,740 |
| American Indian and Alaska Native | 6,673 | 2,323 | 4,136 | 287 | 6,746 |
| Asian | 139,501 | 43,297 | 85,696 | 10,334 | 139,327 |
| Native Hawaiian and Other Pacific Islander | 1,821 | 4 | 741 | S | 745 |
| | | | | | |
| **Nonemployer** | | | | | |
| Total | 5,175,100 | 2,440,500 | 2,597,000 | 56,850 | 5,094,350 |
| White | 4,136,800 | 1,902,450 | 2,187,700 | 46,400 | 4,136,550 |
| Black or African American | 521,000 | 330,900 | 184,100 | 1,770 | 516,770 |
| American Indian and Alaska Native | 50,880 | 27,870 | 22,940 | 5,360 | 56,170 |
| Asian | 462,100 | 215,400 | 238,780 | 5,410 | 459,590 |
| Native Hawaiian and Other Pacific Islander | 13,600 | 7,290 | 6,290 | 20 | 13,600 |

Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900NESD01

S- Estimate did not meet Census reporting standards so it is unreported

Most STEM business owners within the U.S. are non-Hispanic men, followed by non-Hispanic women as noted in Table 4-3B. Non-Hispanic men are over 49% of all classifiable STEM firms, whereas non-Hispanic women are 38% of these firms.

This is also true for employer and nonemployer firms. Non-Hispanic men are close to 62% of all classifiable STEM employer firms, whereas non-Hispanic women are 23% of these firms. For nonemployer businesses, non-Hispanic men are 46% of all classifiable STEM nonemployer firms, whereas non-Hispanic women are 42% of these businesses.

STEM firms owned by Hispanic women outnumber the number of firms owned by Hispanic men, by 8,098 firms. For nonemployer firms, Hispanic women are close to 53% of classifiable Hispanic STEM firms, versus Hispanic men that are approximately 47% of these firms. There are more equally Hispanic/non-Hispanic employer firms than there are equally Hispanic/non-Hispanic nonemployer firms.

## Table 4-3B: Total Number of STEM Firms by Ethnicity and Owner Sex (2019)

| All | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable |
|---|---|---|---|---|---|
| **Total** | 6,678,411 | 2,797,342 | 3,531,222 | 197,834 | 6,526,398 |
| Hispanic | 584,165 | 291,557 | 283,459 | 5,469 | 580,485 |
| Equally Hispanic/non-Hispanic | 17,102 | 874 | 3,512 | 11,066 | 15,452 |
| Non-Hispanic | 5,924,555 | 2,500,992 | 3,243,679 | 178,479 | 5,923,150 |
| | | | | | |
| **Employer** | | | | | |
| Total | 1,475,795 | 356,826 | 926,606 | 139,529 | 1,422,961 |
| Hispanic | 69,357 | 22,265 | 42,789 | 2,651 | 67,705 |
| Equally Hispanic/non-Hispanic | 10,784 | 374 | 1,682 | 7,444 | 9,500 |
| Non-Hispanic | 1,344,839 | 333,476 | 881,763 | 127,161 | 1,342,400 |
| | | | | | |
| **Nonemployer** | | | | | |
| Total | 5,202,600 | 2,440,500 | 2,604,600 | 56,850 | 5,101,950 |
| Hispanic | 514,800 | 271,400 | 240,550 | 3,340 | 515,290 |
| Equally Hispanic/non-Hispanic | 6,480 | 650 | 1,680 | 3,810 | 6,140 |
| Non-Hispanic | 4,579,700 | 2,167,500 | 2,361,900 | 50,450 | 4,579,850 |

Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900NESD01

### 4-2-5 STEM Entrepreneurship by Veteran Status

Table 4-3C below shows the demographic representation of STEM firms by veteran status. The number of STEM veteran nonemployer businesses is more than twice the number of veteran employer businesses. There are also a greater number of veteran nonemployer female-owned businesses than veteran employer female-owned businesses in STEM. Within veteran employer businesses, the number of male-owned businesses is 16 times the number of female-owned businesses. This is in comparison to veteran nonemployer businesses, where the number of male-owned businesses is only seven times the number of female-owned businesses. Overall, the number of veteran male-owned businesses is eight times the number of veteran female-owned businesses.

Women veterans were only approximately 10% of the veteran population[xvii] in 2019. The large differences in male-owned versus female-owned veteran STEM businesses, could to some extent reflect the difference in the number of female- versus male veterans.

## Table 4-3C: Number of STEM Firms by Veteran Status and Owner Sex (2019)

| | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable |
|---|---|---|---|---|---|
| **Total** | 6,678,411 | 2,797,342 | 3,531,222 | 197,834 | 6,526,398 |
| Veteran | 381,817 | 41,088 | 339,676 | - | 380,764 |
| Equally veteran/non-veteran | 34,803 | - | 11,014 | 21,893 | 32,907 |
| Non-veteran | 6,105,233 | 2,755,005 | 3,173,712 | 172,821 | 6,101,538 |
| | | | | | |
| **Employer** | | | | | |
| Total | 1,475,795 | 356,826 | 926,606 | 139,529 | 1,422,961 |
| Veteran | 100,059 | 5,742 | 93,568 | - | 99,310 |
| Equally veteran/non-veteran | 26,003 | - | 8,264 | 16,283 | 24,547 |
| Non-veteran | 1,296,617 | 350,589 | 822,096 | 121,771 | 1,294,456 |
| | | | | | |
| **Nonemployer** | | | | | |
| Total | 5,202,600 | 2,440,500 | 2,604,600 | 57,400 | 5,102,500 |
| Veteran | 285,250 | 35,500 | 249,200 | 270 | 284,970 |
| Equally veteran/non-veteran | 8,800 | 210 | 2,900 | 5,760 | 8,870 |
| Non-veteran | 4,808,600 | 2,404,400 | 2,351,600 | 51,550 | 4,807,550 |
| | | | | | |

Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900NESD01

Some cells have no numbers because either the estimate did not meet Census reporting standards and is unreported, or because estimate is withheld to avoid disclosing data for individual companies, but is included in higher-level totals.

### 4-2-6 STEM Entrepreneurship by Owner Age and Citizenship Status

Table 4-3D shows a breakdown of STEM firms by owner age and sex. Regardless of age, most STEM firms are nonemployer firms. Nonemployer women-owned firms outnumber the number of male firm owners under the age of 25, 25-34, and 35 to 44. Female-owned firms are close to 53% of STEM nonemployer businesses in the under 25 age category, whereas male-owned firms are 47% in this category. For the 25 to 34 age category, female-owned STEM nonemployer firms are 55% whereas male-owned firms are 45%. For the 35 to 44 age group, female-owned firms are 53% of STEM nonemployer firms, whereas male-owned firms are 47%. This trend disappears starting at ages 45-54. This could imply that STEM policy interventions that expose women early on to STEM in the past might have proved effective. For employer firms, male-owned firms outnumber female-owned firms for all age categories.

## Table 4-3D: Total Number of STEM Owners by Owner Age and Sex (2019)

| | Total Reporting | Female | Male |
|---|---|---|---|
| **Owners of All Firms** | | | |
| Under 25 | 183,452 | 96,113 | 87,339 |
| 25 to 34 | 863,220 | 469,879 | 393,341 |
| 35 to 44 | 1,321,794 | 668,434 | 653,360 |
| 45 to 54 | 1,421,116 | 661,995 | 759,121 |
| 55 to 64 | 1,417,347 | 607,026 | 810,321 |
| 65 or over | 1,174,842 | 379,232 | 795,610 |
| Total | 6,381,771 | 2,882,679 | 3,499,092 |
| | | | |
| **Owners of Employer Firms** | | | |
| Under 25 | 2,002 | 563 | 1,439 |
| 25 to 34 | 43,920 | 16,029 | 27,891 |
| 35 to 44 | 189,644 | 68,184 | 121,460 |
| 45 to 54 | 282,466 | 98,945 | 183,521 |
| 55 to 64 | 314,597 | 96,976 | 217,621 |
| 65 or over | 229,792 | 52,082 | 177,710 |
| Total | 1,062,421 | 332,779 | 729,642 |
| | | | |
| **Owners of Nonemployer Firms** | | | |
| Under 25 | 181,450 | 95,550 | 85,900 |
| 25 to 34 | 819,300 | 453,850 | 365,450 |
| 35 to 44 | 1,132,150 | 600,250 | 531,900 |
| 45 to 54 | 1,138,650 | 563,050 | 575,600 |
| 55 to 64 | 1,102,750 | 510,050 | 592,700 |
| 65 or over | 945,050 | 327,150 | 617,900 |
| Total | 5,319,350 | 2,549,900 | 2,769,450 |

Sources: Annual Business Survey: Owner Characteristics of Respondent Employer Firms by Sector, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

Nonemployer Statistics by Demographics series (NES-D): Owner Characteristics of Nonemployer Firms by Sector, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900CSCBO, AB1900NESD04

The vast majority of STEM business owners within the U.S. are U.S. citizens, as shown in Table 4-3E. There are more male citizen and non-citizen STEM owners than their female counterparts, although the difference is greater for citizens. This is true for owners of all STEM firms and also for owners of employer and nonemployer STEM firms.

**Table 4-3E: Total Number of STEM Owners by Owner Citizenship and Sex (2019)**

| | Total | Female | Male |
|---|---|---|---|
| **Owners of All Firms** | | | |
| Owner is a citizen of the U.S. | 5,784,049 | 2,603,594 | 3,180,555 |
| Owner is not a citizen of the U.S. | 596,943 | 279,458 | 317,584 |
| Total reporting | 6,380,992 | 2,883,052 | 3,498,139 |
| | | | |
| **Owners of Employer Firms** | | | |
| Owner is a citizen of the U.S. | 1,038,449 | 325,594 | 712,855 |
| Owner is not a citizen of the U.S. | 24,043 | 7,208 | 16,834 |
| Total reporting | 1,062,492 | 332,802 | 729,689 |
| | | | |
| **Owners of Nonemployer Firms** | | | |
| Owner is a citizen of the U.S. | 4,745,600 | 2,278,000 | 2,467,700 |
| Owner is not a citizen of the U.S. | 572,900 | 272,250 | 300,750 |
| Total reporting | 5,318,500 | 2,550,250 | 2,768,450 |

Sources: Annual Business Survey: Owner Characteristics of Respondent Employer Firms by Sector, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

Nonemployer Statistics by Demographics series (NES-D): Owner Characteristics of Nonemployer Firms by Sector, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900CSCBO, AB1900NESD04

## 4-2-7 STEM Entrepreneurship by Revenue and Employment Size

As shown in Table 4-4A, in all sectors, the combined receipts of firms are $5 billion or more. Female-owned firms have combined receipts of $1 billion to less than $5 billion, for Data processing, hosting, and related services, Hospitals, Electrical equipment, appliance, and component manufacturing sectors. Equally male/female-owned firms have combined receipts in that range for Data processing, hosting, and related services, and Electrical equipment, appliance, and component manufacturing. There is no sector where male-owned firms have receipts of less than $5 billion or more.

## Table 4-4A: STEM Firms by Total Combined Receipts per Sector and Owner Sex (2019)

| Sector | Total Number of firms | Total Combined Receipts of employer and nonemployer firms | Number of Majority Female-Owned firms | Total Combined Receipts Majority Female-Owned employer and nonemployer firms | Number of Majority Male-Owned firms | Total Combined Receipts of Majority Male-Owned employer and nonemployer firms | Number of Equally Male/Female-Owned firms | Total Combined Receipts of Equally Male/Female-Owned employer and nonemployer firms | Total # Classifiable |
|---|---|---|---|---|---|---|---|---|---|
| **Total (Employer + Nonemployer)** | | | | | | | | | |
| Total for All Sectors | 6,678,411 | ≥ $5billion | 2,797,342 | ≥ $5billion | 3,531,222 | ≥ $5billion | 197,834 | ≥ $5billion | 6,526,398 |
| Ambulatory health care services | 1,705,637 | ≥ $5billion | 949,660 | ≥ $5billion | 678,397 | ≥ $5billion | 46,761 | ≥ $5billion | 1,674,818 |
| Chemical manufacturing | 25,717 | ≥ $5billion | 8,154 | ≥ $5billion | 13,910 | ≥ $5billion | 1,335 | ≥ $5billion | 23,399 |
| Computer and electronic product manufacturing | 18,603 | ≥ $5billion | 2,456 | ≥ $5billion | 13,153 | ≥ $5billion | 1,236 | ≥ $5billion | 16,845 |
| Data processing, hosting, and related services | 56,966 | ≥ $5billion | 22,155 | $1billion - <$5 billion | 30,852 | ≥ $5billion | 1,455 | $1billion - <$5 billion | 54,462 |
| Electrical equipment, appliance, and component manufacturing | 11,447 | ≥ $5billion | 1,807 | $1billion - <$5 billion | 7,889 | ≥ $5billion | 638 | $1billion - <$5 billion | 10,334 |
| Fabricated metal product manufacturing | 90,350 | ≥ $5billion | 9,352 | ≥ $5billion | 70,073 | ≥ $5billion | 7,659 | ≥ $5billion | 87,084 |
| Hospitals | 1,789 | ≥ $5billion | 63 | $1billion - <$5 billion | 361 | ≥ $5billion | S | S | 424 |
| Machinery manufacturing | 35,061 | ≥ $5billion | 3,532 | ≥ $5billion | 26,146 | ≥ $5billion | 2,984 | ≥ $5billion | 32,662 |
| Management of companies and enterprises | 25,777 | S | 2,463 | S | 12,681 | S | S | S | 15,144 |
| Miscellaneous manufacturing | 90,721 | ≥ $5billion | 28,162 | ≥ $5billion | 53,925 | ≥ $5billion | 5,443 | ≥ $5billion | 87,530 |
| Professional, scientific, and technical services | 4,595,410 | ≥ $5billion | 1,766,815 | ≥ $5billion | 2,608,284 | ≥ $5billion | 129,020 | ≥ $5billion | 4,504,119 |
| Transportation equipment manufacturing | 20,933 | ≥ $5billion | 2,723 | ≥ $5billion | 15,551 | ≥ $5billion | 1,303 | ≥ $5billion | 19,577 |

Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900NESD01

Note:

S- Estimate did not meet the U.S Census Bureau reporting standards so it is unreported

Table 4-4B depicts the total number of employees for employer firms in the different STEM sectors. Ambulatory health care services and Professional, scientific, and technical sectors have the maximum total number of employees amongst employer firms. Female-owned employer firms have fewer total employees than male-owned firms for all STEM sectors. This is also true of equally male/female-owned firms.

## Table 4-4B: STEM Employer Firms by Employment Size per Sector and Owner Sex (2019)

| Sector | Total Number of employer Firms | Total Number of employees of employer firms | Number of Majority Female-Owned employer firms | Total Number of employees of Majority Female-Owned employer firms | Number of Majority Male-Owned employer firms | Total Number of employees of Majority Male-Owned employer firms | Number of Equally Male/Female-Owned employer firms | Total Number of employees of Equally Male/Female-Owned employer firms | Total # Firms Classifiable |
|---|---|---|---|---|---|---|---|---|---|
| **Employer** | | | | | | | | | |
| Total for All Sectors | 1,475,795 | 12,662,574 | 356,826 | 2,601,870 | 926,606 | 10,060,704 | 139,529 | 1,098,585 | 1,422,961 |
| Ambulatory health care services | 487,637 | 4,126,936 | 138,660 | 1,183,602 | 294,397 | 2,943,334 | 39,761 | 400,102 | 472,818 |
| Chemical manufacturing | 10,217 | 244,119 | 1,554 | 30,460 | 6,310 | 213,659 | 1,035 | 23,043 | 8,899 |
| Computer and electronic product manufacturing | 10,203 | 240,954 | 1,156 | 30,674 | 7,053 | 210,280 | 1,036 | 23,450 | 9,245 |
| Data processing, hosting, and related services | 10,466 | 242,546 | 1,155 | 19,755 | 7,352 | 222,791 | S | S | 8,507 |
| Electrical equipment, appliance, and component manufacturing | 4,747 | 129,816 | 707 | 16,075 | 2,989 | 113,741 | 488 | 9,284 | 4,184 |
| Fabricated metal product manufacturing | 50,350 | 869,781 | 5,652 | 107,534 | 36,573 | 762,247 | 6,559 | 93,013 | 48,784 |
| Hospitals | 1,781 | 115,680 | 55 | 16,754 | 353 | 98,926 | S | S | 408 |
| Machinery manufacturing | 20,061 | 444,609 | 1,932 | 47,101 | 14,146 | 397,508 | 2,534 | 48,673 | 18,612 |
| Management of companies and enterprises | 25,769 | 564,276 | 2,455 | 63,403 | 12,673 | 500,873 | S | S | 15,128 |
| Miscellaneous manufacturing | 23,221 | 288,281 | 3,662 | 31,423 | 15,425 | 256,858 | 3,543 | 29,049 | 22,630 |
| Professional, scientific, and technical services | 822,410 | 5,058,594 | 198,815 | 1,018,245 | 523,284 | 4,040,349 | 83,520 | 431,130 | 805,619 |
| Transportation equipment manufacturing | 8,933 | 336,982 | 1,023 | 36,844 | 6,051 | 300,138 | 1,053 | 40,841 | 8,127 |

Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

Table ID: AB1900NESD01

S- Estimate did not meet Census Bureau reporting standards and is unreported

## 4-2-8 STEM and STEM-adjacent Employer Firm Entrepreneurship

From Table 4-5A, there are more STEM-adjacent employer firms than there are STEM employer firms. STEM and STEM-adjacent fields are both primarily composed of male-owned employer firms. Female-owned STEM employer firms are 27% of classifiable STEM employer firms and female-owned STEM-adjacent employer firms are 11% of classifiable STEM-adjacent employer firms.

**Table 4-5A: Total Number of STEM and STEM-adjacent Employer Firms by Sex (2020)**

| | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable | Percent Female-owned of STEM and STEM-adjacent |
|---|---|---|---|---|---|---|
| **Total** | 1,913,060 | 340,675 | 1,302,625 | 216,521 | 1,859,821 | 18% |
| **STEM** | 900,215 | 229,880 | 545,559 | 85,289 | 860,728 | 27% |
| **STEM-adjacent** | 1,012,845 | 110,795 | 757,066 | 131,232 | 999,093 | 11% |

Source: Annual Business Survey: Statistics for Employer Firms by Industry, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2020

Table ID: AB2000CSA01

Table 4-5B lists the number of STEM employer firms by sector. The sector with the highest number of STEM employer firms is Management, scientific, and technical consulting services followed by Offices of physicians and Offices of other health practitioners. Female- and male-owned employer firms are 30% and 58% of the Management, scientific and technical consulting services sector, respectively. Within the Offices of physicians sector, 35% of the employer firms are female-owned and 69% are male-owned. Female-owned and male-owned employer firms are 42% and 48% of the Offices of other health practitioners sector, respectively.

## Table 4-5B: Total Number of STEM Employer Firms by Sector and Owner Sex (2020)

| Sector | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable |
|---|---|---|---|---|---|
| Aerospace product and parts manufacturing | 1,316 | 141 | 840 | 130 | 1,111 |
| Commercial and service industry machinery manufacturing | 1,457 | 194 | 891 | S | 1,085 |
| Communications equipment manufacturing | 1,158 | 82 | 734 | 187 | 1,003 |
| Computer and peripheral equipment manufacturing | 784 | 74 | 584 | 47 | 705 |
| Computer systems design and related services | 122,232 | 17,704 | 88,274 | 13,799 | 119,777 |
| Data processing, hosting, and related services | 10,596 | 1,410 | 7,295 | 868 | 9,573 |
| Engine, turbine, and power transmission equipment manufacturing | 750 | 51 | 522 | 61 | 634 |
| General medical and surgical hospitals | 1,215 | 12 | 53 | 2 | 67 |
| Industrial machinery manufacturing | 2,659 | S | 1,885 | 230 | 2,115 |
| Management of companies and enterprises | 25,188 | S | 12,071 | 0 | 12,071 |
| Management, scientific, and technical consulting services | 181,472 | 52,772 | 103,570 | 21,381 | 177,723 |
| Manufacturing and reproducing magnetic and optical media | 314 | S | 222 | 44 | 266 |
| Medical equipment and supplies manufacturing | 8,639 | 1,049 | 5,788 | 1,519 | 8,356 |
| Metalworking machinery manufacturing | 6,558 | S | 4,685 | 714 | 5,399 |
| Navigational, measuring, electromedical, and control instruments manufacturing | 4,370 | 495 | 2,885 | 404 | 3,784 |
| Offices of dentists | 120,045 | 28,778 | 82,198 | 8,417 | 119,393 |
| Offices of other health practitioners | 145,604 | 60,012 | 68,196 | 14,754 | 142,962 |
| Offices of physicians | 168,210 | 40,035 | 113,309 | 11,107 | 164,451 |
| Other electrical equipment and component manufacturing | 1,816 | 286 | 1,082 | S | 1,368 |
| Other fabricated metal product manufacturing | 5,705 | 768 | 3,913 | 691 | 5,372 |
| Other professional, scientific, and technical services | 67,267 | 22,785 | 33,691 | 9,397 | 65,873 |
| Pesticide, fertilizer, and other agricultural chemical manufacturing | 694 | 125 | S | S | 125 |
| Pharmaceutical and medicine manufacturing | 2,200 | 242 | 1,293 | 262 | 1,797 |
| Psychiatric and substance abuse hospitals | 149 | 3 | 14 | 4 | 21 |
| Scientific research and development services | 16,318 | 2,449 | 9,278 | 985 | 12,712 |
| Semiconductor and other electronic component manufacturing | 3,223 | 410 | 2,172 | 282 | 2,864 |
| Specialty (except psychiatric and substance abuse) hospitals | 276 | 3 | 114 | 4 | 121 |

Source: Annual Business Survey: Statistics for Employer Firms by Industry, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2020

Table ID: AB2000CSA01

S- Estimate did not meet Census reporting standards and is unreported

Table 4-5C lists the number of STEM-adjacent employer firms by sector. Residential building construction followed by building equipment contractors and building finishing contractors have the greatest number of STEM-adjacent employer firms. In the residential building construction sector, 7% of employer firms are female-owned firms and 78% are male-owned firms. Both the Building equipment contractors and Building finishing contractors sectors have 9% female-owned and 78% male-owned employer firms.

Female-owned employer firms outnumber male-owned firms in the Specialized design services sector. Sectors such as Inland water transportation and Support activities for rail transportation have very few employer female-owned firms.

### Table 4-5C: Total Number of STEM-adjacent Employer Firms by Sector and Owner Sex (2020)

| Sector | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable |
|---|---|---|---|---|---|
| Architectural, engineering, and related services | 93,573 | 11,994 | 71,063 | 8,582 | 91,639 |
| Building equipment contractors | 183,020 | 16,463 | 142,454 | 22,839 | 181,756 |
| Building finishing contractors | 121,706 | 10,953 | 94,238 | 16,158 | 121,349 |
| Deep sea, coastal, and great lakes water transportation | 801 | S | 525 | S | 525 |
| Foundation, structure, and building exterior contractors | 91,470 | 8,230 | 71,880 | 11,053 | 91,163 |
| Freight transportation arrangement | 15,099 | 2,768 | 9,849 | 2,040 | 14,657 |
| General freight trucking | 79,807 | 8,584 | 57,812 | 12,887 | 79,283 |
| Highway, street, and bridge construction | 8,750 | 1,572 | 6,406 | S | 7,978 |
| Inland water transportation | 341 | 10 | 260 | S | 270 |
| Land subdivision | 4,303 | S | 3,404 | S | 3,404 |
| Nonresidential building construction | 38,769 | 3,550 | 30,609 | 4,202 | 38,361 |
| Nonscheduled air transportation | 2,051 | S | 1,310 | S | 1,310 |
| Other heavy and civil engineering construction | 4,276 | S | 3,065 | 480 | 3,545 |
| Other specialty trade contractors | 73,298 | 8,599 | 53,987 | 10,284 | 72,870 |
| Residential building construction | 186,352 | 13,581 | 144,466 | 27,438 | 185,485 |
| Scheduled air transportation | 606 | 29 | S | S | 29 |
| Specialized design services | 34,547 | 15,839 | 14,335 | 4,121 | 34,295 |
| Specialized freight trucking | 46,201 | 5,406 | 32,188 | 8,075 | 45,669 |
| Support activities for rail transportation | 505 | 11 | 437 | S | 448 |
| Support activities for water transportation | 2,372 | S | 1,642 | S | 1,642 |
| Utility system construction | 17,517 | 2,152 | 12,838 | 2,193 | 17,183 |
| Warehousing and storage | 7,481 | 1,054 | 4,298 | 880 | 6,232 |

Source: Annual Business Survey: Statistics for Employer Firms by Industry, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2020

Table ID: AB2000CSA01

S- Estimate did not meet Census reporting standards and is unreported

## 4-3 Data Limitations

There were limitations to the data we collected for this analysis. These include the following:

- We used 2019 ABS and NES-D data, the latest year with the most complete information available on female STEM businesses, including employer and nonemployer firms. So, the data captures the state of Women in STEM only for 2019, and does not reflect changes in female STEM ownership over the years.
- Some values in the Census data collected included letters rather than numbers, making it difficult to compile the data. Below are the letters included and their interpretation[xviii]:
    - D- Estimate is withheld to avoid disclosing data for individual companies; data are included in higher level totals.
    - N - Estimates are not available or not comparable.
    - S- Estimate did not meet the Census reporting standards so it is unreported.
    - X- Estimates that were identified as " Not applicable" by the Census.

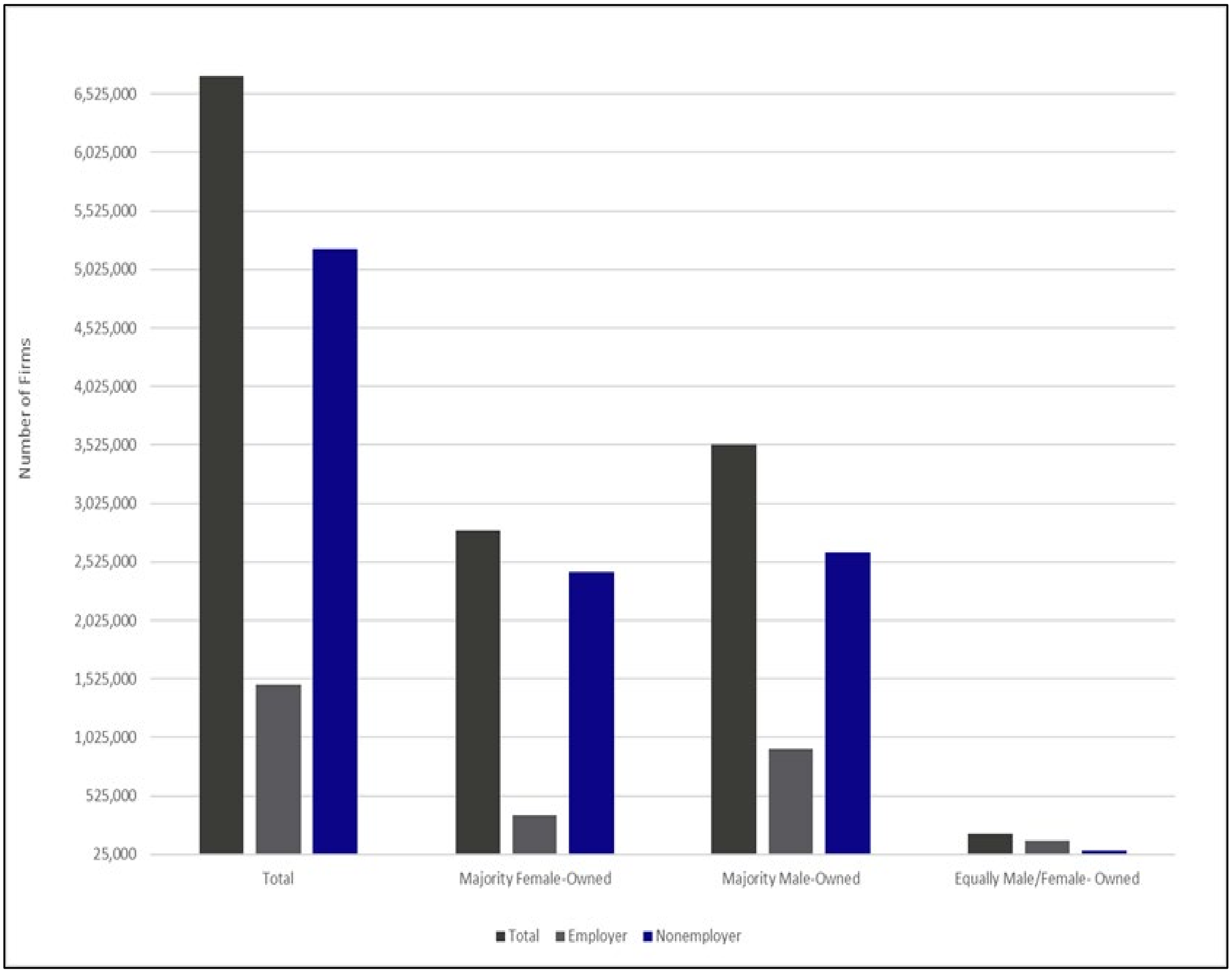
We did not impute values to estimates where these letters occurred in the data, and did not count them.

# 5. Women in STEM Entrepreneurship Trends

## 5-1 STEM Entrepreneurship Gender Trends

Figure 5-1A shows that the number of nonemployer STEM businesses is greater than the number of employer STEM businesses for both female-owned and male-owned STEM firms. Regardless of firm type, most STEM firms are male-owned. Male-owned employer firms are more than double the number of female-owned employer firms. The gender gap is smaller between nonemployer firms. The majority of equally male/female-owned firms are employer firms.

**Figure 5-1A: Total Number of STEM Firms by Owner Sex (2019)**




Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

## 5-2 STEM Entrepreneurship Geographic Trend

Figures 5-1B and 5-1C show geographic trends for employer and nonemployer firms across the U.S.

Figure 5-1B depicts female nonemployer STEM firms as a percentage of total STEM nonemployer firms within each state. This percentage ranges from 38% to 55%. There are a few states where the percentage is below the average of 48%, with the lowest being Utah at about 38%.

A group of southern states (Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas and Louisiana) have a rate above the average rate of female nonemployer firms. This could be because of a better entrepreneurial climate for nonemployer women-owned firms in these states, or because of the lack of formal employment for Women in STEM in this region. States with lower-than-average rates of female nonemployer firms do not cluster or follow a regional trend.

## Figure 5-1B: Percent of STEM Female Nonemployer Firms by State (2019)

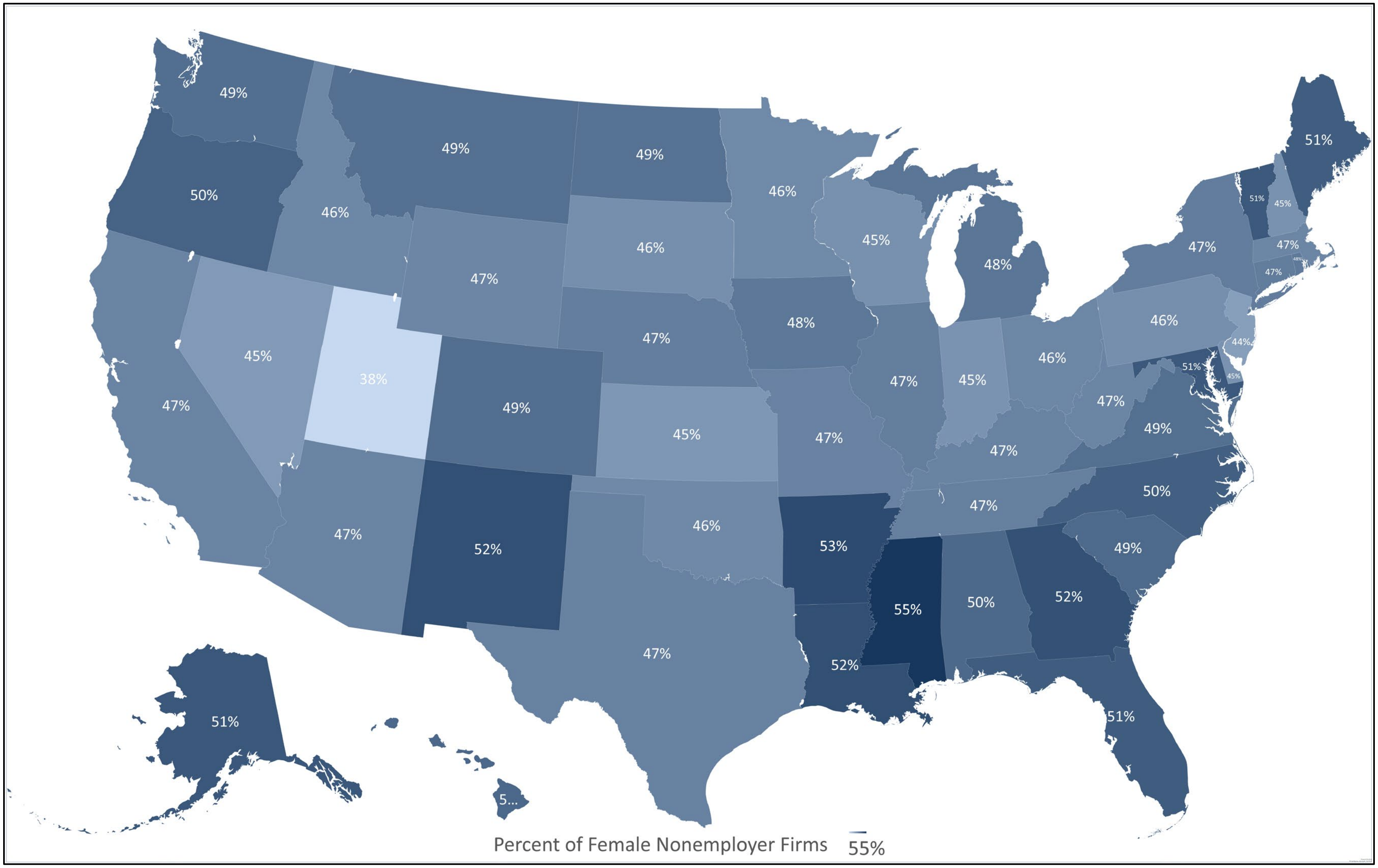


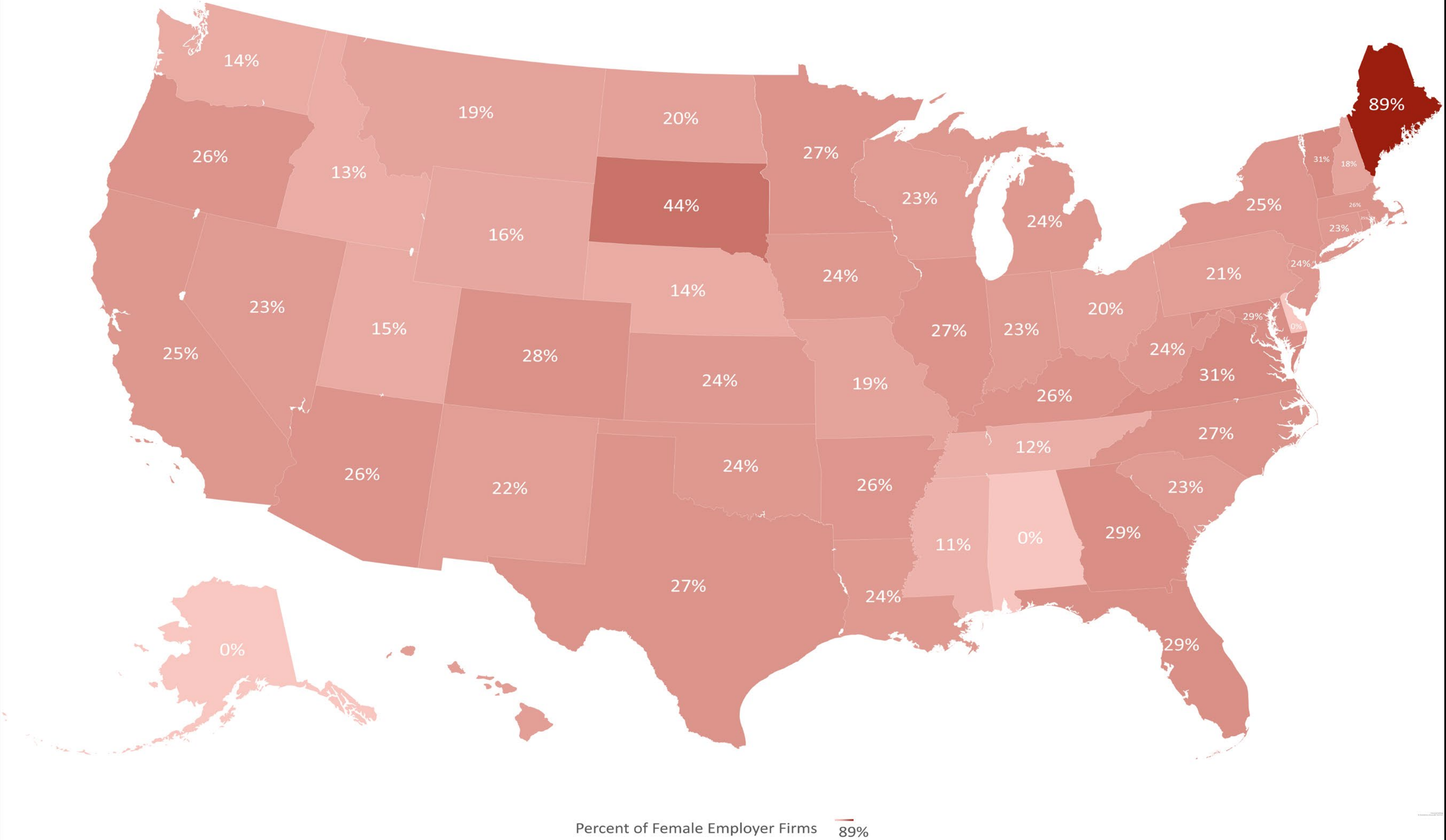
Figure 5-1C shows the percentage of female STEM employer firms with respect to all STEM employer firms within that state. The previously described Southern states, except for South Carolina, Alabama and Mississippi, do slightly better than the average rate of 24%. The percentage of female-owned employer firms in South Carolina is the same as the average rate.

The state with the lowest rate of female STEM employer firms is Alabama at 0.4%. The two states that have the highest rate of female employer firms are South Dakota at 44% and Maine at 89%. Factors such as a higher percentage of women working in the STEM fields in Maine than nationwide[6], or women-owned businesses in general doing better compared to other states could influence this[7] rate.

[6] http://statusofwomendata.org/wp-content/uploads/2015/08/Maine-Fact-Sheet.pdf

[7] https://www.pressherald.com/2018/08/24/maines-women-owned-businesses-lead-the-nation-in-job-revenue-growth/

## Figure 5-1C: Percent of STEM Female Employer Firms by State (2019)



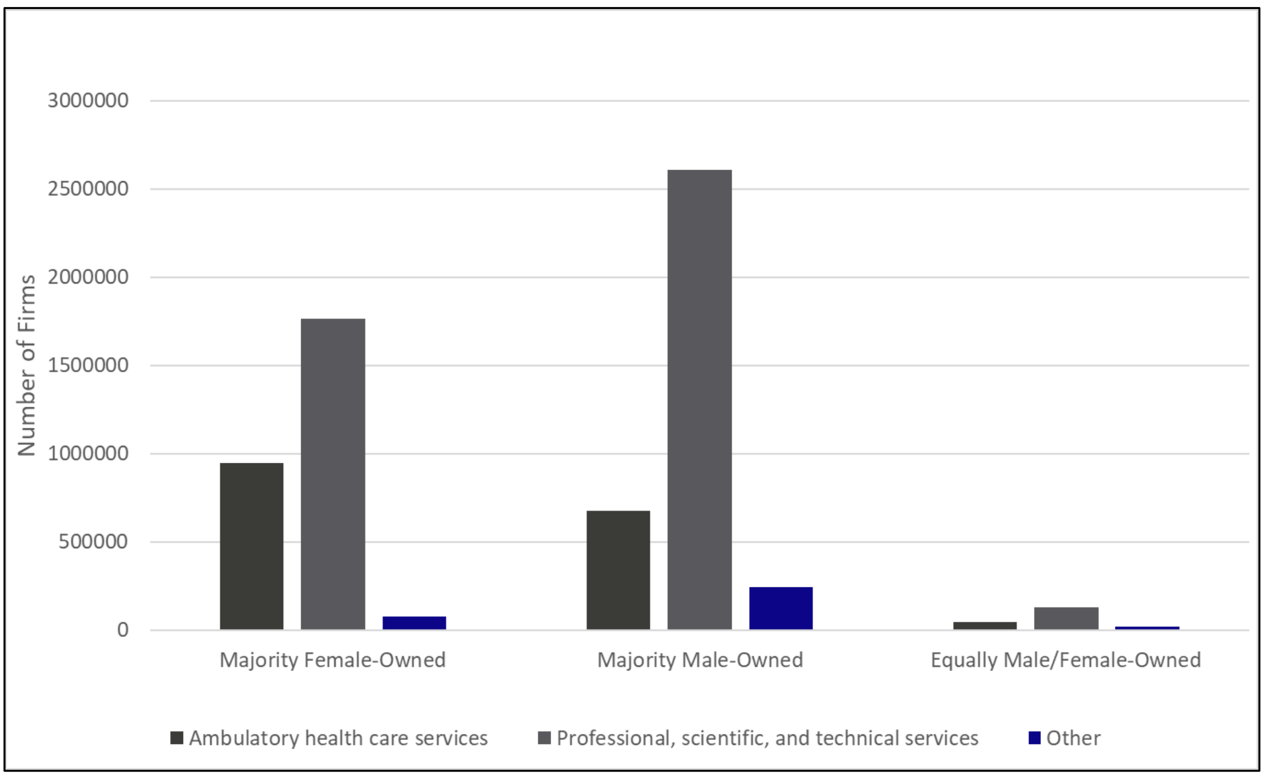
Source for Figures 5-1B and 5-1C: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

Note: For Alabama, Alaska and Delaware, the map shows 0% employer firms. In the case of Alabama, it is actually 0.4%, whereas for Alaska and Delaware, the data is either not reported or not disclosed.

## 5-3 STEM Entrepreneurship Sector Trends

From figures 5-2A and 5-2B, the most common sector for both female- and male-owned STEM firms is Professional, scientific, and technical services, followed by Ambulatory health care services. Women-owned firms tend to concentrate within these two sectors with less variation in the number of firms between these two sectors, compared to male-owned firms. The concentration of women in these two sectors should be looked at in light of the fact that these sectors represent broader categories, than other sectors such as Fabricated metal product manufacturing. The number of male-owned firms in the Professional, scientific, and technical services sector is close to one and a half times that of female-owned firms. The high concentration of men-owned versus women-owned firms in this sector could explain some of the gender disparity in the STEM fields.

**Figure 5-2: Total Number of STEM Firms by Sector and Owner Sex (2019)**

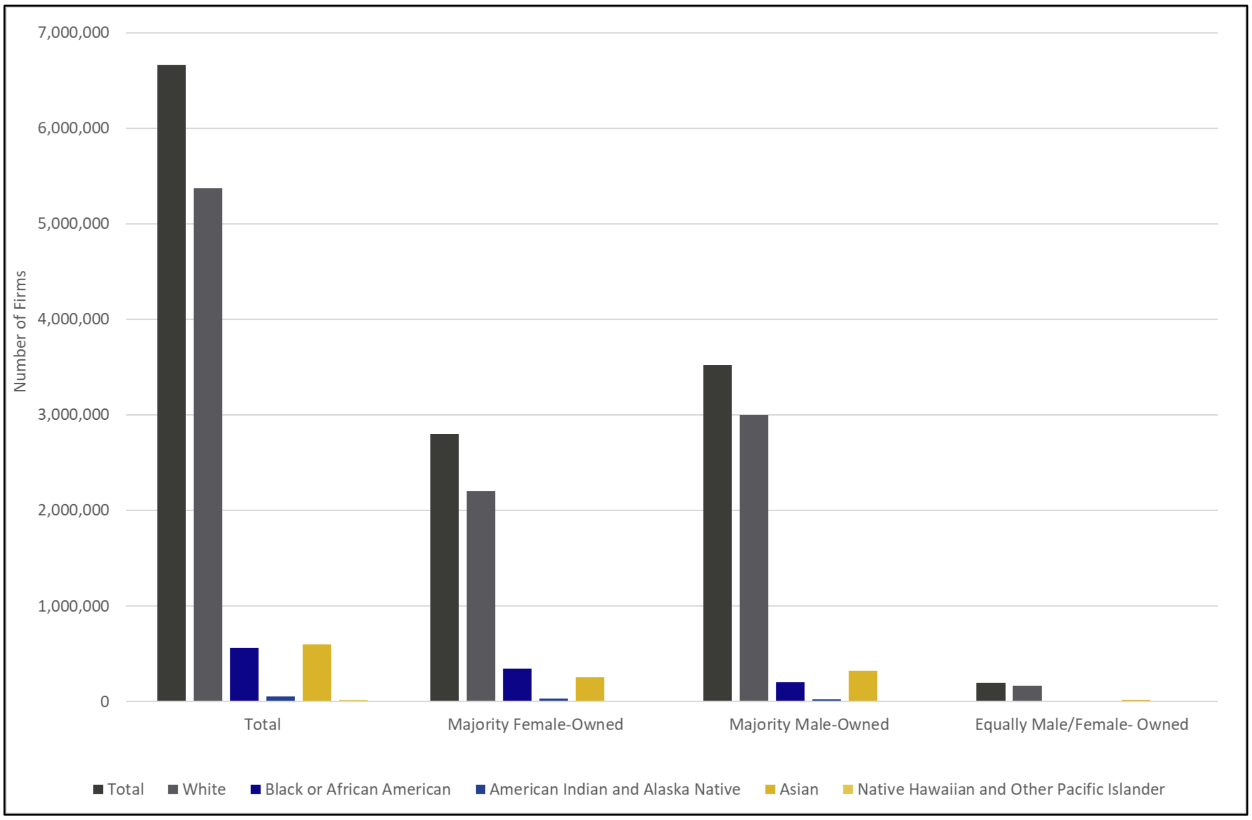



Source: Nonemployer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

## 5-4 STEM Entrepreneurship Race and Ethnicity Trends

Figure 5-3A shows that White men and women own the majority of STEM businesses. In general, White male-owned firms dominate the STEM industry. There are more female-owned firms than male-owned STEM firms for Black or African American, and American Indian and Alaska Native racial categories. For all other categories there are more men that own STEM firms than their female counterparts.

**Figure 5-3A: Total Number of STEM Firms by Owner Race and Sex (2019)**

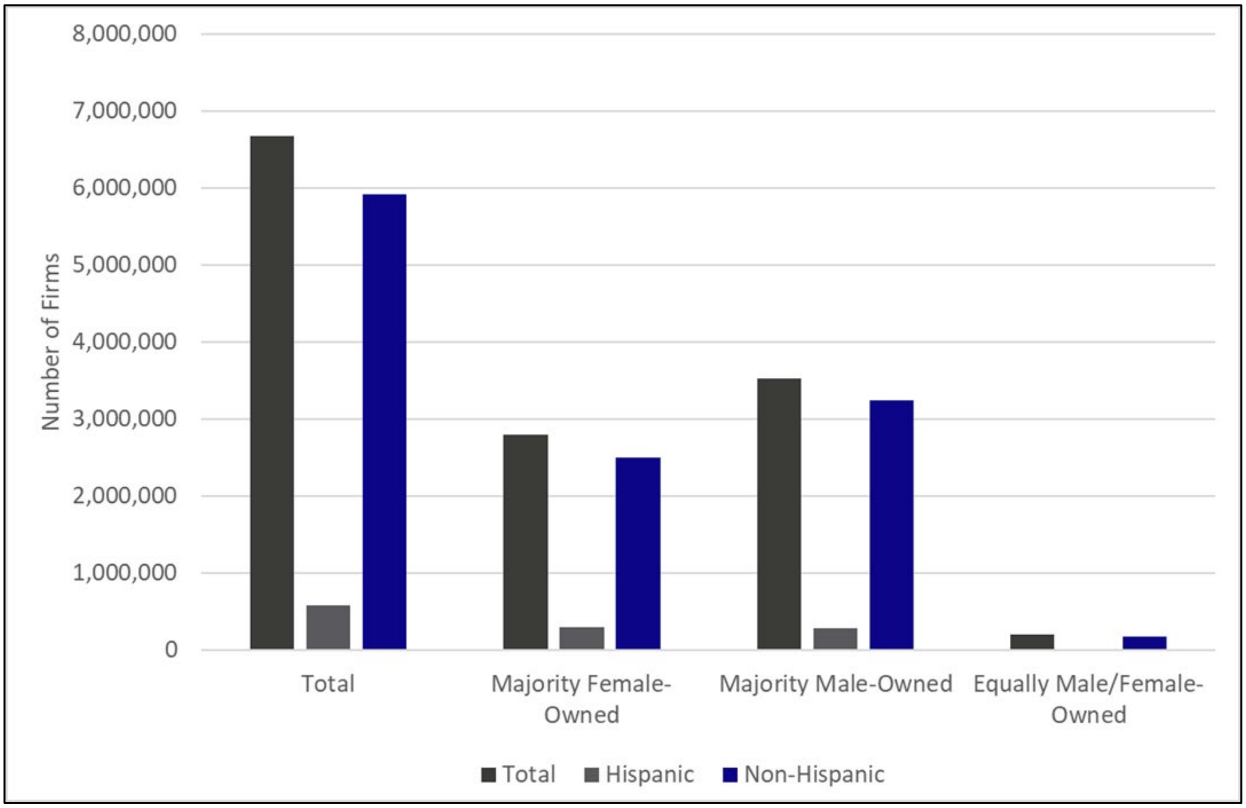



Source: Nonemployer and Employer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

Note: All races are included in this graph, some bars are too small because of the small number of firms, and are not visible.

Figure 5-3B below, depicts that the majority of STEM Firms are non-Hispanic owned businesses. Non-Hispanic male-owned STEM firms outnumber non-Hispanic female-owned firms by more than 700,000 firms. The number of women-owned and men-owned Hispanic STEM firms is close, with more female-owned firms. This could imply that compared to the non-Hispanic population, there is greater social equality leading Hispanic women to form STEM businesses at the same or higher rate than Hispanic men.

**Figure 5-3B: Total Number of STEM Firms by Ethnicity and Owner Sex (2019)**




Source: Nonemployer and Employer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

Notes:

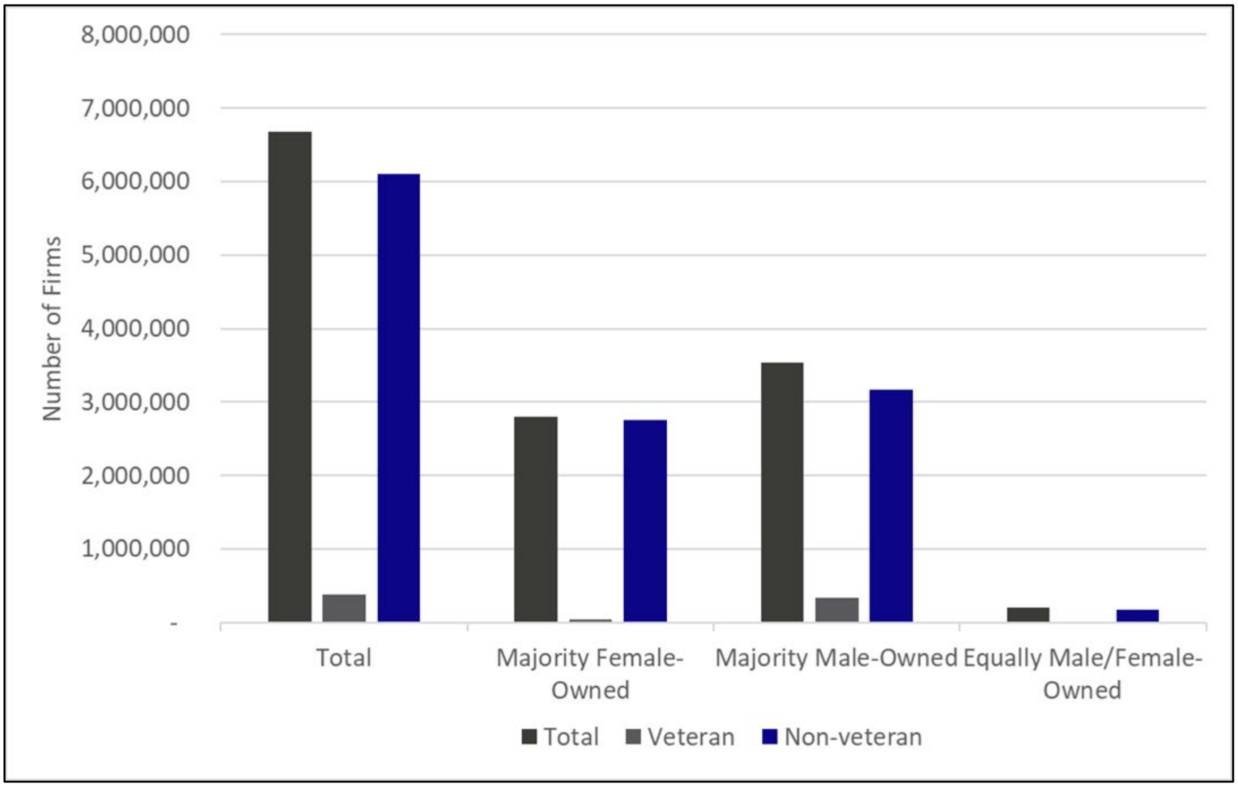
1. The Equally Hispanic/non-Hispanic ethnic category is not included in the Figure, because the number of firms is too small for the bars to be visible.
2. Some of the bars in the Equally Male/Female-Owned category are not visible, because the number of firms is too small.

## 5-5 STEM Entrepreneurship Veteran Status Trends

From Figure 5-3C, the number of veteran female-owned businesses is significantly lower than the number of veteran male-owned businesses. This implies that in spite of the progress being made by women veterans in starting more STEM businesses (Maury and Stutsman, 2019), they have a long way to go to catch up with male veterans in the STEM arena. Hence, programs focused towards training, financing, and supporting women veterans to succeed in STEM entrepreneurship are essential.

Women veterans were only approximately 10% of the veteran population in 2019. The large differences in male- versus female-owned veteran STEM businesses, could reflect the fact that male veterans significantly outnumber female veterans.

**Figure 5-3C: Number of STEM Firms by Veteran Status and Owner Sex (2019)**




Source: Nonemployer and Employer Statistics by Demographics series (NES-D): Statistics for Employer and Nonemployer Firms by Industry, Sex, Ethnicity, Race and Veteran Status for the U.S., States, and Metro Areas: 2019

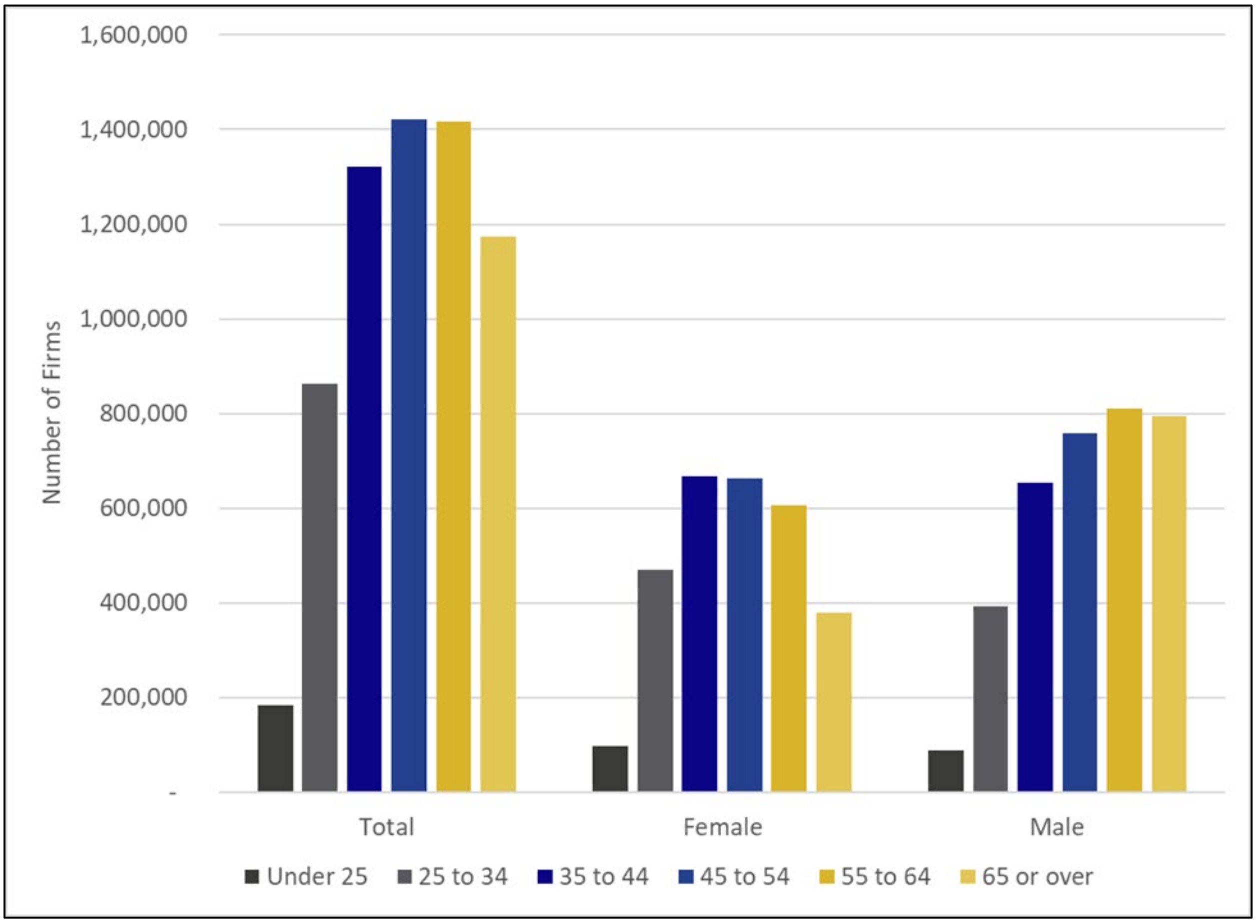
Notes:

1. The Equally veteran/non-veteran category is not included in the Figure, because the number of firms is too small for the bars to be visible.
2. The number of veteran firms that are Equally Male/Female-Owned is too small, and that bar is not visible in the figure.

## 5-6 STEM Entrepreneurship Age Trends

Figure 5-3D below shows that the number of female-owned STEM firms is roughly equal between the ages of 35 to 44, 45 to 54 and 55 to 64. Male-owned STEM firm owners are older and concentrated in the 45 and above age group. There are more female-owned STEM firms than male-owned STEM firms in the under 25, and 25 to 34 age groups. The number of female- and male-owned STEM firms is roughly equal for the 35-44 age interval, with slightly more female-owned firms. From age 45 and beyond, the number of female-owned STEM firms starts falling behind male-owned firms. This has policy implications in that the focus of programs to support women-owned businesses in STEM, should align with the greater needs of women 45 years of age and older. It also shows that existing policy interventions are positively impacting female entrepreneurs below age 45.

**Figure 5-3D: Total Number of STEM Owners by Owner Age and Sex (2019)**



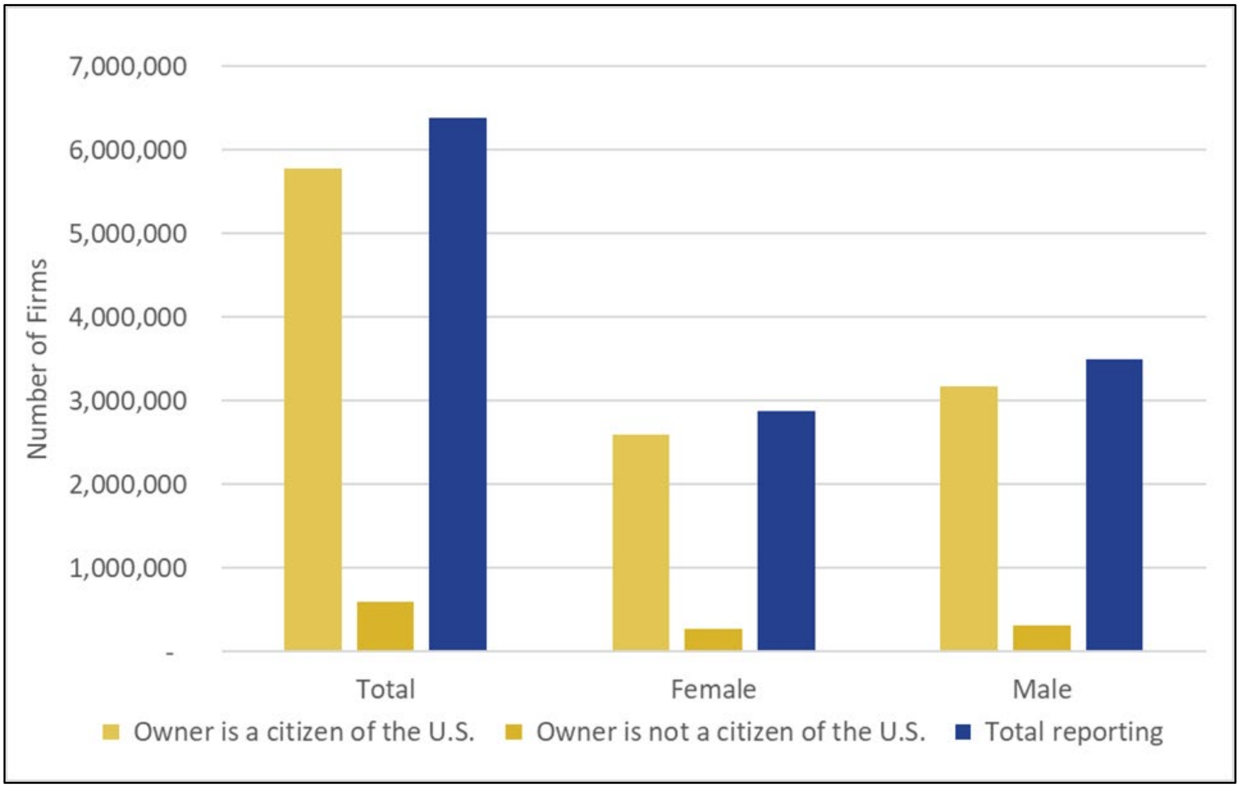

Sources: Annual Business Survey: Owner Characteristics of Respondent Employer Firms by Sector, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

Nonemployer Statistics by Demographics series (NES-D): Owner Characteristics of Nonemployer Firms by Sector, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

## 5-7 STEM Entrepreneurship Citizenship Trends

Within the U.S. citizens own the overwhelming majority of STEM firms, as show in Figure 5-3E. The number of female- and male- non-citizen entrepreneurs is about the same, with slightly more male-owned firms. There is a greater disparity in the number of female and male STEM firms among U.S. citizens. The graph also shows that there is a large gap between the number of citizen versus non-citizen female STEM firms. Policies and programs that assist female non-citizens could close this gap, and boost overall female STEM entrepreneurship numbers.

**Figure 5-3E: Total Number of STEM Owners by Owner Citizenship and Sex (2019)**




Sources: Annual Business Survey: Owner Characteristics of Respondent Employer Firms by Sector, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

Nonemployer Statistics by Demographics series (NES-D): Owner Characteristics of Nonemployer Firms by Sector, Sex, Ethnicity, Race, and Veteran Status for the U.S., States, and Metro Areas: 2019

# 6. Policy Review and Solutions

This chapter reviews both existing and potential policies at the federal, state, local, institutional, and private levels that impact or could impact Women in STEM. Some of the policies, practices and programs are for small businesses, others are targeted towards women-owned businesses, and yet others are specific to STEM entrepreneurship and have equity goals. Some of these policies were mentioned in the Literature Review chapter previously. Here, we categorize them to the extent possible between different branches and levels of government, institutional offices, and private programs. We also provide policy solutions that address gaps in policymaking, based on this review and the literature search and data analysis conducted above.

## 6-1 Policy Review

In this section we review the Executive Orders (EOs), legislation, rules, programs, and policies of different entities that impact female entrepreneurs and Women in STEM. These policies and programs are resources for female STEM entrepreneurs that help them in different ways.

Table 6-1 below shows a breakdown of these policies and programs by the resource area that the initiatives pertain to. Each initiative is referenced by the section in which it is described.

**Table 6-1: Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| **Resource 1 – Procurement and Contracting** | 1. EO 11625 - Prescribing additional arrangements for developing and coordinating a national program for minority business enterprise (Section 6-1-1-A)<br>2. EO 12138 - Creating a National Women's Business Enterprise Policy and prescribing arrangements for developing, coordinating and implementing a national program for women's business enterprise (Section 6-1-1-B)<br>3. EO 12928 - Promoting Procurement With Small Businesses Owned and Controlled by Socially and Economically Disadvantaged Individuals, Historically Black Colleges and Universities, and Minority Institutions (Section 6-1-1-D)<br>4. The Small Business Act of 1978 (P.L. 95-507), (Section 6-1-2-E)<br>5. Women's Business Ownership Act of 1988, (Section 6-1-2-H)<br>6. The Federal Acquisition Streamlining Act (FASA) of 1994, (Section 6-1-2-I)<br>7. The Historically Underutilized Business Zone (HUBZone) Act of 1997 (Section 6-1-2-J)<br>8. Veterans Entrepreneurship and Small Business Development Act of 1999 (P.L. 106.50) (Section 6-1-2-L)<br>9. The Treasury and General Government Appropriations Act of 2000 (Section 6-1-2-M)<br>10. The BIL of 2021 (P.L. 117-58) (Section 6-1-2-Y)<br>11. The IRA of 2022, (Section 6-1-2-AA)<br>12. The Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act of 2022 (Section 6-1-2-AC)<br>13. The Office of Small and Disadvantaged Business Utilization (OSDBU) or the Office of Small Business Programs (OSBP) at many federal agencies (Section 6-1-3)<br>14. SBA Community Navigators Pilot Program (Section 6-1-3-A ii)<br>15. SBA's 8(a) Business Development Program (Section 6-1-3-A xiii)<br>16. SBA's WOSB Program (Section 6-1-3-A xv)<br>17. SBA's HUBZone Program (Section 6-1-3-A xvi)<br>18. Department of Veteran Affairs (VA) VetBizLadyStart program (Section 6-1-3-E ii) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| | 19. U.S. Department of Transportation (USDOT) Disadvantaged Business Enterprise (DBE) Program (Section 6-1-3-K)<br>20. USDOT Small Business Transportation Resource Centers (SBTRCs) (Section 6-1-3-K iii)<br>21. Department of Defense (DOD) APEX Accelerators program (Section 6-1-3-Q)<br>22. State small business certification programs (Section 6-1-4) |
| **Resource 2 – Education and Workforce Development** | 1. EO 12881 - Establishment of the National Science and Technology Council (Section 6-1-1-C)<br>2. Diversity and Equity EOs of 2021 (Section 6-1-1-E)<br>3. The Supplemental Military Construction Authorization Act (P.L. 85-325) and Department of Defense (DOD) Directive 5105.15, of 1958, (Section 6-1-2-C)<br>4. The National Science and Technology Policy, Organization, and Priorities Act of 1976 (P.L. 94-282) (Section 6-1-2-D)<br>5. The Small Business Development Centers (SBDCs) Act of 1980 (P.L. 96-302) (Section 6-1-2-F)<br>6. The NSF Authorization and Science and Technology Equal Opportunities Act of 1980 (Section 6-1-2-G)<br>7. The Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (P.L. 108-375), (Section 6-1-2-N)<br>8. The National Defense Authorization Act of 2006 (P.L. 109-163), (Section 6-1-2-O)<br>9. The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act of 2007 (Section 6-1-2-P)<br>10. The America COMPETES Reauthorization Act of 2010 (Section 6-1-2-Q)<br>11. The STEM Education Act of 2015 (Section 6-1-2-R)<br>12. The Inspiring the Next Space Pioneers, Innovators, Researchers, and Explorers (INSPIRE) Women Act of 2017 (Section 6-1-2-S)<br>13. The Promoting Women in Entrepreneurship Act of 2017 (Section 6-1-2-T)<br>14. The Crowdsourcing and Citizen Science Act of 2017 (Section 6-1-2-V)<br>15. The BIL of 2021 (P.L. 117-58) (Section 6-1-2-Y) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| | 16. The Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act of 2022 (Section 6-1-2-AC)<br>17. The OSDBUs or the OSBPs at many federal agencies (Section 6-1-3)<br>18. SBA technical assistance (Section 6-1-3-A i)<br>19. SBA Community Navigators Pilot Program (Section 6-1-3-A ii)<br>20. SBA Office of Entrepreneurial Development (OED) (Section 6-1-3-A xi)<br>21. SBA Programs for Investors in Microentrepreneurs (PRIME) (Section 6-1-2-A xii)<br>22. SBA's 8(a) Business Development Program (Section 6-1-3-A xiii)<br>23. SBA's Office of Women's Business Ownership (OWBO) (Section 6-1-2-A xiv)<br>24. Treasury's CDFI Fund (Section 6-1-3-B iii)<br>25. Commerce Department Minority Business Development Agency (MBDA) (Section 6-1-3-C i)<br>26. Commerce Department National Advisory Council on Innovation & Entrepreneurship (NACIE) (Section 6-1-3-C ii)<br>27. Commerce Department Economic Development Agency (EDA) Tech Hubs program. (Section 6-1-3-C iii)<br>28. Commerce Department EDA STEM Talent Challenge. (Section 6-1-3-C iv)<br>29. Commerce Department EDA Scaling Pandemic Resilience Through Innovation and Technology (SPRINT) Challenge (Section 6-1-3-C v)<br>30. Commerce Department EDA University Center program. (Section 6-1-3-C vi)<br>31. Commerce Department USPTO Women's Entrepreneurship (WE) initiative (Section 6-1-3-C vii)<br>32. Commerce Department USPTO STEMM (STEM plus Medicine) training (Section 6-1-3-C viii)<br>33. Commerce Department International Trade Administration (ITA) (Section 6-1-3-C x)<br>34. NSF ADVANCE program (Section 6-1-3-D ii)<br>35. NSF Directorate for Education and Human Resources (Section 6-1-3-D iii) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
| --- | --- |
| | 36. NSF "Rural girls engaged in math and science plus technology" project (Section 6-1-3-D iv)<br>37. NSF "Code: SciGirls! media to engage girls in computing pathways" project (Section 6-1-3-D v)<br>38. NSF SciGirls in the national parks (Section 6-1-3-D vi)<br>39. NSF Innovation Corps (I-Corps) program (Section 6-1-3-D vii)<br>40. NSF Regional Engine program (Section 6-1-3-D ix)<br>41. NSF's S-STEM program (Section 6-1-3-D x)<br>42. NSF Experiential Learning for Emerging and Novel Technologies (ExLENT) program (Section 6-1-3-D x)<br>43. NSF Research Traineeship (NRT) program. (Section 6-1-3-D x)<br>44. NSF Non-Academic Research Internships for Graduate Students (INTERN) program (Section 6-1-3-D x)<br>45. NSF grants for STEMM teachers (Section 6-1-3-D xi)<br>46. NSF program with the Intel Corporation. (Section 6-1-3-D xii)<br>47. NSF's Quantum Information Science and Engineering (ExpandQISE) program (Section 6-1-3-D xiii)<br>48. NSF's Growing Research Access for Nationally Transformative Equity and Diversity (GRANTED) program (Section 6-1-3-D xiii)<br>49. NSF TILOS research institute (Section 6-1-3-D xiv)<br>50. VA VetBizLadyStart program. (Section 6-1-3-E ii)<br>51. VA and PenFed Foundation Women Veteran Boot Camp Accelerator program (Section 6-1-3-E iii)<br>52. VA Veteran Women Igniting the Spirit of Entrepreneurship (V-WISE) program. (Section 6-1-3-E iv)<br>53. VA Edith Nourse Rogers STEM Scholarship Program (Section 6-1-3-E v)<br>54. VA's Veteran Employment through Technology Education Courses (VET TEC) program. (Section 6-1-3-E v)<br>55. State Department Providing Opportunities for Women's Economic Rise (POWER) (Section 6-1-3-F i) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| | 56. State Department Academy for Women Entrepreneurs (AWE) (Section 6-1-3-F ii)<br>57. U.S. Department of Agriculture (USDA) Rural Cooperative Development Grant program (Section 6-1-3-G iv)<br>58. USDA Rural Innovation Stronger Economy (RISE) Grant Program (Section 6-1-3-G vi)<br>59. USDA Rural Microentrepreneur Assistance Program (RMAP). (Section 6-1-3-G vii)<br>60. USDA Socially Disadvantaged Groups Grant program. (Section 6-1-3-G viii)<br>61. USDA National Institute of Food and Agriculture (NIFA) (Section 6-1-3-G ix)<br>62. USDA memorandum of understanding (MOU) with SBA (Section 6-1-3-G x)<br>63. Environmental Protection Agency (EPA) Environmental Education (EE) Grants (Section 6-1-3-I i)<br>64. EPA RTP-STEM outreach program (Section 6-1-3-I ii)<br>65. EPA Oak Ridge Institute for Science and Education (ORISE) (Section 6-1-3-I iii)<br>66. EPA Science To Achieve Results (STAR) program (Section 6-1-3-I iv)<br>67. EPA People, Prosperity and the Planet Program (Section 6-1-3-I v)<br>68. Department of Energy (DOE) program to develop clean energy innovation in underserved communities (Section 6-1-3-J i)<br>69. DOE Inclusive Energy Innovation Prize (Section 6-1-3-J ii)<br>70. DOE National Nuclear Security Administration Stewardship Science Graduate Fellowship (Section 6-1-3-J iii)<br>71. DOE New Energy Sciences Workforce (RENEW) program (Section 6-1-3-J iv)<br>72. DOE's Accelerated, Inclusive Research (FAIR) program (Section 6-1-3-J iv)<br>73. USDOT STEP program (Section 6-1-3-K i)<br>74. USDOT SBTRCs) (Section 6-1-3-K iii)<br>75. USDOT Women and Girls in Transportation program (WITI) (Section 6-1-3-K iv) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| | 76. USDOT Bonding Education Program (BEP). (Section 6-1-3-K v)<br>77. State transportation departments support the education and development of AEC entrepreneurs (Section 6-1-3-K vi)<br>78. Education Department "You Belong in STEM" National Coordinating Conference (Section 6-1-3-L i)<br>79. Education Department federal outreach and student services programs (Section 6-1-3-L ii)<br>80. Department of Interior (DOI) partnership with the University of Alaska Anchorage's Alaska Native Science and Engineering Program (ANSEP) (Section 6-1-3-M ii)<br>81. DOI partnerships between Bureau of Land Management (BLM) and non-governmental organizations (NGOs) (Section 6-1-3-M iii)<br>82. National Aeronautics and Space Administration (NASA) STEM education programs (Section 6-1-3-N i)<br>83. NASA Open Innovation Team program (Section 6-1-3-N ii)<br>84. Department of Labor (DOL) cybersecurity apprenticeships (Section 6-1-3-O i)<br>85. DOL WANTO grant (Section 6-1-3-O ii)<br>86. DOL Fostering Access, Rights, and Equity (FARE) grant<br>87. NIH training and mentoring grants (Section 6-1-3-P i)<br>88. NIH Transformative Research to Address Health Disparities and Advance Health Equity program (Section 6-1-3-P ii)<br>89. NIH UNITE initiative (Section (Section 6-1-3-P ii)<br>90. DOD's National Defense Education Program (NDEP) (Section 6-1-3-Q i)<br>91. DOD's Science, Mathematics, and Research for Transformation (SMART) program (Section 6-1-3-Q ii)<br>92. Department of Homeland Security (DHS) STEM Optional Practical Training (OPT) program. (Section 6-1-3-R i)<br>93. DHS national interest waiver for STEM fields (Section 6-1-3-R ii) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
| --- | --- |
| | 94. DHS O-1A nonimmigrant status visa initiative (Section 6-1-3-R iii)<br>95. DHS visa requirement change for Artificial Intelligence (AI) workers (Section 6-1-3-R iv)<br>96. State small business certification programs (Section 6-1-4)<br>97. Texas Skills for Small Business Program (Section 6-1-4-C)<br>98. Illinois Department of Commerce and Economic Opportunity (DCEO) Grants for Women Entrepreneurs (Section 6-1-4-D)<br>99. State Level STEM Education Programs (Section 6-1-4-H)<br>100. Babson College Frank & Eileen™ for Women's Center Entrepreneurial Leadership (F&E CWEL) programs (Section 6-1-5-A i)<br>101. The California Program for Entrepreneurship (CAPE) (Section 6-1-5-A ii)<br>102. The University of Utah's Department of Entrepreneurship & Strategy at the David Eccles School of Business (Section 6-1-5-A iii)<br>103. The University of Dayton entrepreneurship major (Section 6-1-5-A v)<br>104. The University of Tennessee at Chattanooga Center for Innovation and Entrepreneurship. (Section 6-1-5-A vi)<br>105. Vanderbilt University and Fisk University partnership for STEMM-related research. (Section 6-1-5-A vii)<br>106. Johns Hopkins University Vivien Thomas Scholars Initiative (Section 6-1-5-A viii)<br>107. East Carolina University (ECU) diversity, equity and inclusion (DEI) program (Section 6-1-5-A ix (a))<br>108. University of Michigan Women in Science and Engineering (WISE) and WISE Residence Program (WISE RP) (Section 6-1-5-A ix (b))<br>109. University of Michigan College of Engineering Office of Culture, Community and Equity (OCCE) (Section 6-1-5-A ix (b))<br>110. University of Michigan Rackham Graduate School DEI instruction (Section 6-1-5-A ix (b)) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| | 111. University of Michigan STEM-related women's groups (Section 6-1-5-A ix (b))<br>112. Texas Christian University (TCU) DEI program (Section 6-1-5-A ix (c))<br>113. NAWIC programs (Section 6-1-6 i)<br>114. CARE Women's Entrepreneurship programming (Section 6-1-6 ii)<br>115. The Rising Tide (Section 6-1-6 iv)<br>116. 3M incremental giving commitment (Section 6-1-6 xi)<br>117. Novartis program with historically black college and university (HBCU) medical centers (Section 6-1-6-xi)<br>118. Microsoft Racial Equity Initiative (Section 6-1-6 xi)<br>119. Ballard Spahr INVEST sponsorship program (Section 6-1-6-xi)<br>120. Arcweb Technologies DEI training (Section 6-1-6 xi)<br>121. Burroughs Wellcome Fund and STEMM Opportunity Alliance (Section 6-1-6-xi)<br>122. Chan Zuckerberg Initiative (CZI) (Section 6-1-6-xi)<br>123. The National GEM Foundation Consortium (Section 6-1-6-xi)<br>124. Heising-Simons Foundation STEMM Opportunity Alliance funding (Section 6-1-6-xi)<br>125. Howard Hughes Medical Institute (HHMI) training programs (Section 6-1-6-xi)<br>126. The Last Mile Education Fund (Section 6-1-6-xi)<br>127. Simons Foundation STEMM efforts (Section 6-1-6-xi)<br>128. Tiger Global Investment Ventures (TGIV) Gender Equity in Tech Fund (T-GET) (Section 6-1-6-xi)<br>129. OECD's Women's Entrepreneurship Initiative – WE Initiative (Section 6-1-7-i)<br>130. Women in the Sustainable Economy (WISE) initiative (Section 6-1-7-ii) |
| **Resource 3 – Diverse Faculty Hiring, Promotion, and Entrepreneurship** | 1. NSF ACCelerating Entrepreneurial succeSS (ACCESS) project (Section 6-1-3-D i)<br>2. NSF ADVANCE program (Section 6-1-3-D ii) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| | 3. Cornell University W.E. Cornell program (Section 6-1-5-A iv)<br>4. The University of Tennessee at Chattanooga Center for Innovation and Entrepreneurship. (Section 6-1-5-A vi)<br>5. University of Michigan College of Engineering Office of Culture, Community and Equity (OCCE) (Section 6-1-5-A ix (b))<br>6. Texas Christian University (TCU) DEI program (Section 6-1-5-A ix (c))<br>7. Grant-writing boot camp for academic women in the STEM fields (Section 6-1-6 vii)<br>8. ECU DEI program (Section 6-1-5-A ix (a))<br>9. HHMI Freeman Hrabowski Scholars program (Section 6-1-6-xi) |
| **Resource 4 – Patenting, Licensing, and Commercialization** | 1. The CHIPS and Science Act of 2022 (Section 6-1-2-AC)<br>2. Commerce Department NACIE (Section 6-1-3-C ii)<br>3. Commerce Department EDA Tech Hubs program (Section 6-1-3-C iii)<br>4. Commerce Department EDA SPRINT Challenge (Section 6-1-3-C v)<br>5. Commerce Department University Center program (Section 6-1-3-C vi)<br>6. Commerce Department USPTO WE initiative (Section 6-1-3-C vii)<br>7. Commerce Department USPTO Invention-Con conferences, Council for Inclusive Innovation and the Patent Pro Bono Program (Section 6-1-3-C ix)<br>8. NSF's ACCESS project (Section 6-1-3-D i)<br>9. NSF's I-Corps program. (Section 6-1-3-D vii)<br>10. DOE's program to develop clean energy innovation in underserved communities. (Section 6-1-3-J i)<br>11. NASA technology transfer programs (Section 6-1-3-N ii)<br>12. Virginia Regional Innovation Fund (RIF) (Section 6-1-4-G)<br>13. Virgina Commonwealth Commercialization Fund (CCF) (Section 6-1-4-G)<br>14. Cornell University W.E. Cornell program (Section 6-1-5-A iv) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| | 15. The University of Tennessee at Chattanooga Center for Innovation and Entrepreneurship. (Section 6-1-5-A vi)<br>16. WIPO GREEN online connection place for new technology owners and licensing entities (Section 6-1-6 vi)<br>17. Tory Burch Foundation Fellows Program (Section 6-1-6 viii)<br>18. Cartier Women's Initiative (Section 6-1-6 viii) |
| **Resource 5 – Grant Funding** | 1. The Coronavirus Aid, Relief, and Economic Security (CARES) Act of 2020, (Section 6-1-2-W)<br>2. The American Rescue Plan (ARP) Act of 2021 (P.L. 117-2), (Section 6-1-2-X)<br>3. The SBIR and STTR Extension Act of 2022, (Section 6-1-2-AB)<br>4. SBA's Federal and State Technology (FAST) Partnership Program, (Section 6-1-2-AC vii)<br>5. SBA SBIR and STTR programs, (Section 6-1-3-A iv)<br>6. NSF's ACCESS project. (Section 6-1-3-D i)<br>7. VA and PenFed Foundation Women Veteran Boot Camp Accelerator program (Section 6-1-3-E iii)<br>8. USDOT SBIR funding related to transportation, aviation and shipping. (Section 6-1-3-K ii)<br>9. Tory Burch Foundation Fellows Program (Section 6-1-6 viii)<br>10. Cartier Women's Initiative (Section 6-1-6 viii)<br>11. The Amber Grant (Section 6-1-6-viii)<br>12. Eileen-Fisher Women-Owned Business Grant Program (Section 6-1-6-viii)<br>13. The SoGal Black Founder Startup Grant (Section 6-1-6-ix)<br>14. The Women of Color Grant Program (Section 6-1-6-ix) |
| **Resource 6 – Other Funding and Financing** | 1. The Small Business Acts of 1953 (P.L. 83-163) & 1958 (P.L. 85-536) (Section 6-1-2-A)<br>2. The Small Business Investment Act of 1958 (P. L. 85–699) (Section 6-1-2-B)<br>3. Women's Business Ownership Act of 1988, (Section 6-1-2-H)<br>4. The CARES Act of 2020 (Section 6-1-2-W)<br>5. The ARP Act of 2021 (P.L. 117-2) (Section 6-1-2-X) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
| --- | --- |
| | 6. The Consolidated Appropriations Act of 2021 (P.L. 116-260) (Section 6-1-2-Z)<br>7. The IRA of 2022 (Section 6-1-2-AA)<br>8. SBA technical assistance (Section 6-1-3-A i)<br>9. SBA Community Navigators Pilot Program (Section 6-1-3-A ii)<br>10. SBA 7(a) and 504 loan programs (Section 6-1-3-A iii)<br>11. SBA SBIC Program (Section 6-1-3-A v)<br>12. SBA Growth Accelerator Fund Competition (GAFC) Program (Section 6-1-3-A vi)<br>13. SBA Small Business Lending Company (SBLC) licenses, (Section 6-1-3-A x)<br>14. Treasury Department State Small Business Credit Initiative (SSBCI) (Section 6-1-3-B i)<br>15. Treasury Department Small Business Lending Fund (SBLF) (Section 6-1-3-B ii)<br>16. Treasury Department CDFI Fund (Section 6-1-3-B iii)<br>17. Commerce Department EDA SPRINT Challenge (Section 6-1-3-C v)<br>18. USDA Business and Industry Loan Guarantees (B&I) program (Section 6-1-3-G i)<br>19. USDA Intermediary Relending Program (IRP) (Section 6-1-3-G ii)<br>20. USDA Rural Business Investment Program (RBIP) (Section 6-1-3-G iii)<br>21. USDA Rural Economic Development Loan and Grant (REDLG) programs (Section 6-1-3-G v)<br>22. USDA RISE Grant Program (Section 6-1-3-G vi)<br>23. USDA RMAP (Section 6-1-3-G vii)<br>24. California Small Business Grant Program (Section 6-1-4-A)<br>25. New York State MWBE Development & Lending Program (Section 6-1-4-B)<br>26. Illinois DCEO Grants for Women Entrepreneurs (Section 6-1-4-D)<br>27. Virginia Small Business Financing Authority (VSBFA) Industrial Development Bonds (IDBs) (Section 6-1-4-F i)<br>28. VSBFA Economic Development Loan Fund (EDLF) (Section 6-1-4-F ii) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| | 29. VSBFA Loan Guaranty Program (LGP) (Section 6-1-4-F iii)<br>30. VSBFA Cash Collateral Program (CCP) (Section 6-1-4-F iv)<br>31. Virginia Venture Partners (VVP) (Section 6-1-4-G)<br>32. Virginia State Small Business Credit Initiative (SSBCI) (Section 6-1-4-G)<br>33. VVP Fund of Funds. (Section 6-1-4-G)<br>34. Virginia Founders Fund (VFF) (Section 6-1-4-G)<br>35. Virginia RIF (Section 6-1-4-G)<br>36. Virginia CCF (Section 6-1-4-G)<br>37. The University of Dayton entrepreneurship major (Section 6-1-5-A v)<br>38. The University of Tennessee at Chattanooga Center for Innovation and Entrepreneurship (Section 6-1-5-A vi)<br>39. CARE Women's Entrepreneurship programming (Section 6-1-6 ii)<br>40. Black Founders in San Francisco (Section 6-1-6 iii)<br>41. 37 Angels investor platform (Section 6-1-6 x)<br>42. TEDCO Social Impact Funds (Section 6-1-6-xi)<br>43. OECD CEFIM program (Section 6-1-7-i)<br>44. Women in the Sustainable Economy (WISE) initiative (Section 6-1-7-ii) |
| **Resource 7 – Networking and Mentoring** | 1. SBA technical assistance (Section 6-1-3-A i)<br>2. SBA's Mentor-Protégé Program (MPP) (Section 6-1-3-A viii)<br>3. SBA Regional Innovation Clusters (RICs) (Section 6-1-3-A ix)<br>4. Commerce Department USPTO WE initiative (Section 6-1-3-C vii)<br>5. NSF Regional Engine program (Section 6-1-3-D ix)<br>6. VA Women Veteran-Owned Small Business Initiative (WVOSBI) (Section 6-1-3-E i)<br>7. VA VetBizLadyStart program (Section 6-1-3-E ii)<br>8. State Department POWER (Section 6-1-3-F i)<br>9. State Department AWE (Section 6-1-3-F ii)<br>10. USDA MOU with SBA (Section 6-1-3-G x)<br>11. DOI STEM Mentoring Event (Section 6-1-3-M i)<br>12. NIH provides grants to support training and mentoring. (Section 6-1-3-P i) |

**Table 6-1 (Continued): Policies and Programs Broken Down by Resource Area**

| Resources | Policies and Programs |
|---|---|
| | 13. DOD APEX Accelerators program (Section 6-1-3-Q)<br>14. The California CAPE (Section 6-1-5-A ii)<br>15. The University of Tennessee at Chattanooga Center for Innovation and Entrepreneurship (Section 6-1-5-A vi)<br>16. NAWIC programs (Section 6-1-6 i)<br>17. CARE Women's Entrepreneurship programming (Section 6-1-6 ii)<br>18. The Rising Tide (Section 6-1-6 iv)<br>19. Women's Initiative Network (WIN), Taking the Stage, Oracle Women Leadership Mentoring program, Dell Women's Entrepreneur Network (DWEN) and Astia (Section 6-1-6 v)<br>20. Tory Burch Foundation Fellows Program (Section 6-1-6 viii)<br>21. Cartier Women's Initiative (Section 6-1-6 viii)<br>22. OECD's WE Initiative (Section 6-1-7-i)<br>23. Women in the Sustainable Economy (WISE) initiative (Section 6-1-7-ii) |
| **Resource 8 - Taxes and Payment Assistance** | 1. Taxpayer Relief Act of 1997 (Section 6-1-2-K)<br>2. Tax Cuts and Jobs Act of 2017 (Section 6-1-2-U)<br>3. The CARES Act of 2020 (Section 6-1-2-W)<br>4. The ARP Act of 2021 (P.L. 117-2) (Section 6-1-2-X)<br>5. The IRA of 2022 (Section 6-1-2-AA)<br>6. Internal Revenue Service (IRS) Retirement Plans Startup Costs Tax Credit (Section 6-1-3-H i)<br>7. IRS Small Business Health Care Tax Credit (Section 6-1-3-H ii)<br>8. Maryland Biotechnology Investment Incentive Tax Credit (BIITC) (Section 6-1-4-E) |

### 6-1-1 Federal Executive Orders

This section describes the federal EOs[xix] that impact women entrepreneurs and Women in STEM.

#### *6-1-1-A EO 11625 - Prescribing additional arrangements for developing and coordinating a national program for minority business enterprise*

EO 11625 issued in 1971 authorized the Secretary of Commerce to coordinate federal government plans, programs, and operations related to Minority Business Enterprises (MBE)[xx]. Federal agencies were required to cooperate with the Secretary of Commerce and collect data helpful in evaluating and promoting MBE efforts. This order is relevant to women-owned businesses that are minority-owned.

#### *6-1-1-B EO 12138 - Creating a National Women's Business Enterprise Policy and prescribing arrangements for developing, coordinating and implementing a national program for women's business enterprise*

EO 12138 was issued in 1979[xxi]. The Order created a National Women's Business Enterprise Policy and specified provisions for developing, coordinating and implementing a Women's Business Enterprise (WBE) national program. Per the Order, each Federal agency was required to designate a high level official responsible for carrying out the Order. Each agency was also required to ensure the participation of WBEs in all business-related activities including procurement. The order also established the Interagency Committee on Women's Business Enterprise. The Committee was responsible for establishing policies, and procedures for implementation, interpretation, and application of the Order, and for promoting, coordinating and monitoring the plans, programs and operations of different departments.

#### *6-1-1-C EO 12881 - Establishment of the National Science and Technology Council*

EO 12881 issued in 1993 established the National Science and Technology Council (NSTC)[xxii]. The NSTC advises the President on science and technology issues. The NSTC coordinates policies related to these issues across the federal government, and makes sure they are consistent with the President's priorities[xxiii]. There are six committees that carry out the work of the NSTC – Science & Technology Enterprise, Environment, Homeland and National Security, Science, STEM Education, and Technology. Women entrepreneurs in STEM fields are possibly helped by this work, designed to promote STEM education and STEM overall.

#### *6-1-1-D EO 12928 - Promoting Procurement With Small Businesses Owned and Controlled by Socially and Economically Disadvantaged Individuals, Historically Black Colleges and Universities, and Minority Institutions*

This Order was signed in 1994 to promote procurement with small businesses controlled by socially and economically disadvantaged individuals, HBCUs and Minority

Institutions (MI)[xxiv]. The Order established a contracting goal for these entities and reaffirmed existing laws, EOs and regulations relevant to minority participation.

### *6-1-1-E Diversity and Equity EOs of 2021 – EOs 13985, 13988, 14020 and succeeding EOs 14041, 14045, 14049, 14050, and 14091*

A number of EOs issued in 2021[xxv], intended to promote diversity and equity in the Federal workforce. Table 6-2 below lists these EOs and what they aimed to do.

**Table 6-2: Diversity and Equity EOs of 2021**

| EOs | Description |
|---|---|
| EO 13985 | This EO ordered federal agencies to support underserved communities. |
| EO 13988 | This EO expanded protections based on gender identity and sexual orientation |
| EO 14031 | This EO aimed to advance equity, opportunity and justice for Asian Americans, Native Hawaiians, and Pacific Islanders |
| EO 14034 | This EO targeted training opportunities for underserved communities. It also directed federal offices such as the Office of Management and Budget (OMB), and the Office of Science and Technology Policy (OSTP) focused on science and technology to build partnerships with underserved communities, to diversify the federal employment pipeline[xxvi]. |
| EO 14035 | This was a government-wide initiative to promote diversity and equity |

The succeeding EOs primarily addressed racial and tribal inequities in education and in partnerships, with the Federal government and others. Table 6-3 below lists these EOs and describes the groups they were trying to help.

**Table 6-3: Subsequent Diversity and Equity EOs**

| EOs | Description |
|---|---|
| EO 14041 | This EO was directed primarily towards Historically Black Colleges and Universities (HBCUs) |
| EO 14045 | This EO was directed towards Hispanic students, and updated and expanded an office originally begun in 1990[xxvii]. |
| EO 14049 | This EO was directed towards Native Americans |
| EO 14050 | This EO was directed towards Black students |
| EO 14091 | This EO concerned underserved communities and racial Equity[xxviii]. |

These EOs could increase the opportunities for women entrepreneurs in these groups, by increasing training opportunities and the possibilities for patenting through motivation.

### 6-1-2 Federal Legislation

This section describes the federal legislation that impacts women entrepreneurs and Women in STEM.

#### *6-1-2-A The Small Business Acts of 1953 (P.L. 83-163) & 1958 (P.L. 85-536)[xxix]*

The 1953 Act created the SBA, an agency with programs to provide loans and other assistance to small businesses. The 1958 Act provided permanent status to the SBA, allowing it to continue its small business programs[xxx].

#### *6-1-2-B The Small Business Investment Act of 1958 (P. L. 85–699)[xxxi]*

This purpose of this Act was to help meet small business equity and long-term credit needs better than before[xxxii]. The Act created the Small Business Investment Company (SBIC) program. The SBA licenses SBICs, privately organized and managed companies that invest in small businesses. SBICs use their own funds and investor funds backed by SBA guarantees to provide capital to small businesses[xxxiii].

#### *6-1-2-C The Supplemental Military Construction Authorization Act (P.L. 85-325) and DOD Directive 5105.15, of 1958*

This Act and Directive resulted in the creation of the Advanced Research Projects Agency (ARPA) within DOD. The purpose of this agency was to develop R&D projects in technology and science[xxxiv]. ARPA was renamed in 1972 as the Defense Advanced Research Projects Agency (DARPA). DARPA has helped create precision weapons, stealth technology, the internet, automated voice recognition and other technological advancements[xxxv]. While this agency is not specifically focused on women entrepreneurs, some of its creations have possibly helped create an environment of innovation indirectly helpful to female businesses.

### *6-1-2-D The National Science and Technology Policy, Organization, and Priorities Act of 1976 (P.L. 94-282)*

This Act established the OSTP to serve as a scientific and technological analysis source for the President[xxxvi]. OSTP was also responsible for the lead on The Federal STEM Education Strategic Plan, which involved an Interagency Working Group (IWG). The IWG was made of a number of agencies, including the departments of Defense, Commerce, Energy, Interior, Homeland Security, Labor, and State, the EPA, especially its Office of Environmental Education, and others. The IWG was responsible for the Federal STEM Education Strategic Plan, a 5-year plan to increase STEM participation to prepare individuals in the STEM fields, and to increase diversity among their numbers. The two latest progress reports on this work are one describing work as of 2021

.

OSTP also hosts events to introduce women to STEM fields, such as "Water Unites Us", an event co-sponsored with The Smithsonian Institution in 2022[xxxix].

### *6-1-2-E The Small Business Act of 1978 (P.L. 95-507)*

This Act amended the *Small Business Act* and the *Small Business Investment Act*. It called for maximum opportunities for small businesses, small disadvantaged businesses (SDBs) and women-owned businesses in government acquisitions. Each federal agency with contracting authority was required to establish an Office of Small and Disadvantaged Business Utilization (OSDBU), and appoint a director responsible for carrying out the Act[xl].

### *6-1-2-F The SBDCs Act of 1980 [xli](P.L. 96-302)*

The SBA's SBDCs partner with state governments and educational institutions to provide free services to small business owners that include counseling, training, and resources. Before the 1970s the SBA provided these services directly. Starting in the 1970s these services were provided through third party providers. In 1980, Congress authorized the SBDC program through the *SBDCs Act of 1980 (P.L. 96-302)*.

### *6-1-2-G The NSF Authorization and Science and Technology Equal Opportunities Act of 1980*

This Act authorized NSF to fully use human resources in science and technology through efforts to advance women and minorities in scientific, professional, and technical careers[xlii]. This Act also established the Committee on Equal Opportunities in Science and Engineering (CEOSE), to advice NSF on programs and policies to encourage women, minorities, disabled persons in STEM.

### *6-1-2-H Women's Business Ownership Act of 1988*

*The Women's Business Ownership Act of 1988 (House Bill 5050)* enhanced EO 12138. This Act created NWBC. The NWBC serves as an advisory council to the federal government and makes recommendations to the Congress, the President, and the SBA on initiatives, policies, and programs related to female-owned businesses[xliii]. This legislation also did the following:

i) Eliminated state laws that required women to have a male relative or husband co-sign a business loan.

ii) Established the Women's Business Center (WBC) program.

iii) Required the Census to include women-owned corporations in data collection.

### *6-1-2-I The FASA of 1994*[xliv]

This Act increased thresholds for small business set-asides, established a government wide procurement goal for women-owned businesses, authorized civilian agencies to set-aside contracts for SDBs, and created a “"Small Business Advisory Council", with representatives from federal agencies[xlv].

### *6-1-2-J The HUBZone Act of 1997*

This Act created the HUBZone Program to provide federal contracting opportunities for qualified small businesses located in economically distressed communities. It is relevant to small women-owned businesses located in these zones[xlvi].

### *6-1-2-K Taxpayer Relief Act of 1997*

This Act had the following measures that could be beneficial to women-owned small businesses:

i) A $400 child tax credit was introduced in 1998 and increased to $500 in 1999.

ii) Starting in 1998, family farms and small businesses could qualify for an exemption from the estate tax on estates up to $1.3 million[xlvii].

This Act may have helped some women entrepreneurs, especially in rural areas.

### *6-1-2-L Veterans Entrepreneurship and Small Business Development Act of 1999 (P.L. 106.50)*

This Act amended the *Small Business Act* to include service-disabled veteran small businesses. It established a government contracting goal for these businesses, and required federal agencies to develop prime contracting targets[xlviii]. This impacts women-owned businesses that are service-disabled veterans.

### *6-1-2-M The Treasury and General Government Appropriations Act of 2000*

The Women-Owned Small Business (WOSB) program began in December 2000 as a result of this Act[xlix]. It was established to help the federal government meet its goal of awarding at least 5% of all contracting dollars to women-owned small businesses[l]. It has expanded since as explained in Section 6-1-3-A, "SBA Initiatives and Programs", below.

### *6-1-2-N The Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (P.L. 108-375)*

This Act required the Secretary of Defense to implement the Science, Mathematics, and Research for Transformation (SMART) scholarship pilot program[li]. The program was to provide financial assistance for STEM skills education critical for national security. This was possibly helpful to female STEM entrepreneurs, through the development of STEM skills.

### *6-1-2-O The National Defense Authorization Act of 2006 (P.L. 109-163)*

This Act made permanent the SMART pilot program to address scientist and engineer deficiencies in the national security workforce[lii]. This was probably helpful to female STEM entrepreneurs by the enhancement of STEM skills over time.

### *6-1-2-P The America COMPETES Act of 2007*

This Act aimed to strengthen U.S. competitiveness in science and technology. It authorized investments in science, technology R&D, and STEM education[liii]. The law also authorized the creation of the Advanced Research Projects Agency-Energy (ARPA-E)[liv]. This agency makes investments in early-stage critical energy technologies to accelerate their development. Such investments could increase market size in STEM fields, and possibly provide more demand for women STEM entrepreneurs.

### *6-1-2-Q The America COMPETES Reauthorization Act of 2010*

The Committee on STEM Education (CoSTEM) was established in 2011 as a result of this Act[lv]. This committee reviews and coordinates STEM education programs in federal agencies, and works with them to develop a STEM education strategic plan every five years. The Federal Coordination in STEM Education (FC-STEM) subcommittee of CoSTEM facilitates the development and implementation of the strategic plan[lvi]. Women entrepreneurs in STEM are possibly helped by this promotion of STEM education overall.

### *6-1-2-R The STEM Education Act of 2015*

This Act directed the NSF to continue awarding merit-based grants for informal STEM education carried out by entities such as museums, science centers, and afterschool programs[lvii]. This was probably helpful to female STEM entrepreneurs by increasing the availability of STEM education.

### *6-1-2-S The INSPIRE Women Act of 2017*

This Act directs NASA to encourage women and girls to study STEM, pursue aerospace careers, and advance space science and exploration efforts through three initiatives[lviii]. These initiatives include NASA girls and boys mentoring programs, an outreach program and a summer institute program for middle school students. The Act also directs the agency to facilitate engagement by female astronauts and STEM professionals with K-12 female students. This Act helps women STEM businesses by potentially increasing the STEM workforce.

### *6-1-2-T The Promoting Women in Entrepreneurship Act of 2017*

This Act amended the Science and Engineering Equal Opportunities Act. It authorized NSF's entrepreneurship programs to recruit and support women, beyond the laboratory and into the commercial world[lix].

### *6-1-2-U Tax Cuts and Jobs Act of 2017*

The *December 2017 Tax Cuts and Jobs Act* established "Opportunity Zones"[lx]. This was done to provide tax incentives for investments in economically distressed communities. These investments - if they took place in distressed communities - could provide benefits to female entrepreneurs in these areas.

### *6-1-2-V The Crowdsourcing and Citizen Science Act of 2017*

This Act describes the benefits of public participation in science. It encourages federal agencies to increase public involvement to accelerate and make scientific research more cost-effective, address societal needs, provide hands-on learning in STEM, and to connect with citizens[lxi]. This could help women STEM entrepreneurs by making available a more enlightened and engaged workforce.

### *6-1-2-W The CARES Act of 2020*

The *CARES Act* provided benefits to individuals, families and businesses to tide them over the COVID 19 pandemic[lxii]. Some of the measures under the Act included:

i) Direct payments to families making less than an income threshold, additional payments if they had children.

ii) Mortgage and Rent Relief through a moratorium on foreclosures and evictions.

iii) Extension of the eligibility and benefits of unemployment assistance.

iv) The PPP program for businesses, nonprofit and veteran organizations, and tribal businesses with fewer than 500 employees. Eligible businesses could receive a small business loan up to two and a half times their average monthly payroll, to cover payroll, benefits, salaries, interest payments, rent, and utilities. The loan principal could be forgiven up to the total cost of payroll, mortgage interest payments, rent, and utility payments, with the caveat that the forgiven amount would be reduced if there was a reduction in the average number of employees during that time period.

v) Emergency grants for small businesses, private nonprofits, sole proprietorships, agricultural co-ops, and employee-owned firms.

vi) Small businesses impacted by COVID-19 could apply for an Economic Injury Disaster Loan (EIDL). EIDLs of $10,000 did not have to be paid back, and businesses could borrow loans up to $200,000 without a personal guarantee.

The measures for individuals and families described above may have increased their financial stability, and propensity to invest in businesses. The small business initiatives under the programs helped businesses maintain their payroll and operations in light of the pandemic. However, the first round of PPP was delivered through mainstream financial institutions that are "less relevant to underbanked and unbanked MWBEs" (Liu and Parilla 2020). Wiersch and Misera (2021) find that amongst PPP applicants, women-owned firms were more likely to be denied funding and less likely to receive the total amount of funding they applied for. Black women-owned businesses were least likely to receive all of the PPP funding that they applied for. The second round of PPP used community organizations to deliver assistance, which was probably more beneficial to women and minorities. Government assistance provided to businesses in light of anticipated shocks to the economy in the future, needs to account for these "assistance gaps" and nontraditional ways of delivering funding.

### *6-1-2-X The American Rescue Plan (ARP) Act of 2021 (P.L. 117-2)*

*The ARP* Act featured several initiatives[lxiii] that could increase the financial stability and entrepreneurship of disadvantaged individuals, including those led by female entrepreneurs:

i) An increase in the amount of the Child Tax Credit per child and in the age limit for the credit.

ii) An increase and expansion in the Child and Dependent Care Tax Credit, which made more people eligible and increased the amount of the credit.

iii) An extension of unemployment benefits and provision of supplemental benefit.

iv) Emergency grants, lending, and investment to hard-hit small businesses.

v) Establishing a Small Business Opportunity Fund to provide funding to main street small businesses in economically disadvantaged areas, including minority-owned businesses.

vi) Lowering health insurance premiums for low- and middle-income families and continuation of health coverage (COBRA) subsidy.

### *6-1-2-Y The BIL of 2021 (P.L. 117-58)*

There are some features in this Act that could provide direct or indirect to women entrepreneurs, especially women entrepreneurs in STEM-adjacent sectors such as construction[lxiv] and clean energy. These include:

i) A six-year plan in partnership with states[lxv] to provide no-cost preschool for families with 3- and 4-year-olds.

ii) Technological advancements to increase workplace safety through worker training.

iii) Infrastructure expansion through the construction of roads and bridges, utility infrastructure, green energy grids and building improvements. This will lead to more construction jobs for women, which could lead to more women entrepreneurs in this sector.

iv) An Infrastructure Talent Pipeline Challenge that requires businesses in construction, electrification and broadband to educate traditionally underrepresented groups such as women.

v) A memorandum of understanding (MOU) by the DOL and the USDOT to help benefiting industries diversify their workforce.

vi) The law includes billions of dollars in clean energy expenditures including $7.5 billion for electric vehicle (EV) charging, $65 billion for electricity grid upgrades, and $8 billion for four (4) hydrogen hubs. Given the goals to commit some of these funds to disadvantaged communities, women-owned firms that have been underrepresented in infrastructure development projects could benefit from the spending[lxvi].

One example of the implementation of the BIL at the state level is in Louisiana[lxvii] where $4 billion in BIL funding has been announced for more than 100 projects across the state. The state is anticipating $5.9 billion in federal funding for highways and bridges over five (5) years. EO #2022-19 in Louisiana, aims to increase access to BIL-funded projects for small, minority, women veteran-owned, and disadvantaged businesses.

Nationally, $185 billion in funding for over 6,900 specific projects in 4000 communities across the U.S. had been announced by the end of 2022[lxviii]. Some of the highlights include:

- The USDOT and Federal Highway Administration (FHWA) announced close to $120 billion in funding for highways and bridges for fiscal years 2022 and 2023.
- USDOT announced $2.2 billion in funding for 166 projects to modernize roads, bridges, transit, rail, ports, and intermodal transportation in urban and rural communities.
- All states have access to $1.5 billion in funding from the National Electric Vehicle Infrastructure (NEVI) Formula Program, to build EV chargers for approximately 75,000 miles of highway across the U.S.
- The Indian Health Service (IHS) will allocate $700 million per fiscal year 2022 through 2026 for the IHS Sanitation Facilities Construction Program.
- The DOE launched the Grid Resilience Innovation Programs (GRIP) for power grid resilience and reliability.
- DOE also launched the regional clean hydrogen hubs program (H2Hubs).

### *6-1-2-Z The Consolidated Appropriations Act of 2021 (P.L. 116-260)*

This Act provided additional funding for pandemic relief and approved the federal fiscal year 2021 funding[lxix]. The Act continued many of the CARES Act programs and added new phases, allocations and guidance to these programs[lxx]. The Act made several amendments to the PPP. It included additional funding for the first and second rounds of forgivable PPP loans. It also set aside funds for loans made by CDFIs and institutions with less assets[lxxi]. These funds probably made it easier for underserved businesses to access PPP loans and recover from the pandemic.

The Consolidated Appropriations Act of 2021 established the Emergency Capital Investment Program (ECIP). Under this program Treasury provides capital directly to CDFIs or MDIs for funding small, minority-owned businesses in low-income and underserved communities impacted by the pandemic. Early reporting from this program shows that one-third of the lending was made to hard-to-serve borrowers. The program has the potential to boost lending to Black and Hispanic communities sharply over a decade[lxxii].

### *6-1-2-AA The IRA of 2022*

The *IRA* does not specifically target women entrepreneurs, but does have features that could benefit small businesses including women entrepreneurs[lxxiii]. These include:

i) Extensions for tax credits supporting small business owners' health care costs until 2025.

ii) Tax credits for small businesses energy costs including energy efficiency improvement investments, investments in solar, and tax credits for switching transport from fossil-fuel vehicles to electric vehicles (EVs) or fuel-cell vehicles (FCVs).

iii) Lowering prescription costs for senior citizens, which could benefit seniors owning small businesses, and women entrepreneurs in that age group.

iv) Increases in the Research and Development (R&D) tax credit for small businesses.

v) Tax credits for domestic sourcing (e.g., for steel) in energy development.

vi) Opportunities for small businesses by stimulating U.S. supply chains in clean energy technologies like solar, wind, carbon capture, and clean hydrogen.

vii) Funding state and local clean energy institutions through a new Clean Energy and Sustainability Accelerator, which will increase opportunities for clean energy entrepreneurship and prioritize over 50% of its investments in disadvantaged communities.

viii) Increases in funds for the Rural Energy for America Program, which supports rural small businesses and agricultural producers with clean energy and energy efficiency upgrades.

ix) Tax code changes designed to increase collection from wealthy individuals and corporations.

One year since the IRA was signed, some of the things that have happened include[lxxiv]:

- The private sector has announced over $110 billion in clean energy manufacturing investments, including more than $70 billion in the EV supply chain and over $10 billion in solar manufacturing.
- Clean energy and climate investments have created over 170,00 jobs.
- Approximately 15 million people are saving on health insurance premiums.

### *6-1-2-AB The SBIR and STTR Extension Act of 2022*

The *Small Business Innovation Development Act* of 1982 established the SBIR program to help innovative small business concerns in federally-funded research and R&D. The *Small Business Technology Transfer Act of 1992* established the STTR program to stimulate the partnership of innovative small business concerns and research institutions in ideas and technologies. This Act was amended in 2001 to make the STTR program permanent. The *National Defense Authorization Act for Fiscal Year 2012 (Defense Reauthorization Act)* contained the *SBIR/STTR Reauthorization Act of 2011 (SBIR/STTR Reauthorization Act)*. The *SBIR/STTR Reauthorization Act* extended he SBIR and STTR programs through September 30, 2017[lxxv]. The *2017 National Defense Authorization Act* reauthorized the SBIR and STTR programs until September 30, 2022[lxxvi].

The *SBIR and STTR Extension Act of 2022* extended the SBIR and STTR programs for three more years. Eleven federal agencies participate in the SBIR program and provide R&D funds to small businesses to help them commercialize cutting-edge technologies. Five agencies participate in the STTR program, to help technology transfer at research institutions into the commercial market. In addition to the extension of these programs, the Act makes small changes to the programs as follows[lxxvii]:

i) Stricter reporting standards and scrutiny for foreign-linked firms.

ii) Stricter "transition" requirements for experienced firms between SBIR phases.

iii) Replacing patents to meet commercialization standards with actual sales and/or investments.

iv) Requiring the Government Accountability Office (GAO) to produce reports on rates of awards made to first-time applicants, first-time awardees, and businesses in underserved demographics; businesses with multiple awards and subcontracting practices.

These reforms could help underrepresented businesses including women-owned businesses in winning these awards.

### *6-1-2-AC The CHIPS and Science Act of 2022*

The *CHIPS and Science Act* provides billions of dollars for American semiconductor research, development, manufacturing, and workforce development[lxxviii]. The Act benefits small businesses, including STEM focused small businesses in the following ways:

i) Recipients of these funds need to show significant worker and community investments, in the form of opportunities for small businesses and disadvantaged communities.

ii) The Act authorizes greater investments in STEM education and training from K-12 and for community colleges, undergraduate and graduate education.

iii) The legislation provides new investment initiatives through the NSF for HBCUs, minority-serving institutions, and academic institutions with opportunities for historically-underserved students and communities.

iv) The legislation gives agencies and institutions "the mission and the tools to combat sexual and gender-based harassment in the sciences, a demonstrated barrier to participation in STEM for too many Americans".

v) An article by Burris et al. (2022) discusses the Act's equity goals through place-based industrial policy. These goals aim to encourage tech development outside Silicon Valley and Boston, such that economically disadvantaged Americans, rural Americans, women, and minority-owned businesses are prioritized. This could help women STEM entrepreneurs by providing more funding and procurement opportunities. However, funding for this Act has not reached the envisioned targets, per a 2023 Brookings institution study by Hourihan et al.

vi) This Act also created the Regional Technology and Innovation Hubs (Tech Hubs) program, which is administered by the U.S. Department of Commerce EDA, and is discussed below.

This Act promotes STEM education overall, with the possibility of positive effects for women STEM entrepreneurs.

## 6-1-3 Federal Agency and Department Programs and Policies

The OSDBU or the OSBP are located in many federal agencies and departments that assist small businesses. Examples of these offices are the OSDBUs in the EPA[lxxix], and the Department of Treasury[lxxx] and the OSBP in the Department of Defense[lxxxi]. These offices assist small businesses, SDBs, WOSBs, economically disadvantaged women-owned small businesses (EDWOSBs), veteran-owned small businesses, service-disabled veteran-owned small businesses, and HUBZone businesses. They provide procurement opportunities support to these businesses, maintain Vendor Databases and agency Procurement Forecasts, conduct outreach and host small business events.

Several federal agencies have other ongoing programs to aid women entrepreneurs. These are described below, including relevant rulemaking that could impact Women in STEM.

### *6-1-3-A SBA Initiatives and Programs*

i) In addition to the SBDCs, SBA provides technical assistance through WBCs, Veteran Business Outreach Centers (VBOCs), and SCORE chapters. These entities have training, funding and mentorship programs for small businesses and can be located in each applicable area by using SBA tools[lxxxii].

The WBC Program was established under Title II of the *Women's Business Ownership Act of 1988*[lxxxiii]. The WBC network has seen increases in its size through increased funding. The network has expanded for the first time into all 50 states, the District of Columbia, and Puerto Rico. The number of WBCs at HBCUs, Hispanic-Serving Institutions (HSI), and other minority-serving institutions (MSI) has tripled. The SBA is tasked to expand the WBC network with an additional 15 locations, bringing the total to 160 centers across the country.

ii) The SBA engages with states, local governments, resource partners, and other organizations through the Community Navigators Pilot Program, which serves small businesses in underserved communities. Nonprofits, state and local governments, universities, and tribal entities are funded through this program, and partner with the SBA to reach out to local groups and individuals to support entrepreneurs in these communities[lxxxiv]. The program is focused to provide support to socially and economically disadvantaged small businesses, rural communities, and small businesses owned by women and veterans, and has seen increases in funding.

iii) The SBA administers the 7(a) and 504 loan programs. The 7(a)-loan program provides short-term and long-term loans to help small businesses grow. The 504-loan program provides long-term fixed rate financing for major asset purchases by small businesses. These programs delivered over $10 billion in capital to women-owned small businesses in 2021 and 2022[lxxxv].

iv) The SBA has administered two major programs to help STEM entrepreneurs for several years: the SBIR and STTR programs[lxxxvi]. These programs are especially helpful for women STEM entrepreneurs because the chances of funding are higher as compared to venture capital and the money does not need to be paid back (Stengel 2020).

v) An ongoing SBA program to help entrepreneurs is the SBIC Program. "Small businesses seeking capital from SBICs are typically later-stage, mature, profitable businesses that are generating cash flows sufficient to service interest and sometimes principal payments. SBIC small business financings are primarily in the form of subordinated debt with equity enhancements."[lxxxvii].

SBIC rules have recently been updated, however, to strengthen controls, develop new SBIC forms, and to reduce administrative frictions, among other changes[lxxxviii]. The SBIC program's funding will diversify to address capital deficiencies for underserved and newly formed businesses[lxxxix]. The SBIC Investment Diversification and Growth (IDG) rule "will unlock unrealized potential and strengthen, diversify, and expand our network of SBIC licensed private funds to address capital deficiencies in underserved small businesses, startups, and critical U.S. industries impacting our nation's security."[xc].

There were structural aspects of the SBIC Program that limited equity and investment from SBIC-licensed funds to small businesses in underserved communities, capital-intensive industries and critical technology areas. The IDG rule aims to rectify this. Some of the highlights of this rule are:

- The rule introduces a new instrument called an "Accrual Debenture". This instrument permits investments of longer duration going from a typical three-year SBIC investment previously to a ten-year investment.
- The rule introduces a new type of SBIC called a "Reinvestor SBIC". These SBICs invest in funds with an underserved focus such as for disadvantaged businesses, and rural, low- and moderate-income areas. These funds then invest in small businesses and start-ups.
- The rule allows more diversified investment teams to participate, by broadening the eligibility requirements for fund managers.
- The rule improves program access by modifying licensing fees to reduce the financial burden of new program applicants.
- The rule provides clarity on affiliation rules by specifying that equity investment by an SBIC licensee does not establish affiliation with the SBIC or its other investments. This is important for firms that pursue set-aside government contracts.
- The rule implements stronger controls to improve SBA risk management, and reduces administrative friction for participants and investors.
- The rule expedites licensing of subsequent funds to existing program participants.

This new rule will help investors funding innovative small businesses by providing easier access and less administrative friction. Small businesses will benefit by increased access to private equity[xci].

vi) SBA also conducts the GAFC Program. The SBA created this program in 2014 to draw attention and funding to areas with gaps in the entrepreneurial ecosystem[xcii]. This program aims to increase the collaboration of local and national organizations trying to help science and technology companies succeed[xciii]. The competition makes awards to high-growth small businesses and newly formed companies providing critical technologies.

vii) The FAST Partnership program provides funding to state/regional organizations for programs that lead to an increase in the number of SBIR/STTR proposals. This is done to help women, socially/economically disadvantaged individuals, and underrepresented small businesses win more SBIR/STTR awards."[xciv] This program was established under the Consolidated Appropriations Act of 2001 and re-established under the Consolidated Appropriations Act of 2010[xcv].

viii) Another part of the SBA portfolio is the MPP. This program helps facilitate business relationships between mentors that are typically large businesses and proteges that are smaller firms. The relationship is formalized by SBA approving a mentor-protégé agreement that specifies the type of help the mentor is going to provide to the protégé, such as financing, networking etc.[xcvi].

ix) SBA is also involved with RICs, an initiative launched in September 2010[xcvii]. RICs are networks of businesses and other organizations that work together, to pool resources, grow and compete at a larger scale. The clusters are high-tech, and are located primarily in Western states (such as Oregon, Oklahoma, Utah, Montana and California), in the Midwest (Missouri and Kansas), and in the South (Arkansas, Tennessee, and Mississippi), though there is one in New Jersey .

x) An SBA intervention in the capital markets, of relevance to entrepreneurs, is the possibility of obtaining the agency's Small Business Lending Company (SBLC) licenses. The SBLCs provide loans, under the 7(a) aegis, and as such, the change has raised concerns from traditional financial institutions[xcix].

There was a window to obtain such licenses between June 1, 2023 and July 31, 2023. There had been 14 licensees previously[c]. Three additional licenses were granted during this window, and on August 1, 2023, the relevant SBA rules were liberalized. Other nonbank financial institutions, which can also be considered SBLCs, although not licensed by the SBA, may enter the market and provide 7(a) loans. Data collection for the liberalized program is scheduled to begin in 2024[ci]. The Independent Community Bankers of America (ICBA) has been especially outspoken in its request for modification of the new rules[cii].

xi) The SBA's OED helps small businesses start, grow and compete in international markets[ciii]. OED programs and services include the SBDCs, WBCs and the Office of Entrepreneurship Education (OEE). SBA promotes entrepreneurship, through OEE[civ]. This office assists small businesses through training, learning materials, websites and other means of information.

xii) The SBA also runs PRIME. This program provides funding to microenterprise development organizations so that they can offer training, technical assistance and coaching to disadvantaged microentrepreneurs[cv]. These in turn could help disadvantaged women entrepreneurs.

xiii) SBA's 8(a) Business Development program ((8a)-program) helps small businesses owned by socially and economically disadvantaged individuals over a nine-year term.

The program provides training and technical assistance, and participants receive federal contracting preferences. This program can help women entrepreneurs expand in the federal marketplace.

However, the 8(a) program has been temporarily suspended by court order[cvi]. The Supreme Court's ruling on race-based admissions at Harvard University could impact other preference programs. On July 19 2023, a federal district court in Tennessee ruled that the SBA's use of a "rebuttable presumption" of social disadvantage for certain minority groups to qualify for the 8(a)-program violates the Fifth Amendment's Due Process Clause. The district court "enjoined the SBA from using the rebuttable presumption of social disadvantage in administering the 8(a) Program"[cvii].

xiv) The SBA's OWBO is specifically designed to help women entrepreneurs[cviii] through advocacy, outreach, education and support. The office was established in 1979 per EO 12138 and oversees the WBCs. The work of this office has not been suspended, as the challenge to the 8(a)-program granted by the Tennessee court was made on the basis of racial preference[cix]. The SBA's oversight of its WBCs has been reviewed[cx] and progress noted [cxi].

xv) WOSB Federal Contract program aims to help women entrepreneurs in Federal contracting, and has a goal of awarding at least 5% of all federal contracting dollars to certified female-owned businesses each year[cxii]. The government restricts competition for certain contracts in specific industries as identified by NAICS code to certified WOSBs. Some contracts are further restricted to EDWOSBs based on NAICS codes.

The SBA has a list of the eligible industries and their NACIS codes under these programs[cxiii]. A number of the industries in the STEM fields that we have analyzed, such as NAICS 541690: Other scientific and technical consulting services; 541940: Veterinary services; and 541990: All other professional, scientific, and technical services, are on this list under the WOSB program. Also, a number of other industries that we have analyzed under the STEM-adjacent fields, such as 541614: Process, physical distribution, and logistics consulting services; and 541620: Environmental consulting services are included on this list.

xvi) SBA's HUBZone program[cxiv] limits competition for certain contracts to businesses in these zones. It has a goal of awarding at least 3% of federal contract dollars to certified HUBZone firms annually. Women-owned firms including those in the STEM fields can take advantage of this program, if they are located in these business zones.

### *6-1-3-B U.S. Department of the Treasury Initiatives and Programs*

The Treasury Department's Small Business Programs include the following[cxv]:

i) The SSBCI provides funds to state programs that increase access to capital for traditionally underserved small businesses and entrepreneurs, by supporting private sector loans to these entrepreneurs. The American Rescue Plan reauthorized and expanded this initiative to help small businesses access capital as they emerged from the pandemic.

ii) The Small Business Lending Fund (SBLF) incentivizes community banks and community development loan funds (CDLFs) to increase small business lending[cxvi].

iii) The most prominent effort by the Treasury Department to help women entrepreneurs is through the CDFI Fund. The CDFI Fund provides investment and assistance to CDFIs and other community development organizations that the Department certifies[cxvii]. This enables these organizations to revitalize and develop low-income communities.

CDFI loans are an alternative to standard bank loans for minority-owned and women-owned small businesses and entrepreneurs. They have lower barriers to approval and offer more favorable terms than a standard bank loan. The interest rates on these loans are lower with a fixed monthly payment amount that covers the full interest, plus some of the principal. They assist first-time borrowers and offer borrowers free advice, which traditional banks don't provide[cxviii].

### *6-1-3-C U.S. Department of Commerce Initiatives and Programs*

The Commerce Department supports businesses through the following programs:

i) The MBDA[cxix] promotes minority-owned business growth. MBDA funds a network of centers in different states that provide business assistance to Minority Business Enterprises (MBEs). These Centers are located in areas with high concentrations of minority populations and minority businesses[cxx].

ii) The EDA, a bureau within the Commerce Department has the NACIE[cxxi]. The NACIE works with entrepreneurship and workforce development communities, including businesses and trade associations to help develop solutions that drive the innovation economy. It makes recommendations to foster entrepreneurship and commercialize ideas from labs to the marketplace.

iii) Part of the EDA's authority is to manage the Tech Hubs program. This program is "designed to drive regional technology- and innovation-centric growth by strengthening a region's capacity to manufacture, commercialize, and deploy critical technologies." Twenty Tech Hubs across the country were designated, and there were separate awards of approximately $15 million in strategy development grants to accelerate the development of future Tech Hubs. Consortia were required in order to be eligible for funding, and they could include various entities in academia, private sector, government, federal labs, and unions, among others. The funding awards will be announced in late 2023[cxxii].

This funding will not be targeted to areas of long-term economic distress, nor does it fund "nascent or less resourced technology areas", but instead is devoted increasing the scale and scope of established but strictly regional operations. The regions are mandated to develop the STEM workforce, and to satisfy equity demands, including rural and underserved area development, working through a variety of established institutions in the region[cxxiii].

iv) EDA also manages the STEM Talent Challenge, which is a national competition to supports programs to train STEM talent". Institutions funded through this program are educational institutions, primarily colleges and universities or university systems), but also including Liberty Science Center, in Jersey City, New Jersey and Goodwill of Western Missouri and Eastern Kansas (in Kansas City, Missouri)[cxxiv].

v) In the aftermath of the onset of the COVID-19 pandemic, EDA also conducted the Scaling Pandemic Resilience Through Innovation and Technology (SPRINT) Challenge. This covered funding to address the economic, health, and safety risks caused by the coronavirus pandemic through entrepreneurship and innovation. The project awarded $9 million in funding to awardees such as Los Angeles' LA-R2C Accelerator, which worked on bioscience applications, and the Manufacturing Advocacy and Growth Network (MAGNET)'s project that worked on smart manufacturing technologies in Northeast Ohio[cxxv]. The program application deadline has passed, however, and the program may no longer be accepting applications[cxxvi].

vi) EDA also provides funding through its University Center program. This program helps institutions of higher education and consortia of these institutions to establish and operate University Centers (UCs) to leverage university assets to build regional economic ecosystems, by providing expertise, applied research, and technical assistance[cxxvii]. The program also received funding in response to the pandemic[cxxviii], but remains in operation[cxxix].

vii) The Commerce Department's USPTO has also made efforts to promote STEM and entrepreneurship. A specific case in point is the WE initiative, launched in 2022. This program builds on USPTO's previous Women's Entrepreneurship Symposium[cxxx], and provides a mentoring program with Intellectual Property Owners Association (IPO)[cxxxi], an online site[cxxxii], and a continuing series of events, such as a forthcoming event in Evanston, Illinois[cxxxiii]. An additional element of the program is an (online) Intellectual Property (IP) Identifier tool[cxxxiv].

viii) USPTO also provided STEMM related training funding, which created the Intellectual Property Skills Work-Based Learning program[cxxxv] to provide high school students with paid work-based opportunities for integrated STEMM learning, intellectual property awareness, invention education, entrepreneurship, and federal service. Though not directly part of this program, there are parallel efforts the USPTO conducts for veterans[cxxxvi], which also has events (such as one in San Diego)[cxxxvii].

ix) The USPTO also hosts Invention-Con conferences to help commercialize ideas[cxxxviii], has liberalized patent filing via the Council for Inclusive Innovation[cxxxix], and provides a limited amount of free legal services through the Patent Pro Bono Program[cxl].

x) The Commerce Department is directly concerned with AEC development, through the ITA[cxli]. The ITA is necessarily focused on trade, but of necessity, has to examine the U.S.

market in order to make sensible recommendations. The ITA's Design and Construction Team has industry expertise, and U.S. firms are part of the industry[cxlii]. A similar team exists for Architecture and Engineering[cxliii].

### *6-1-3-D NSF Programs*

The NSF has a variety of programs to promote women and girls in STEM.

i) The NSF sponsors aid for women entrepreneurs through its Accelerating Women And underRepresented Entrepreneurs (AWARE): ACCelerating Entrepreneurial succeSS (ACCESS) project[cxliv]. This program is designed to broaden the participation and access of faculty, staff, post-doctoral fellows and students from underrepresented populations in commercialization, SBIR/STTR funding and entrepreneurship. The underrepresented populations are defined as female, African American, Hispanic/Latino, Asian American, and Native American. This program aims to address the limited past success for these groups in SBIR/STTR funding, even though they represent a significant share of the general population, STEM graduates and business owners. The program has the following four goals:

"1) identify, engage, encourage, and mentor women and underrepresented innovators to consider entrepreneurship as a career path;

2) expand access for women and underrepresented entrepreneurs to educational, experiential and networking opportunities;

3) increase the volume and enhance competitiveness of the SBIR/STTR applications of these innovators; and,

4) share best practices with other institutions to create a regional ecosystem that provides an inviting, rewarding experience and climate for entrepreneurial women and underrepresented innovators."

The program aims to achieve these goals through six (6) key components:

"1) An Innovation Entrepreneurship Resource Center;

2) Entrepreneur talent matching series;

3) Grant writing assistance program;

4) Phase Double Zero supplement program;

5) Commercialization and Entrepreneurship Summit; and,

6) Outreach and sharing of success stories to the community."

ii) NSF's ADVANCE program aims to promote gender diversity in STEM faculty that brings novel research agenda, methods, education and mentors to classrooms[cxlv].

iii) NSF's Directorate for Education and Human Resources supports STEM education research to increase the participation of underrepresented populations in STEM programs and careers[cxlvi].

iv) NSF's "Rural girls engaged in math and science plus technology" project aims to increase the awareness and preparedness of rural girls for STEM careers[cxlvii].

v) The agency's "Code: SciGirls! media to engage girls in computing pathways" project helps increase the awareness and engagement of girls in computer science careers[cxlviii].

vi) The SciGirls in the national parks (a Public Broadcasting Service (PBS) Kids television show) covers different aspects of STEM education[cxlix] and aims to increase the STEM participation of girls.

vii) NSF promotes entrepreneurship overall through the I-Corps program. This involves teams, hubs, and cooperation with other federal agencies, and has supported over 1,000 startups[cl].

viii) NSF's S-STEM program awards grants to higher education institutions to fund scholarships, and to study and implement curricular and co-curricular activities that support student success and graduation in STEM. The goal of the S-STEM program is to increase the number of low-income students who graduate from 4-year colleges with a STEM degree[cli]. These awards are made to a very select group of grantees. NSF has made one award, to North Carolina A & T State University, at Greensboro, North Carolina, to advance education in the AEC fields[clii].

ix) NSF also makes awards under its Regional Engine program. The awards under this heading are to "[i]ncrease the level of commercial investment in research and development (R&D) activities across distinct geographic regions, particularly regions that have not fully participated in the technology boom of the past few decades." The awardees are expected to form partnerships, and to "[c]reate thriving companies focused on emerging technologies", but also to be inclusive, to deliver training, and to address regional needs. An awardee that receives the full amount is to move from the nascent, and emergent stages to growth over a period of 12 years[cliii].

The semi-finalists for the awards are primarily university and other nonprofit consortia located along the East and South Coasts, the Midwest, the Southwest and the West Coast[cliv].

x) Other NSF programs include the ExLENT program, to foster experiential learning, especially in advanced manufacturing, artificial intelligence, biotechnology, quantum information science, and semiconductors and microelectronics; the NRT program to support people pursuing research-based master's and doctoral degree programs; and the INTERN program to annually support graduate students training in semiconductor and microelectronics research and development[clv].

xi) The NSF is also funding certain grants for STEMM teachers, including the Robert Noyce Teacher Scholarship Program and funding (with the Smithsonian Institution), and separate partnerships with the Micron Technology, Inc. and the Micron Foundation, and funding for guidance to state and local education agencies[clvi].

xii) The NSF has a program with the Intel Corporation to educate and train the nation's semiconductor manufacturing workforce and advance opportunities for equitable STEMM education, with a focus on underserved communities and institutions[clvii].

xiii) The NSF's ExpandQISE program intends to increase research capacity and broaden participation by engaging universities that are historically underrepresented in quantum information science. The similar Growing Research Access for Nationally Transformative Equity and Diversity (GRANTED) program aims to address systemic barriers within the nation's research enterprise by improving research support and service capacity at emerging, developing, and underserved research institutions [clviii].

xiv) One of the aspects of NSF's work that is relevant in this regard and not well-known is its funding of TILOS, a National Artificial Intelligence (AI) Research Institute. TILOS is a partnership of faculty from University of California, San Diego, Massachusetts Institute of Technology, National University (also in San Diego), University of Pennsylvania, University of Texas at Austin, and Yale University. TILOS will pioneer learning-enabled optimizations that transform chip design, robotics, communication networks, and other use domains[clix]. NSF has funded these universities with a $20 million grant to develop AI, and to serve adult learners, military veterans, and underserved students in STEM[clx]

### *6-1-3-E VA Programs*

The VA's OSDBU supports the Veteran-Owned Small Businesses and Service-Disabled Veteran-Owned Small Businesses in federal contracting and is the point of contact for women Veterans to receive help. Some of the programs offered to women veterans include:

i) The WVOSBI[clxi] connects women veterans to networking and collaborative opportunities with federal agencies, commercial, non-profit and educational entities to enable women-owned businesses become prime vendors.

ii) VetBizLadyStart[clxii] is a federally funded program that collaborates with WBCs in the District of Columbia, Maryland, and Virginia's Old Dominion University to prepare women veterans for procurement. Program participants attend training and networking sessions with women mentors from government and the private sector to learn about contracts.

iii) The VA and the PenFed Foundation bring women veteran entrepreneurs together through the Women Veteran Boot Camp Accelerator program[clxiii]. The women veterans attend relationship building, product/market analysis, business development and business growth classes. The program ends with a pitch competition where the participant with the winning pitch receives a PenFed Foundation grant for business growth.

iv) The Veteran Women Igniting the Spirit of Entrepreneurship (V-WISE) program[clxiv] is a training program in entrepreneurship and small business management. Honorably discharged women veterans, active-duty women service members, women military spouses and same-sex life partners are eligible to apply for this program. Program participants are trained in opportunity recognition, business planning, financing, economics, market, capital access, business, law, social media and other skills.

v) In addition to the OSDBU programs above, the Department has a couple of programs to provide STEM education related support. One is the Edith Nourse Rogers STEM Scholarship Program that provides additional GI Bill benefits toward qualifying STEMM degrees. The other is the Veteran Employment through Technology Education Courses (VET TEC) 5-year pilot program provides tuition and housing assistance to help Veterans advance in an IT career[clxv].

### *6-1-3-F U.S. Department of State Programs and Initiatives*

The State Department has programs and initiatives to support female entrepreneurs. Below is a description of some of these initiatives:

i) The Department of State's Economic and Business Affairs Bureau launched POWER in 2019. POWER uses a multi-tiered approach to build global professional networks for female entrepreneurs. In the first tier, POWER works with U.S. missions overseas and the private sector to build programs for helping women establish and expand their businesses. In the second tier, POWER provides support for the State Department's economic policy dialogues related to gender issues.

Since the pandemic accelerated the adoption of new technologies, a number of POWER's programs focus on reducing the entry barriers women face in the digital economy. These include entrepreneur and engineer seminars, roundtables, and partnerships to close the digital divide. POWER is also developing programs to support women in the energy, agriculture and infrastructure sectors focused on access to international markets and networks (Ehdaie and Spring 2022).

ii) The AWE[clxvi] gives women entrepreneurs the tools to start and grow businesses. AWE's uses a hybrid approach that combines the online platform DreamBuilder with in-class mentoring and facilitation. Program participants have the opportunity to discuss business related material with implementers, mentors, and U.S. Exchange Alumni. AWE has partnerships with local NGOs, universities, and chambers of commerce. This allows women entrepreneurs to network with other business owners through speed mentoring, pitch competitions, and entrepreneurship fairs.

### *6-1-3-G USDA Programs*

The USDA's business programs for rural development[clxvii] are not specifically geared towards women entrepreneurs, but to the extent female-owned businesses exist in rural areas, these programs are beneficial to them as well. Some of these programs are described below:

i) The B&I program offers loan guarantees to lenders for their loans to rural businesses.

ii) The IRP provides low-interest loans at one (1) percent to local lenders that act as "intermediaries" and re-lend to rural businesses.

iii) The RBIP grants a Rural Business Investment Company (RBIC) license to capital organizations formed to meet the equity capital investment needs of rural communities.

iv) The Rural Cooperative Development Grant program funds Cooperative Development Centers that assist individuals and businesses in rural areas.

v) The REDLG programs provide zero-interest loans to local utilities. These utilities use the funding to establish Revolving Loan Funds (RLF) that fund projects for local businesses. These businesses repay the loan to the RLF that in turn funds other business projects. The grant is repaid to the USDA once the RLF ceases to exist.

vi) The RISE Grant Program funds jobs accelerator partnerships in low-income rural areas to accelerate business formation, support industry clusters and provide worker training.

vii) The RMAP provides loans and grants to Microenterprise Development Organizations (MDOs) to help microenterprises through a Rural Microloan Revolving Fund and to provide training and technical assistance to these microentrepreneurs.

viii) The Socially Disadvantaged Groups Grant program provides technical assistance to socially-disadvantaged groups through cooperatives and Cooperative Development Centers.

ix) NIFA within the USDA will invest $25 million in its Meat and Poultry Agricultural Workforce Training initiative, creating workforce development programs to provide a pipeline of well-trained workers to meet the demand for increased independent processing capacity. NIFA will also invest $15 million in workforce development initiatives at Minority-serving Institutions including 1890 Land-grant Universities, as well as Tribal, Alaska Native and Native Hawaiian, Insular and Hispanic-Serving Institutions (HSIs)[clxviii].

x) The USDA has also entered into an MOU[clxix] with SBA to increase investments in small and underserved communities. The agencies will also expand opportunities for rural technical assistance providers, entrepreneurs and small business owners. They will provide resources to help small business compete in domestic and international markets. As part of the MOU the agencies may do the following:

- Provide joint trainings, technical assistance, and mentorship opportunities for rural small business owners
- Help agricultural producers and small business export their products
- Expand the collaboration of SBA's Resource Partners Network and USDA's Rural Partners Network

- Cross-promote programs that support rural businesses and socially disadvantaged communities.

### *6-1-3-H IRS Tax Credits*

The IRS has retirement and health related tax credits for small businesses.

i) There is a Retirement Plans Startup Costs Tax Credit[clxx] for businesses with 100 or fewer employees. This helps businesses by reducing the amount of taxes they owe, if they start offering retirement plans for their employees.

ii) The IRS also has a Small Business Health Care Tax Credit for employers with fewer than 25 full-time equivalent employees. The maximum credit is 50% of premiums paid for small business employers. The credit works on a sliding scale. So, the smaller the employer, the bigger the credit they receive[clxxi].

These credits could encourage women-owned businesses to hire more employees and start offering them retirement and health plan options.

### *6-1-3-I EPA Programs*

The EPA has several programs to promote STEM education. These include:

i) Since 1992, EPA has promoted STEM education, with an environmental focus, through its EE Grants[clxxii]. A listing of these grants is available[clxxiii] by year, state and EPA region.

ii) EPA has also organized volunteers since 2004 to provide STEM education through its RTP-STEM outreach program[clxxiv]. RTP is "Research Triangle Park" in North Carolina. EPA has a facility for this program there, and also one in Cincinnati, Ohio[clxxv]. One focus of the program is to work with HBCUs[clxxvi]. But other institutions, such as the University of Tennessee at Chattanooga, have also received funding[clxxvii].

iii) EPA also offers a number of paid research opportunities through ORISE, which provide STEM training with an environmental focus[clxxviii]. One example of these fellowships is the EPA Community Resilience and Equity Social Science Fellowship[clxxix].

iv) EPA has also promoted the STAR program, to promote STEM education with a focus on the environment, since 1995[clxxx].

v) EPA has also funded the People, Prosperity and the Planet Program. This is a student competition to design innovative environmental solutions. Fifty percent of the funding is designated to go to underserved institutions[clxxxi].

### *6-1-3-J DOE Programs*

The Department of Energy has promoted STEM entrepreneurship in the energy field through a variety of programs[clxxxii].

i) One of the more recent innovations is a program to develop clean energy innovation in underserved communities[clxxxiii]. Entry into the programs is competitive, and not all ideas are sponsored. The competitive programs include work with ARPA-E, Lab-Embedded Entrepreneurship Programs (LEEPs), and The Technology Commercialization Fund (TCF)[clxxxiv].

ii) A major focus of the DOE is STEM education[clxxxv]. The portal for access to Energy STEM opportunities was modernized in 2022, and is under the direction of Dr. Geri Richmond, Under Secretary for Science & Innovation[clxxxvi]. One of the newer efforts is The Inclusive Energy Innovation Prize, developed by the Office for Energy Efficiency and Renewable Energy (EERE). This prize awards efforts to serve minority or disadvantaged communities.

iii) The DOE also provides fellowship funding for senior undergraduate students and first- and second-year graduate students. These students focus their studies on high energy density physics, nuclear science, or properties of materials under extreme conditions and hydrodynamics. They agree to work at one of the Department's national defense laboratories (Lawrence Livermore National Laboratory, Los Alamos National Laboratory or Sandia National Laboratories), through the National Nuclear Security Administration Stewardship Science Graduate Fellowship[clxxxvii].

iv) The DOE is also funding the RENEW program and the FAIRprogram, to enable DOE research at institutions historically underrepresented in the office's research portfolio[clxxxviii].

### *6-1-3-K USDOT Programs*

The USDOT's Disadvantaged Business Enterprise (DBE) program aims to level the playing field for small businesses owned by disadvantaged individuals to compete for federally funded transportation contracts[clxxxix]. Recipients of USDOT funds are required

The USDOT has a limited involvement in STEM and STEM entrepreneurship promotion. Some of its STEM initiatives are mentioned below.

i) The most significant program is aimed towards young children and teenagers[cxc]. The Department's FHWA developed five STEM lessons through its STEP program. These lessons emphasize roadway design and safety and include instructions, materials and visual aids.

ii) The Department did provide funding for SBIR efforts in 2014, related to Intelligent Transportation[cxci], and SBIR funding in 2016, related to aviation and shipping[cxcii].

iii) The Department sponsors SBTRCs.  These centers serve small disadvantaged transportation businesses[cxciii].  They provide free market research, training, certification, and procurement technical assistance to these businesses.

iv) The SBTRCs implement the USDOT's Women and Girls in Transportation program (WITI). WITI is an internship program for young women from colleges and universities to enter the transportation field[cxciv].

v) SBTRCs administer the BEP.  They work with SBA's Surety Bond Program to provide SBA-approved bond producers to small businesses and help them become bond ready."[cxcv]

vi) State departments of transportation support the education and development of AEC entrepreneurs, such as the program for the state of Georgia via its Department of Education[cxcvi].

### *6-1-3-L Department of Education Programs*

The U.S. Department of Education has several programs devoted to STEM education.

i)  The Department hosted the "You Belong in STEM"[cxcvii] National Coordinating Conference on December 7, 2022 to introduce the STEM career path, and to describe the Department's efforts[cxcviii].  More than 90 public and private sector organizations made specific commitments to enhance STEM education, including local efforts and national initiatives.

ii) The Department's spending efforts to promote STEM, as of Fiscal Year, 2020, had as highlights, $124.7 million for Gaining Early Awareness and Readiness for Undergraduate Programs (Partnership Grants) (GEAR-UP), $151.2 million for Federal TRIO Programs, $73.7 million for Supporting Effective Educator Development (SEED), and $49.4 million for the Teacher Quality Partnership (TQP)[cxcix].  The Federal TRIO Programs (TRIO) are Federal outreach and student services programs designed to identify and provide services for individuals from disadvantaged backgrounds[cc].  They include the Upward Bound Math-Science program[cci].

### *6-1-3-M DOI Programs*

The Interior Department plays a meaningful role in The Federal STEM Education Strategic Plan, described earlier.  Other activities of the Department promoting STEM Education are as follows:

i)  A STEM Mentoring Event at the Smithsonian's Museum of Natural History which involved DOI's Bureau of Safety and Environmental Enforcement (BSEE)[ccii].

ii) DOI's partnership with ANSEP to help ANSEP students find employment with DOI bureaus and offices[cciii].  This to encourage underrepresented populations in federal service.

iii) Partnerships between DOI's BLM and NGOssuch as the National Environmental Education Foundation (NEEF)[cciv]. NEEF's Greening STEM program facilitates partnerships between educators and land managers, to engage students in real-world environmental experiences. BLM sites have received NEEF grants for citizen science projects on public lands.

### *6-1-3-N NASA Programs*

NASA has many programs to increase STEM education and involve female entrepreneurs.

i) NASA's STEM education programs include the Next Gen STEM for K-12 students, the National Space Grant College and Fellowship Project for college and university students, Established Program to Stimulate Competitive Research to increase research efforts, and the Minority University Research and Education Project, which works with HBCUs and other institutions of higher education.

These programs are run by NASA's Office of STEM Engagement (OSTEM) [ccv]. OSTEM makes special efforts to involve women in STEM activities[ccvi]. Part of these efforts include awards to women's colleges, as part of the agency's Minority University Research and Education Project (MUREP)[ccvii]. OSTEM has also sponsored events for young girls to interest them in STEM, such as the Girls in STEM 2023 event on July 13, 2023 in Houston[ccviii].

ii) NASA has also made efforts to involve women STEM entrepreneurs, through the Open Innovation team[ccix], and through technology transfer programs, such as one sponsored by NASA's Jet Propulsion Laboratory (JPL)[ccx]. JPL has an Office of Technology Transfer to continue this work[ccxi].

### *6-1-3-O DOL Programs*

DOL helps Women in STEM through the following programs:

i) DOL works with the White House Office of the National Cyber Director, and the Departments of Commerce, Homeland Security, and Defense, to provide paid apprenticeships in cybersecurity[ccxii].

ii) In addition to its participation in the IWG mentioned above, DOL administers a number of grants. These are conducted through the ETA, which has a Women's Bureau. The Women's Bureau is involved with two grant programs: the WANTO[ccxiii] program, which helps women enter and lead in underrepresented industries; and Fostering Access, Rights, and Equity (FARE), which helps women workers who are paid low wages learn about and access their employment rights and benefits[ccxiv].

### *6-1-3-P Department of Health and Human Services – NIH Programs*

The NIH promotes women and girls in STEM through the following programs:

i) NIH provides grants to support training and mentoring, especially to individuals from groups that have been historically excluded in health-related sciences[ccxv].

ii) NIH is funding two programs to address health inequities. One is the Transformative Research to Address Health Disparities and Advance Health Equity program. This program supports research projects to reduce health disparities. It increases the research base studying health disparities at institutions focused on minorities, such as HBCUs[ccxvi]. The second program is the UNITE initiative, to address structural racism within biomedical research and to support NIH offices addressing diversity and equity issues[ccxvii].

### *6-1-3-Q DOD Programs*

The DOD's Office of Small Business Programs (OSBP) manages and operates the APEX Accelerators program[ccxviii]. This program was previously the Procurement Technical Assistance Program (PTAP) and was established in 1985. The *National Defense Authorization Act for Fiscal Year 2020* moved this program to Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)). OSBP began to manage this program under the name APEX Accelerators.

APEX Accelerators help businesses that work with DOD, other federal agencies, state and local governments and government prime contractors. They help these businesses:

- Complete registration in government databases
- Identify and connect with buying agencies and offices
- Position them to succeed
- Navigate solicitations and funding opportunities
- Provide them with bid-matching services
- Help them network with contracting offices, prime contractors, and other businesses
- Resolve performance issues if needed

The DOD has STEM educational programs such as the following:

i) DOD's NDEP fosters the development of consortiums of two-year community college (2YI/CC) STEM) education[ccxix].

ii) An additional DOD program, is the SMART program[ccxx]. It provides scholarships for undergraduate and graduates students in STEM disciplines who commit to work at DOD laboratories, for a limited period of time.

### *6-1-3-R DHS Programs*

In addition to the cooperation with OSTP mentioned above, DHS provides immigration waivers for STEM students to work professionally in the U.S.[ccxxi]. These include the following:

i) The STEM OPT program that allows international STEM students to work in the U.S. for 36 months after completion of their degrees.

ii) DHS also allows the national interest waiver for an employment-based immigrant visa for noncitizens with needed skills such as, in the STEM fields.

iii) Another visa initiative is the O-1A nonimmigrant status. This is based on extraordinary ability and is available to individuals working in STEM.

iv) An EO dated October 30, 2023, aims to lessen visa requirements for foreign talent interested in working for American AI companies. DHS's implementation of this requirement will increase the AI workforce and help STEM businesses in the U.S.[ccxxii].

### 6-1-4 State and Local Programs

A number of states have small business certification programs that aim to level the playing field for small businesses. For example, Virginia's Small, Women, and Minority-Owned (SWaM)[ccxxiii] certification program enhances procurement opportunities for SWaM businesses in state-funded projects, and increases their visibility through an online SWaM directory. The program also provides training.

Through its minority and/or women-owned business enterprise (MWBE)[ccxxiv] certification program, the state of New York increases access to government contracts, lists businesses in an online directory of certified businesses, and offers networking events, customized courses and targeted consultations for certified businesses. Besides these certification programs, which are available in several states, many states provide funding to help women entrepreneurs. The Women's Business Enterprise Council (WBEC) provides an introduction to some of these programs, including those in New York, California and Texas[ccxxv].

#### *6-1-4-A California Small Business Grant Program*

This program provides grants to small companies impacted by COVID-19. Businesses that are located in California, and have yearly gross revenues of $2.5 million or less are eligible for this grant. The program helps women-owned enterprises obtain the financial assistance needed to stay in business[ccxxvi].

#### *6-1-4-B New York State MWBE Development & Lending Program*

This program provides financial assistance to minority- and women-owned businesses. It also assists women and minority entrepreneurship development programs in the state. Certified MWBEs receive assistance from this program. The program gives business development loans and loan guarantees and supports business incubators[ccxxvii].

#### *6-1-4-C Texas Skills for Small Business Program*

This grant program supports businesses that have less than 100 employees. It helps these businesses train new and incumbent employees. Eligible businesses can apply to the Texas Workforce Commission (TWC) for this training. The TWC works with local community colleges to fund the training courses. Businesses are able to select the courses and customize the training per their needs[ccxxviii].

### *6-1-4-D Illinois DCEO Grants for Women Entrepreneurs*

The Illinois DCEO has a number of grants for female entrepreneurs. The Community Development Block Grant is for community organizations that assist small companies in underserved areas. The Small Business Development Center Grant is for organizations that provide technical assistance and counseling to small businesses, including women-owned businesses. The Minority Business Development Grant is for businesses that need help with marketing, technology, and other business expenses. The state also matches various Federal grants, especially with DCEO's Federal Grant Match program[ccxxix.]

### *6-1-4-E Maryland BIITC*

This is a special program and is connected with Opportunity Zones[ccxxx]. "BIITC provides an income tax credit equal to 33% of an eligible investment in a Qualified Maryland Biotechnology Company (QMBC) up to $250,000 in tax credits, or 50% of an eligible investment in a QMBC up to $500,000 in tax credits if the QMBC is located in Allegany, Dorchester, Garrett or Somerset County.

In qualified Opportunity Zones, the credit can total up to 75% of the investment, and the overall stacked structure of the tax credit is aimed at attracting investors by offsetting a certain amount of their investment in a qualifying company, and focusing those investors on company attributes that align with economic development goals."

This program could benefit female founders of biotechnology companies, specially those located in Maryland's Opportunity Zones.

### *6-1-4-F VSBFA*

VSBFA provides debt financing resources to businesses and localities for economic development, small business and entrepreneurial financing needs[ccxxxi]. The VSBFA defines small businesses as those with $10 million or less in annual revenues over three years, or gross net worth less than $2 million, or 250 employees or less in Virginia or qualification as a 501(c)(3) nonprofit entity. Below is a description of some VSBFA programs:

i) VSBFA's IDBs provide businesses and nonprofit entities long-term, fixed-asset financing at favorable interest rates and terms to help with land acquisition, building construction, and capital asset purchases.

ii) VSBFA's EDLF fills the financing gap between private debt financing and private equity by providing permanent working capital, commercial real estate, and equipment loans. These loans are for local industrial or economic development authorities and businesses engaged in technology, biotechnology, tourism, manufacturing, renewable energy, government contracting, or those that enhance local or regional "quality of life".

iii) The LGP helps businesses obtain funds from banks by reducing commercial loan risk through guarantees. These guarantees are for lines of credit, term loans for permanent working capital or fixed asset purchases, and restructured debt to obtain additional funds, a lower interest, and/or a longer repayment period.

iv) The CCP reduces a lender's credit risk by providing cash collateral for a business loan. This helps in cases where a business earns sufficient cash flow so that a bank debt (and interest charges) could be repaid, but does not have sufficient collateral for the bank's underwriting standards.

### *6-1-4-G Virginia Innovation Partnership Authority (VIPA) and Virginia Innovation Partnership Corporation (VIPC)*

VIPA was established in 2020 "to support the life cycle of innovation, from translational research; to entrepreneurship; to pre-seed and seed-stage funding; as well as acceleration, growth, and commercialization, resulting in the creation of new jobs and company formation."[ccxxxii] The Virginia Innovation Partnership Corporation (VIPC) is VIPA's operating arm and provides early commercialization and funding support for Virginia innovators and entrepreneurs[ccxxxiii]. It helps businesses with capital formation and commercialization, and market development. VIPC's capital formation and commercialization programs include the following:

- VVP[ccxxxiv] – VVP invests equity in Virginia-based tech companies. It partners with Virginia fund managers to help realize higher financial returns for founders, investors, partners and the Commonwealth
- Virginia SSBCI[ccxxxv] – This initiative received more than $175 million in funding from the U.S. Department of Treasury to support Virginia's small businesses and entrepreneurs. The program will provide resources for increased access to capital by Virginia's underserved communities.
- VVP Fund of Funds – This fund uses SSBCI funds to invest in emerging and established seed investment funds that help Virginia entrepreneurs.
- VFF[ccxxxvi] - This fund "is for minorities, women founders, and founders of color." The VFF uses proceeds from the VVP program to provide seed funds to female founders and founders of color in sectors such as software, hardware, life science, cleantech, and technology-enabled services.
- RIF[ccxxxvii] – The RIF is a state-funded program. It provides grants to Virginia-based organizations that support science and technology-based entrepreneurs. The grants can be renewed annually if grant recipients meet projected outcomes and metrics.
- CCF[ccxxxviii] – CCF provides funding for "technologies with a high potential for economic development and job creation that position the Commonwealth as a national leader in science- and technology-based research, development, and commercialization."

### *6-1-4-H State Level STEM Education Programs*

A number of U.S. states have specific programs to promote STEM education. A typical example of state government activities in the field is the STEM Action Center in Utah[ccxxxix]. This center funds STEM education in classrooms; hosts conferences and workshops and STEM competitions; brings STEM activities, learning and lesson plans to classrooms throughout the state.

## 6-1-5 Institutional Programs

### *6-1-5-A Academic Institution Programs and Policies*

There are entrenched policies in the academic realm that discourage female STEM entrepreneurship, as described below.

i) These include discrimination in faculty appointments and academic funding, as well as discrimination in licensing (Colyvas et. al 2012). Academic employment and resource allocation policies do not favor women. Women faculty have a similar likelihood of reporting inventions to university licensing offices but end up reporting less due to their lack of seniority and resources. Even in cases where they do report their inventions, their lesser rank and resources lead to less favorable outcomes. The likelihood of their disclosures being converted to patents and licenses is lower than their male counterparts.

ii) The advisory boards that make judgments on promotion and financing are primarily male, and are informed of the applicant gender as well as publications and teaching practices. The lack of women on these boards has an adverse impact on their seniority and commercialization success.

As a contrast to the above negative academic practices, there are some academic programs that encourage female and underrepresented population entrepreneurship. Some of these are described below:

i) The F&E CWEL at Babson College[ccxl] aims to close the gender gap in female entrepreneurship. At the undergraduate level it offers programs such as Women's Leadership Scholarship, mentorship, signature events and speaker series, a Women Innovating Now (WIN) Growth Lab Accelerator and Babson Black Women's Entrepreneurial Leadership Program.

Participants in the Black Women's Entrepreneurial Leadership (BWEL)[ccxli] Program experience the following:

- An online business curriculum,
- In-person program closing,
- Black women entrepreneur and ally cohort,
- Seasoned procurement professional insights,
- Accomplished faculty and top industry leader guidance,
- Procurement, financing and business optimization content, and

- Global BWEL Alumnae Network

ii) The California Program for Entrepreneurship (CAPE)[ccxlii] was started in 2009. It is an initiative of the Leavey School of Business at Santa Clara University and provides education and mentoring to emerging entrepreneurs (possibly non-matriculating entrepreneurs[ccxliii]). Participants are selected based on their business idea, and ability to contribute to the California economy. CAPE helps them develop and implement their business plans.

iii) The Department of Entrepreneurship & Strategy at the David Eccles School of Business at the University of Utah is explicitly devoted to training for entrepreneurship. The Department's "[c]oursework covers building blocks such as ideation, innovative business models, venture funding, strategy, product development, entrepreneurial marketing, and social entrepreneurship."[ccxliv]

iv) The Center for Regional Advancement at Cornell University sponsors the W.E. Cornell program to help women "STEM PhDs and postdocs commercialize their innovations and overcome the challenges of leading a growing technology-based business"[ccxlv].

v) The University of Dayton sponsors an entrepreneurship major through its School of Business Administration. It is distinctive in having students create and run a microbusiness with $5,000 in start-up capital.[ccxlvi]

vi) The University of Tennessee at Chattanooga's Gary W. Rollins College of Business also sponsors a Center for Innovation and Entrepreneurship. This center also hosts the annual Southeast Entrepreneurship Conference (SEEC)[ccxlvii].

vii) Vanderbilt University is investing $4.6 million of its own money and substantial Federal grants, as well as partnering with Fisk University to help students, especially minority students, in STEMM-related research[ccxlviii].

viii) Johns Hopkins University (JHU), with a grant from Bloomberg Philanthropies, is sponsoring the Vivien Thomas Scholars Initiative. The Initiative is dedicated to providing $150 million to provide long-term funding for over 100 new positions in the 30 plus STEM programs offered to students at Johns Hopkins University. The program's primary goal is to address the underrepresentation of minorities in STEM programs. For that purpose, JHU is also working with a number of prominent HBCUs, including Howard University, Morehouse College, and Spelman College[ccxlix].

ix) Colleges and universities also offer DEI programs that could help underrepresented populations in STEM. Some examples of these programs and their successes are below:

(a) One detailed example of DEI programs in action is at ECU. Chambers et al. (2023) mention that "In 2020, ECU applied for and received an NSF ADVANCE grant to implement internal support of structural changes that encourage DEI among faculty in science, technology, engineering, and mathematics (STEM)."

This led to the formation of four subcommittees: Faculty Professional Development, Document Review, Administrative Accountability, and Standing Committee on Diversity, Equity and Inclusion. The first was led by faculty, and covered programming and training, tenure review. The committee has hosted virtual conferences and leadership retreats, among other efforts. The Document Review committee addressed the faculty manual, so as to include DEI criteria. The Administrative Accountability committee addressed keeping current with best practices.

The Standing Committee was an oversight committee for the other three.

Some specifics on what the Standing Committee does are[ccl]:

1. Advising the ECU President and other administration officials on issues relating to diversity on campus such as encouraging assessment of climate and encouraging diversity in hiring and retention;

2. Selecting the winner of the Spirit of Martin Luther King (MLK) Award;

3. Planning and implementing the Louise Young Diversity Lecture;

4. Providing a forum for ECU students, staff, and faculty, to present ideas and issues related to diversity and make recommendations to the ECU administration;

5. Supporting student clubs related to diversity;

6. Maintaining DEI LibGuide;

7. Creating and maintaining diversity calendar.

According to ECU's Office of Undergraduate Admissions, ""ECU has been recognized once again for its commitment to diversity by Insight into Diversity magazine. The magazine awarded ECU with the Higher Education Excellence in Diversity (HEED) award for the twelfth year in a row. The award recognizes universities in the U.S. that demonstrate an outstanding commitment to diversity and inclusion."[ccli]

One of the best practices at ECU for the 2023 HEED Award, noted by INSIGHT Staff, is the ECU Emerging Scholars Symposium, which "aims to bolster ECU's faculty pipeline, focusing on those whose research aligns with the university's innovative mission and strategic plan".[cclii]

ECU ended all mandatory DEI programs for faculty evaluations and trainings earlier this year[ccliii], in response to a state law and University of North Carolina policy. It is unclear if the university will develop other procedures for voluntary efforts in this regard.

(b) Another example is the University of Michigan's WISE program. Ramsey et al. (2013) studied this program in detail. WISE provides a residential environment with other women in STEM fields. The program also offers additional academic support, mentoring with more senior women in STEM fields, and student-run study groups. They argue that environmental messages that highlight women's presence in STEM may help prevent women in the fields from assuming negative stereotypes fit them. The women studied by Ramsey et al. were somewhat younger than others at Michigan, on average. However, there was no major difference in how the WISE women socialized, i.e., they had different numbers of friends in STEM versus a control group. One of the major findings was that learning about women in STEM is important for women entrants into the STEM field in terms of promotion of self-image and success, regardless of living environment.

This program has since diversified. The closest successor to the program studied by Ramsey et. al. appears to be the WISE RP[ccliv]. The WISE RP aims to recruit, support, and retain diverse students in STEM. It links students with resources and opportunities, and helps develop relationships among students with similar interests. WISE RP also offers spring/summer scholarships funded by external donors[cclv].

The current WISE program is a campus-wide social group of faculty, staff and students. The program helps women, non-binary students and postdoctoral scholars succeed in STEM. WISE has also sponsored pre-college summer camps, which include instruction in the form of a bootcamp on the computer language, Python[cclvi].

In addition to WISE RP, the university has the following:

- College of Engineering Office of Culture, Community and Equity (OCCE)[cclvii]. This office provides consultation on DEI-related grant proposal sections, tracks DEI efforts across Michigan Engineering, helps apply engineering-inspired design, build, test and improve processes for DEI success, and offers programs for diverse middle and high school students.
- the Rackham Graduate School, which offers DEI instruction for women STEM students seeking faculty DEI positions[cclviii];
- STEM-related women's groups including a sorority and student organization that hoists STEM outreach programs for 4th-12th grade students from underserved areas[cclix].

Palid *et. al.* (2023)[cclx] cite the WISE program's success, as studied by Ramsey *et. al.* (2013)[cclxi], and state:

"[T]he researchers found that "environmental reminders of ingroup success made women seem more prevalent in STEM careers and reduced participants' stereotyping concerns" (p. 393). The committed support for diverse students within university STEM programming could explain why these programs are successful at achieving their outcomes, as well as showcase a possible solution to helping students feel like they belong in STEM spaces."

(c) TCU is also making a consistent effort to promote DEI goals. TCU has three offices to support its DEI efforts[cclxii]:

- The Office of Diversity and Inclusion, sponsors several initiatives, including a Race and Reconciliation Initiative, a Native American and Indigenous Peoples Initiative, and an Inclusive Excellence Initiative[cclxiii].
- The Office of Institutional Equity, an enforcement office that responds to discrimination and harassment reports based on age, race, sex, gender and other factors[cclxiv].
- The Student Identity and Engagement program runs the TCU Intercultural Center that aims to promote diversity, inclusiveness, and cultural awareness in the TCU community[cclxv]

TCU also has a "Responsible for Inclusion and Sustaining Excellence" (R.I.S.E.) program, run with the TCU Human Resources Office and the Office of Diversity and Inclusion. This is a certificate program for students to develop DEI action plans which can be implemented. This program has received the College and University Professional Association for Human Resources (CUPA-HR) 2023 Inclusion Cultivates Excellence Award[cclxvi].

TCUs DEI program has had some measure of success in increasing minority hiring among faculty[cclxvii]. The number of Black, Indigenous, People of Color (BIPOC) full-time faculty across all university departments has increased from 93 to 161[cclxviii].

TCU publishes an update on their DEI progress every two years[cclxix]. The 2020-2022 report states the following:

"TCU Named a HEED Award Winner for the Fifth Year in a Row. As the university continues to focus on strengthening the TCU experience and campus culture, the university was again recognized with the 2022 Higher Education Excellence in Diversity Award. It's the fourth consecutive year TCU has earned this designation from INSIGHT Into Diversity magazine, which highlights TCU's ongoing commitment to move forward in DEI."

There is a new law that bans DEI offices in Texas, which will take effect in 2024. "However, the bill makes it clear that it does not restrict academic instruction related to race and diversity and makes an exception for equity measures required by a court order or federal law." It is possible that voluntary efforts including the R.I.S.E. program at TCU continue, even after this law goes into effect.

There are significant efforts to eliminate DEI programs from colleges and universities. DEI programs were eliminated at New College in Florida. South Carolina has started to track DEI programs, and the Ohio legislature has passed a bill to limit if not eliminate the programs[cclxx]. Other states are considering bills to eliminate DEI programs, and Florida has passed a law to do so. Iyer and Boyette (2023) mention the Texas law that bans DEI offices. Dey (2023) also notes that this anti-DEI law goes into effect in Texas in 2024[cclxxi]. South Dakota, North Carolina, and Tennessee have also passed such laws. The expectation that a similar law will be passed in Iowa has caused DEI programs to be stopped there. The Iowa Board of Regents has effectively eliminated all DEI programs (Riley 2023)[cclxxii]. Bryant and Appleby report that there are more than 30 bills across the U.S. targeting DEI funding, practices, and promotion at schools[cclxxiii].

The bans have no popularity with either students or faculty, and a departure of faculty and students could occur, which would lower graduation rates and the academic standing of institutions. Benen (2023) reports, "The Tampa Bay Times reviewed records showing an upward tick in staff departures at some of Florida's largest universities." [cclxxiv].

Then there is the financial impact. The Federal Reserve Bank of Atlanta reports that colleges and universities have big economic impacts on the surrounding areas, and these impacts will not be easily replaced if the student and faculty and administration numbers drop[cclxxv].

These changes will have an overall negative effect on promotion of women entrepreneurship in all fields, including STEM. One example of how this would hurt the promotion of women STEM entrepreneurs is that of neuroscientist Andrea C. Gore, who was awarded the $7.5 million grant by the NIH for her studies on brain chemistry. She feels that "In all likelihood, if I didn't have a good DEI component, I would not have scored nearly as well and very likely would not have been in contention for funding,"[cclxxvi].

The impacted institutions have developed strategies to fight against these efforts. According to Williams (2023) Texas A&M, the University of Wisconsin, and Colorado College have specific efforts, as has Rice University[cclxxvii].

### *6-1-5-B Lending Institution Programs and Policies*

The funding policies of banks and other investors also hinder women STEM entrepreneurs' success. Some of the difficulties female entrepreneurs face in funding decisions include:

i) Investors ask promotion-focused questions to male entrepreneurs, and prevention-focused questions to female entrepreneurs (Kuschel 2020). This practice favors male entrepreneurs because more funding is provided to businesses that are asked promotion-focused questions.

ii) One of the major handicaps for women entrepreneurship, which has been shown especially in renewable energy applications, is difficulty with the financial sector evaluation of women's business plans (Davies 2020). There are a number of aspects to these difficulties:

a) Lack of collateral and property, as well as lack of previous documentation. Bankers or venture capitalists, as well as others, would make this argument. They would state that the women entrepreneurs simply do not have the necessary assets and business prospects as compared to the male entrepreneurs, so that loans or other schemes (including equity financing) would be more of a risk, independent of gender because the collateral quantities are significantly less.

b) Even if quantities brought to the table were equal, there would be discrimination based on gender. The financiers could argue justification on the basis that the goals of women entrepreneurs offer a lower pecuniary return, that work-life balance as a goal could not be justified, that business training and management skills were different, etc. Proving discrimination strictly based on gender would be a legal procedure, which could not be afforded by most prospective women entrepreneurs.

c) Risk-aversion could be relevant on both sides of the funding decision. The fact that that investors ask promotion-focused questions to male entrepreneurs and prevention-focused questions to female entrepreneurs could discourage women entrepreneurs, regardless of the funding decision outcomes. This could build a pattern of seeking more vulnerable funding options for them such as credit card debt, which is more vulnerable to interest rate increases (Paul 2023).

### 6-1-6 Private Organization Programs

Private non-governmental organizations (NGOs) and other organizations have several programs to aid women entrepreneurs. Some of these are described below:

i) In the construction industry, NAWIC[cclxxviii] has programs that work to increase the numbers of women in construction, through education, training, technical support and networking.

ii) CARE supports micro and small enterprises (MSEs) run by women[cclxxix]. CARE's Women's Entrepreneurship programming helps reduce barriers for these women by increasing access to tailored finance, shifting social norms, coaching and networking services and promoting women-centered digital solutions.

iii) Effective funding programs focus on issues related to STEM training and efficiency in funding. Monique Woodard, helped establish Black Founders in San Francisco in 2011, focused on developing black women entrepreneurs in the STEM fields, tech in particular (Anid et al. 2016).

iv) Garaizar (2016) mentions The Rising Tide, an educational program for female angel investors that provides networking, training and event support.

v) Liautaud (2016) points out the importance of mentoring and sponsorship programs for female entrepreneurship success such as, the WIN, by the American firm, BNY Mellon; Taking the Stage, a Canadian mentoring program; the Oracle Women Leadership Mentoring program; DWEN, which focuses on networking; and Astia which covers the STEM fields.

vi) WIPO GREEN[cclxxx] connects new technology owners with commercializing, licensing or distributing entities online

vii) One program of special relevance to women STEM entrepreneurs is a grant-writing boot camp that seeks to improve the research capacity for academic women in the STEM fields. Smith et. al. (July 2017) "designed an intervention, a grant-writing bootcamp informed by self-determination theory (Deci and Ryan 2012), to support the participants' feelings of relatedness, autonomy, and competence. Three grant-writing bootcamps were run over an 18-month period. Using a pre- and post-test design over the span of 1 year (and contrasting results with a comparison sample who were not part of the intervention) showed that the women participating in the grant-writing bootcamp significantly increased the number of external grants submitted, the number of proposals led as principal investigator, the number of external grants awarded, and the amount of external funding dollars awarded."

viii) Private foundations offer grants to support women entrepreneurs[cclxxxi].

- The Tory Burch Foundation has the Fellows Program that provides funding, business education and networking opportunities to women-owned firms.
- The Cartier Women's Initiative is an entrepreneurship development program that provides financing, training, and mentoring.
- The Amber Grant provides funding to women-owned businesses.
- The Eileen Fisher Women-Owned Business Grant Program provides funding to women-owned enterprises that aim to bring about environmental and social change.

ix) In her July 2023 article for nerdwallet, Randa Kriss (2023) describes 27 small business grants for women. Some notable ones that target Black female entrepreneurs and women of color include:

- The SoGal Black Founder Startup Grant offered by the SoGal Foundation, offers startup grants to Black women and Black nonbinary entrepreneurs. The grant also provides fundraising advice and lifetime access to the SoGal Foundation team.
- The Women of Color Grant Program organized by the Tory Burch Foundation and the Fearless Foundation awards annual grants to businesses owned by women of color.

x) There are angel investor platforms like 37 Angels[cclxxxii]. Entrepreneurs pitch for their business to a network of angel investors, who provide funding if they like the pitch in exchange for equity or an ownership stake in the business.

xi) Indirect Support - A number of organizations help women entrepreneurs through their support of STEMM education. A subset of these programs is described below.

<u>Corporate Support</u>

- 3M is attempting to support a more equitable pathway to science, manufacturing, and skilled trades jobs. In 2022, the company invested $11.6 million as part of its

$50 million incremental giving commitment over five years[cclxxxiii].

- Novartis is working with HBCU medical centers (including Morehouse School of Medicine, Howard University College of Medicine, Meharry Medical College and Charles R. Drew University of Medicine and Science) to upgrade medical research facilities, to include under-represented students in drug development, and to address inequity in health care. Advarra, BeeKeeper AI, Virb, Merck, Amgen and Alnylam will also participate in this program[cclxxxiv].
- Microsoft also has a Racial Equity Initiative. This includes support of HBCUs, to include computer-oriented development (including broadband support) and entrepreneurship training[cclxxxv].
- Corporations and law firms also offer DEI programs that could help underrepresented populations in STEM.
- Business efforts that have focused on DEI are especially covered by the Maryland Economic Development Administration (MEDA) [cclxxxvi]. Many of the programs are company-wide training programs and mentorship effort. Some of these are listed below:
  - "Ballard Spahr is dedicated to promoting diversity, equity, and inclusion through initiatives like the INVEST sponsorship program, which actively recruits, retains and advances talent from diverse backgrounds. INVEST pairs associates with partners for more than mentorship, offering career development opportunities, exposure to business acumen-building exercises, client networking and encouraging them to take initiative in their career growth." — Kimberly Klayman, partner.
  - Arcweb Technologies has established a company-wide DEI training sessions. The company has a DEI Steering Committee that leads company-wide discussions twice a year. These conversations cover inclusive language, how to be an ally and consider a variety of identities when addressing diversity.
  - TEDCO has created investment strategies that support DEI efforts. TEDCO's Social Impact Funds have supported 100 investment deals in three years, with 60% of the funding awarded to entities led by a woman or person of color. In order to apply for these funds founders or owners of companies need to demonstrate social and/or economic disadvantage[cclxxxvii].
- Alfonseca and Zahn (2023) mention that diversity has been good for business, according to several studies. These studies show that that more diverse companies are more innovative and profitable[cclxxxviii]. The studies they refer to are from a UNC Pembroke 2021 article that mentions research from organizations such as Gartner and World Economic Forum. These studies show that organizations with diverse decision-making teams exceed their financial targets and companies with above-average diversity scores drive a higher percentage of their revenue from innovation[cclxxxix].

- Seramount's Best Law Firms for Women Initiative[ccxc] has surveyed the progress of law firms in gender diversity and family-friendly benefits. In 2023, Seramount expanded this survey to other underrepresented groups and renamed it the Best Law Firms for Women & Diversity. The survey ranked the top 50 law firms and named them to the 2023 list of the Best Law Firms for Women & Diversity. These law firms increased the average fully paid gender-neutral parental leave to associates and equity partners. For associates it was increased to 17 weeks and for equity partners to 20 weeks. The firms also increased many other childcare benefits such as everyday childcare and backup childcare. Seramount also looked at the programs and policies of the ranked firms and found four key business practices:
    - Culture: embedding DEI in their firm cultures
    - Connection: extending DEI to more underrepresented groups
    - Community: aligning their firm's DEI commitments with their communities
    - Leadership: achieving more seats at the table and professional development
- DEI programs are also under attack when run by law firms[ccxci] and corporations[ccxcii]. These programs at corporations were already waning before the 2023 Supreme Court ruling challenging affirmative action as a general practice. Bunn (2023) finds that the DEI roles attrition rate was 33% at the end of 2022, compared to a 21% attrition rate for non-DEI roles [ccxciii]. According to Telford (2023) the Supreme Court decision "emboldened objectors to corporate DEI practices. Goudsward (2023) notes that the law firm McGuireWoods has created a dedicated team to help companies reduce their legal risk under increased scrutiny of their DEI programs. He also mentions the law firms that are facing lawsuits over their diversity initiatives.
- Alfonseca and Zahn (2023) mention that the cutbacks in DEI programs at companies could drive away diverse employees and customers, and impact their bottom line. Pequeño IV (2023) [ccxciv] discusses a Harvard study that found that the end of affirmative action in four key states led to significant declines in the number of Black women, Latino men and Asian women, and increases in the number of white men in the state workforce.
- The legal challenges to these programs could impact innovation. Opie and Washington (2023) in the Harvard Business Review argue that more diverse corporate groups "make smarter decisions and better investments, are more adaptable, and drive innovation when the corporate culture in which they operate is a supportive, psychologically safe one."[ccxcv]. The absence of these diverse groups could negatively impact innovation and indirectly impact female STEM entrepreneurs.
- Williams (2023) in the Harvard Business Review argues that the Supreme Court's affirmative action ruling does not make company DEI programs illegal [ccxcvi]. A number of firms, including State Street[ccxcvii], and Bain and Company[ccxcviii],

continue to advertise their commitment to DEI, and they wouldn't do this if it were illegal or lead to substantial losses. Williams describes how to counter the anti-DEI efforts, including collecting data, developing metrics, and standardizing the structure of recruiting.

Non-Corporate Support

- Burroughs Wellcome Fund has joined the STEMM Opportunity Alliance, and over the next five years will invest an additional $19 million in grant awards that span across its diversity in STEMM programming. This will include scaling up its investment in its Postdoctoral Diversity Enrichment Program (PDEP), which aims to increase the number of underrepresented scientists within the biomedical and medical research and education community[ccxcix].
- CZI has announced a five-year, $46 million partnership with historically Black medical colleges (HBMCs) to advance genomics research and accelerate precision health, particularly for Black people and other people of color[ccc].
- The National GEM Foundation Consortium, founded by Notre Dame University, which provides scholarships for under-represented groups in master's and doctoral programs in engineering and science, and matches the students with consortium employer partners[ccci]
- The Heising-Simons Foundation will fund the STEMM Opportunity Alliance, and anticipates spending roughly $7 million a year on STEMM equity initiatives over the next six years, totaling $42 million by 2028. In 2023, this will include committing $7 million to programs that seek to broaden participation of and support underrepresented groups in physics and astronomy[cccii].
- HHMI is funding programs to help train under-represented students at HHMI research laboratories[ccciii]. Those receiving awards in 2022 included the University of Montana (to work with Native American students), the University of Maryland, Eastern Shore (an HBCU), and the University at Albany (part of the State University of New York system)[ccciv]. HHMI is also funding the Freeman Hrabowski Scholars program, to support diversity in early career faculty biomedical research[cccv].
- The Last Mile Education Fund helps lower-income (enrolled) underrepresented students complete their tech (computing-related) degrees, when facing unforeseen financial difficulty[cccvi]. The program also works with the Rocket Community Fund, and helped create the Detroit Area Talent Fund pilot program[cccvii].
- The Simons Foundation has a number of efforts to support STEMM: $56.6 million to support the Stony Brook (State University of New York) Simons STEM Scholars Program to provide scholarships, housing and stipends to 50 new students each year in the STEM fields[cccviii]; $12.5 million to support the recently launched Team-Up Together Initiative at the American Institute of Physics, which provides financial support to African American students in physics and astronomy departments; and $2.5 million to support the Meyerhoff Scholars

Program at the University of Maryland Baltimore County, which supports diverse students who to pursue advanced STEMM degrees[cccix]. The Foundation is also one of the partners of the STEMM Opportunity Alliance, an effort to achieve equity and excellence in science, technology, engineering, mathematics, and medicine (STEMM), that includes many other partners, including the American Association For The Advancement Of Science (AAAS)[cccx].

- TGIV) is funding T-GET, that will invest $50 million to support nonprofit organizations that are changing the STEMM ecosystem by increasing access, inclusion, representation and parity[cccxi]. This fund is supported by Tiger Global, a hedge fund, whose assets plunged by about half in 2022, as its hedge and long-only funds struggled and venture investments were marked down. The hedge fund has recovered in 2023[cccxii].

## 6-1-7 International Programs

i) The OECD, of which the U.S. is a member, supports women entrepreneurship in renewable energy with its CEFIM program (Davies 2020).

The OECD also helps women entrepreneurs at the global, national and local levels through its WE Initiative[cccxiii]. This is done in four ways:

- By providing gender-disaggregated data on access to finance in the OECD Scoreboard
- Identifying best practices on topics like women tech entrepreneurs
- Providing tailored policy guidance for countries and local areas
- Developing a multi-stakeholder platform that brings together the public and private sectors

ii) The WISE initiative aims to enhance women's economic empowerment internationally. It increases women's access to employment, training, leadership, and financing in the industries of the future. Governments, companies, foundations, and civilians have committed $900 million to increase women's participation in clean energy, fisheries, recycling, forest management, and environmental conservation sectors[cccxiv]. The three key pillars of WISE are:

- Promoting well-paying, quality jobs for women in energy, land, and water use and management
- Supporting women-owned, -led, and -managed businesses in energy, land, and water use and management through increased access to financial services, networks, markets and technical assistance
- Eliminating barriers to women's economic participation in energy, land, and water use and management by advancing girls' access to STEM education and enhancing equal access to assets.

Flagship WISE initiatives aim to:

- Improve Economic Opportunities for Women in the Energy Sector – United States Agency for International Development (USAID) through its Engendering Industries program increases economic opportunities for women in male-dominated sectors, such as, water, agriculture, energy, and information technology.
- Increase Women's Access to Climate Finance – USAID's Climate Gender Equity Fund (CGEF) increases access to climate finance for investment vehicles, intermediaries, businesses, and community-based organizations in developing countries. This expands financial inclusion for women-led organizations and businesses driving sustainable economic growth.
- Promote Women's Access to Land Rights – The State Department through the Equal Stake in the Soil Initiative supports coalitions of civil society organizations in legal, policy, and social change efforts. This helps advance women's land rights.
- Strengthen Women's Inclusion in the Blue Economy – The State Department through the Building Economic Inclusion via the Blue Economy initiative provides financial and technical assistance to women entrepreneurs and young professionals in maritime sectors, helping business growth in fishing, agriculture, green business, and tourism markets.

## 6-2 Policy Solutions

In this section, we summarize some of the remaining challenges for women entrepreneurs in STEM that have not been entirely addressed by existing policies and programs. We describe the potential policies by government, institutions and organizations that address existing policymaking gaps in Table 6-4 below. We mention each challenge, list the policy solutions for each challenge, and summarize the benefits of the policy solutions. The section reference for each challenge is listed next to the challenge.

**Table 6-4: Challenges Facing Women STEM Entrepreneurs, Policy Solutions and Benefits**

| Challenges | Policy Solution/s | Benefits |
|---|---|---|
| **Challenge 1 – Lower enrollment & less exposure to STEM learning, research and patenting for female students (Section 3-1)** | 1. Schools could start exposing girls early on to STEM learning and careers, before college. This change could be tied to federal funding programs for K-12, such as Title I grants given to ensure that low-income students meet academic standards. Schools could bring about internal policy changes to implement this requirement by their STEM staff.<br>2. State governments could provide educational incentives to institutions to help them increase the female STEM workforce. State funding per student for an institution could be tied to increased enrollment of female students in STEM programs. Institutions could change their internal policies by performing outreach to encourage enrollment by female students in STEM programs. They could include sexual harassment training in STEM programs.<br>3. Academic training programs could increase student exposure to commercialization and patenting. State funding for institutions could be tied to the presence and availability of commercialization programs for STEM students. Institutions could incorporate more of this training in their graduate program curriculum.<br>4. Academic institutions could place special emphasis in their entrepreneurship programs on preparing female students for entrepreneurship in the Professional, scientific, and technical services sector. This could involve interaction and guidance from industry leaders in this sector. Institutions could find additional funding to enhance these programs through existing and new sponsors and donors. They could include leadership training for women as part of these programs. | These policies will help prepare a skilled female STEM workforce, and encourage members of this labor force to pursue STEM entrepreneurship. |

**Table 6-4 (Continued): Challengess Facing Women STEM Entrepreneurs, Policy Solutions and Benefits**

| Challenges | Policy Solution/s | Benefits |
|---|---|---|
| **Challenge 2 – Lack of seniority and resources for female faculty (Section 3-4-1)** | 1. Institutions could give tenure and promotion credit for faculty's entrepreneurship activities. Federal grant funding could encourage diverse teams thereby encouraging institutions to find creative ways to promote female faculty. The promotion and tenure committees at institutions could be instructed to give credit for faculty entrepreneurship activities. Institutions could set up faculty committees focused on training and promotion of diverse faculty. These could be led by female STEM faculty and host conferences and seminars to assist promotion committees in reviewing diverse faculty in favorable ways, including accounting for faculty entrepreneurship efforts.<br>2. Academic institutions could use outside reviewers or AI and other tools to foster "gender-blind" tenure, promotion, financing and licensing decisions. Federal grant funding for institutions could be tied to the inclusion of diverse teams in grant applications. This would encourage institutions to find ways to promote diverse faculty and implement some of the procedures mentioned above to remove any biases. | These policies will help female STEM faculty succeed academically, and support their commercialization efforts. |
| **Challenge 3 – Lower conversion of female faculty inventions into patents & licensing (Section 3-4-1)** | 1. Universities could blind licensing offices to faculty seniority and require that licensing offices track their performance by gender. Licensing offices could track their gender metrics annually. A source for this information is the PatentsView Annualized Data Tables[cccxv]. Universities could compare these metrics with other institutions and locations, and share them with faculty. | These policies will help female faculty bring their research to market, and also help all female STEM entrepreneurs (academic and non-academic) patent and license their research. |

**Table 6-4 (Continued): Challenges Facing Women STEM Entrepreneurs, Policy Solutions and Benefits**

| Challenges | Policy Solution/s | Benefits |
|---|---|---|
| | 2. Universities could support licensing offices' outreach by providing resources for more inclusive innovation. Licensing offices at academic institutions could tailor their outreach to access female academics and make them aware of commercialization training programs. Universities could make the continued availability of these resources, contingent on the type, frequency and quality of outreach performed, as reported by female faculty.<br>3. State governments could provide commercialization and funding support. States could establish an organization (authority) by legislation to support research, innovation, entrepreneurship, funding, growth and commercialization in the STEM fields similar to Virginia's VIPA. This entity could work with licensing offices to commercialize research. It could use public and private funds to support STEM businesses.<br>4. State governments could establish interactive online marketplaces similar to WIPO GREEN that connects owners of new technologies with individuals or companies that want to commercialize, license or distribute a new technology. States could establish an authority similar to VIPA, that could develop this online marketplace. | |
| **Challenge 4 – Limited success of female entrepreneurs in obtaining grant funding, such as NIH, SBIR/STTR funding** | 1. Government agencies participating in the SBIR/STTR could develop a program similar to NSF's AWARE program that provides grant writing assistance, commercialization summits and sharing of success stories to underrepresented populations. Congress could legislate that the federal agencies participating in the SBIR and STTR programs should develop programs similar to NSF's AWARE program. | This would lead to a larger number of female STEM entrepreneurs applying for and succeeding in obtaining grant funding. |

**Table 6-4 (Continued): Challenges Facing Women STEM Entrepreneurs, Policy Solutions and Benefits**

| Challenges | Policy Solution/s | Benefits |
|---|---|---|
| **(Section 3-4-2 & 3-4-3)** | 2. Federal agencies participating in the STTR program could provide funding to university licensing offices at partnering research institutions, to specifically train and help female academic entrepreneurs on grant applications. Congress could legislate that federal agencies participating in the STTR program provide this funding to licensing offices. | This would lead to a larger number of female STEM entrepreneurs applying for and succeeding in obtaining grant funding. |
| **Challenge 5 – Unfavorable financial sector evaluation of women's business plans, inhibiting business growth (Section 3-4-2)** | 1. Lending institutions could introduce gender-factored investing which integrates gender-based factors into investment decisions. Lenders could make these changes internally and use initiatives such as "impact investing" or "gender bonds" to make these decisions. Impact investing could generate financial returns but also optimize investments in female STEM businesses. Investors could use gender bonds to finance loans for women-owned STEM businesses.<br>2. Lending institutions could provide gender-sensitive STEM-related business plan evaluation, and funding training to bank officials. The institutions could do this internally, as part of the other training bank officials receive.<br>3. Federal agencies such as the SBA could provide training to increase the number of women in STEM-related venture capital and angel investment. The SBA could create a program to address this gap in the female STEM ecosystem. The agency could partner with its resource partners to provide this training in their local areas. The resource partners could provide a comprehensive program that includes networking, training, and event support for these investors. | This would improve the financial standing of female STEM entrepreneurs, and encourage them to invest in and grow their businesses. |

**Table 6-4 (Continued): Challenges Facing Women STEM Entrepreneurs, Policy Solutions and Benefits**

| Challenges | Policy Solution/s | Benefits |
|---|---|---|
| | 4. Federal agencies such as the SBA could develop loan programs for underserved populations in STEM. The SBA could back loans for female STEM entrepreneurs and work with local lenders to reduce their risk. These loans could have lower or interest rates and fees and allow female STEM businesses to scale up and expand.<br>5. IRS could provide enhanced tax credits for employer health and retirement plans. IRS currently offers a tax credit to small businesses that is 50% of eligible startup costs. IRS could increase this credit to 60% or 70% of startup costs. This would help STEM employer businesses financially. IRS also offers a Small Business Health Care Tax Credit. The maximum credit is 50% of health premiums paid and the amount of credit works on a sliding scale. IRS could restructure the maximum amount and/or the sliding scale of this credit to provide a larger credit to small businesses. This would help STEM employer businesses.<br>6. State governments could offer financial support to female STEM businesses, through cash collateral for a business loan. State governments could create a financing authority similar to Virginia's CCP. The authority would reduce a lender's credit risk by providing cash collateral for a small business loan. This would make more small STEM businesses eligible for loans. | |

**Table 6-4 (Continued): Challengess Facing Women STEM Entrepreneurs, Policy Solutions and Benefits**

| Challenges | Policy Solution/s | Benefits |
|---|---|---|
| **Challenge 6 – Lack of role models, partnerships & networks (Section 3-3)** | 1. Federal agencies could develop programs similar to the State Department's POWER program that uses a multi-tiered approach to build professional networks for women STEM entrepreneurs. The first tier of this program could connect female STEM entrepreneurs to private industry. The second tier could connect them to entities that are changing their policies to take account of gender factors, such as lending institutions, and investors.<br>2. Federal agencies such as the State Department, SBA, USDA, USPTO could collaborate to establish a virtual national mentoring network to assist female STEM businesses. The agencies would choose qualified mentors based on their knowledge of STEM research, innovation, entrepreneurship, contracting, funding, growth and commercialization. They could use partner networks such as, SBA's Resource Partners Network, USDA's Rural Partners Network to inform small businesses in underserved areas of this network. | The increased availability of mentors and networks for female STEM entrepreneurs would help them access the most current information necessary to succeed in their fields. |

**Table 6-4 (Continued): Challenges Facing Women STEM Entrepreneurs, Policy Solutions and Benefits**

| Challenges | Policy Solution/s | Benefits |
|---|---|---|
| | 3. Academic institutions could enhance existing successful mentorship programs with a diversity and STEM component. This would be an internal policy change by institutions. They would examine their existing mentorship programs, identify the program features that make them less or more successful and revise the programs for greater success. They would try to find female STEM mentors and if possible, mentors that are of diverse ethnic and racial backgrounds to engage diverse faculty. They would also expose non-citizen STEM faculty to these mentors to encourage them to start STEM businesses. | |
| **Challenge 7 – Lower government assistance in times of pandemic or other shocks to the economy Section 3-7-1)** | 1. The federal government could learn from the success of the second round of PPP funding, and deliver financial assistance to female STEM businesses through local/community organizations rather than mainstream financial institutions, in the future. Congress could legislate this assistance through these organizations, during unprecedented shocks to the economy, and ask SBA to implement the program. SBA resource partners would make small businesses in underserved areas aware of the program, direct them to appropriate lenders, and act as resources to keep these businesses updated on any changes to the program. | These policy solutions will support female STEM entrepreneurs during unprecedented shocks to the economy. They will also allow eligible women access to affordable child care and other care giving solutions during these times. Women in STEM will become more financially stable and resilient. |

**Table 6-4 (Continued): Challenges Facing Women STEM Entrepreneurs, Policy Solutions and Benefits**

| Challenges | Policy Solution/s | Benefits |
|---|---|---|
| | 2. The federal government could provide limited resources for temporary childcare and other care in emergencies, to increase the financial stability, and entrepreneurship of eligible underserved populations in STEM. As mentioned earlier, the Lloro (2021) study found that the percent of certain groups of women reporting childcare or family responsibilities as a reason for not working in 2020 was the same as in 2019. In addition, Fairlie and Desai (2021) find that the monthly rate of new businesses in 2020 for women was the highest in 24 years. So, it is likely that not all women need these resources.<br><br>However, Washington (2021) finds that even before the pandemic certain groups of mothers were more likely to live in child care deserts, not have access to affordable child care, and have lower workplace flexibility. The pandemic likely made affordable child care further out of reach for these groups, disproportionately affecting them. The federal government's resources could be targeted towards these groups of mothers to help them access affordable child care in times of crisis. Congress could include this funding in the legislation providing emergency assistance. In order to be eligible for this funding, women would need to show that child care affordability was an issue for them, even before the emergency. | |

**Table 6-4 (Continued): Challenges Facing Women STEM Entrepreneurs, Policy Solutions and Benefits**

| Challenges | Policy Solution/s | Benefits |
|---|---|---|
| | 3. The federal government could help female STEM entrepreneurs with emergency funding training and application assistance to increase chances of success. SBA could implement this assistance through its resource networks. SBA resource partners would make small businesses in underserved areas aware of the application process for financial assistance. They would train these businesses on program eligibility, documentation and assist them with applications to ensure greater success in obtaining funding | |

There are non-gender-specific gains, such as an increase in the number of patents and commercial development that women entrepreneurs could provide, if they participated equally. Saksena et al. (2022) in the USPTO study find that commercialized patents could increase by 24%, if gender disparity in patenting was removed. Turrentine (2015) finds that inventions by women address problems in health, poverty, and education. Furstenthal et al. (2022) discuss women entrepreneurs' success through investments in new technology including those related to banking, genome editing, AI, and others. So, these inventions could use novel procedures that improve women's health to lower overall healthcare costs.

Pogessi et. al. (2020) discuss possible gains in ESG practices that may come about through increased support for women's STEM entrepreneurship. Also, increasing women's STEM entrepreneurship can positively impact the national GDP. Muir et al. (2022) mention that diverse inventors help maximize national GDP and prosperity. Shinabarger (2017) argues that higher female entrepreneurship impacts family resiliency, strength, and literacy positively. Gender parity in STEM entrepreneurship could bring about these benefits as well.

# 7. Preliminary Methodology for Next Phase (Task B) of the Study

In this chapter we describe the research methodology to further investigate female entrepreneurship in high-yield and high-growth industries. We explain how we will gather the data, the econometric and statistical methods we will use to analyze the data, the software we will employ to run the model, and what we hope to learn from the research and analysis.

We use the findings from the literature search described in Chapter 3, and the data and trend analyses performed in Chapters 4 and 5 to develop the technical methodology. The technical methodology relies on two approaches. First, we include a continuous variables approach to predict female STEM entrepreneurship participation, at the national and state levels. Second, we describe a logistic regression approach to predict binary outcomes for states, whether a state's percent of female STEM firms for a particular STEM sector increases by a certain percentage, due to changes in underlying factors.

## 7-1 Data Gathering Methods and Methodologies

This section describes the data we will collect and how we will gather the data.

### 7-1-1 Number and Location of Women STEM Entrepreneurs

We will obtain the number of female employer STEM entrepreneurs, and their location by state from the ABS, for the years 2017 to 2020[cccxvi] from the 2018, 2019, 2020 and 2021 ABS. Each ABS provides data for the previous year. For example, the 2018 ABS covers reference year 2017.

The 2018, 2020 and 2021 ABS provide employer information for three-digit NAICS, whereas, the 2019 ABS provides employer data only for two-digit NAICS (the above endnote has links to the methodology of these surveys). So, the employer data for 2017, 2019 and 2020 is more detailed at the three-digit NAICS level, as compared to the data for 2018, which is at the two-digit level. The NAICS at the three-digit level cover both STEM and STEM-adjacent industries. For example, NAICS 541 covers STEM industries such as "Scientific research and development services", but also STEM-adjacent industries such as "Architectural, engineering, and related services". For 2020, employer information is available at the four-digit level, but it is not available for other years.

For the number and location by state of female nonemployer STEM businesses, we will gather data from the NES-D for the years 2017 through 2019[cccxvii]. The NES-D data is available at the three-digit NAICS level for these three years. However, for the year 2017 some data, such as for NAICS code 55, Management of Companies and Enterprises are not available.

For earlier data, we will access two data sources from the Census. The first is the SBO data, which is available for 2012[cccxviii] and is divided into nonemployer and employer firm[cccxix] data. This data is by the 2012 NAICS and is available at the two-digit NAICS level[cccxx].

The second is the ASE. The ASE provides "economic and demographic characteristics of employer businesses and their owners by sector, sex, ethnicity, race, and veteran status for the nation, states, and the fifty most populous metropolitan statistical areas (MSAs)"[cccxxi]. These data are in .DAT format and are available for the years 2014, 2015 and 2016.

The 2013 Statistics of U.S. Businesses (SUSB) Annual Data Tables by Establishment Industry is a source for the number of employer and nonemployer firms in 2013 by 2012 NAICS, but the data are not divided by sex[cccxxii]. The 2013 County Business Patterns (CBP)and Non-employer Statistics (NES) Combined Report provides data on non-employer firms for 2013 by 2012 NAICS, but again the data are not divided by sex[cccxxiii]. We might try a simple approach to interpolate for 2013, such as, doing a similar change for both women and men entrepreneurs. For example, if total employers for the year 2013 increased by 56% of the difference between 2012 and 2014, the interpolation would lead to the following:

Women STEM Entrepreneurs for 2013 = 2012 Women STEM Entrepreneurs + 0.56*(2014 Women STEM Entrepreneurs – 2012 Women STEM Entrepreneurs)

We will access data on female STEM businesses for the years 2012 through 2020, from the sources described above. For years that this data is not readily available, we will use an interpolation method to deduce female STEM business numbers. For example, for 2013 we might use a linear interpolation method to assess female employer and nonemployer firm numbers, as described above, or as preferred. In addition, as mentioned above some of the sources report data by 2017 NAICS, whereas some use 2012 NAICS, and the data is at different NAICS digit levels. We will employ the code lists and crosswalks provided by the Census[cccxxiv] to ensure that the data we collect is consistent by NAICS and levels.

### 7-1-2. Supply-side Data

We identified particular variables important for female STEM entrepreneurs in Chapters 3, 4, and 5. Many of these variables impact the supply of women entrepreneurs. We will gather data for these variables as follows:

#### *7-1-2-A Patent Information*

As we described in Chapter 3, the literature review shows patenting and commercialization gaps for female-owned STEM businesses. So, patents could help explain the disparity in female entrepreneurship in the STEM fields and we will collect data on this variable to study the linkages. We will gather this data from PatentsView Annualized Data Tables[cccxxv] that provide information on the inventors, companies and gender of inventors for the patents granted in a particular year. PatentsView also has information on the location of the patentee[cccxxvi]. These patent data cover all the years 2012 through 2020 included in our methodology. Saksena et al. (2022) in the USPTO study mentioned in the literature review uses PatentsView to examine women patentee data by location at the county level. We will use this source to identify women STEM entrepreneurs by U.S. states.

It is possible that the women entrepreneurs for an industry are not located where the women who receive the patents that are relevant to the industry are located. Fundera, using the Census American Community Survey (ACS), found Seattle as the best city for female entrepreneurs. It is possible that Seattle as a tech location with women entrepreneurs and women patentees distorts the true picture, because other top locations for women entrepreneurs such as Paradise, Nevada and Orlando and St. Petersburg in Florida[cccxxvii] don't show the same correlation between female patentees and entrepreneurs. We will take this into account when we use patents as an explanatory variable for women STEM entrepreneurship success.

### *7-1-2-B Funding and Financing Data*

Since the literature review identified funding as a major barrier for women's entrepreneurship success in STEM, we will gather data on funding for female STEM entrepreneurs. We will access venture capital funding data for women entrepreneur startups by state and by broadly-defined industry from PitchBook's Female Founders Dashboard[cccxxviii]. We will reach out to Pitchbook to see if we can obtain more industry-specific funding data for women entrepreneurs, especially for the larger venture capital investments (such as over $10 million).

Financing differences are important for women STEM entrepreneurs' success, and national interest rates could have an impact, with higher interest rates causing a different effect on female versus male entrepreneurs. We will gather national interest rate data from sources such as the Federal Reserve Bank of St. Louis Federal Reserve Economic Data, (FRED), series[cccxxix]. These data are commonly used for many U.S. financial and economic statistics, and national interest rates impact financing at many levels.

### *7-1-2-C Labor Force or Employment Data*

Childcare and networking opportunities are possible important factors for the success of female STEM entrepreneurs, per the literature review performed in Chapter 3. Saksena et al. (2022) USPTO study mentions that large labor markets could help women build networks and find low-skilled labor for childcare. So, we will collect employment data both at the state and national levels to see how it impacts female STEM entrepreneurship. For state-level employment data we will use the Bureau of Labor Statistics (BLS) [cccxxx] as a source. We will choose a state, and then select Total Nonfarm, Not Seasonally Adjusted, include Annual Average (All Employees, In Thousands)[cccxxxi] data. This is because seasonal adjustment is only used for quarterly and more frequent data. Annual average data are never seasonally adjusted.

We will obtain national level employment data from the Current Population Survey (CPS). For example, for the year 2022 and for other years, the CPS provides employment with industry and demographic level detail [cccxxxii].

### *7-1-2-D Data on Women STEM Graduates*

The underlying basis for many (not all) women STEM entrepreneurs, is educational success in STEM in universities and colleges. Because of the ease of moving from state to state in search of a position, it is possible that the national figures represent the most meaningful source of such entrepreneurial talent – that women STEM engineers from Maryland are capable of moving to California or Washington state. We will access national figures for these graduates from sources such as Statista[cccxxxiii], that provides these numbers by year.

A report mentioned in the literature review also has data on STEM degrees by gender from 2011 to 2020[cccxxxiv] (NSF 2023). We will use these statistics as another source for women STEM graduates.

### 7-1-3. Demand-side Data

There are variables that impact the demand for female STEM entrepreneurs. On a national and state level, possibly the most useful variable is per-capita income. We will access this data from the Bureau of Economic Analysis (BEA) "Regional Data and Personal Income" [cccxxxv]. We will use "Per capita personal income (dollars)" as the chosen statistic, and "United States" as the chosen area for the national data. We will adjust these data to take account of the effects of inflation, so as to get "real" per capita income, to develop an undistorted playing field for all years. For the state-level data, we will pick each state instead of selecting United States. These state per capita income statistics, not adjusted for inflation, go back to the 1930s.

## 7-2 Econometric Methods and Mathematical Equations

As mentioned above, we will use two approaches, a continuous variables approach and a logistic regression approach, to analyze female entrepreneurship in the STEM fields. In this section we describe the variables and equations to model effects on women entrepreneurs using these two approaches.

### 7-2-1 Continuous Variables Approach

In this approach we will evaluate how the number of female STEM entrepreneurs (the dependent variable) is impacted by changes in explanatory variables such as women patentee numbers, venture capital funding, interest rates, etc. (the independent variables). The variables for this approach are based on the data described in Section 7-1 and are differentiated by whether they are at the national or state levels.

### *7-2-1-A Continuous Variables Approach at the National Level*

Variables at the national level are as follows:

$N_{WSTEM}$ = the number of women STEM entrepreneurs nationally.

We will gather this information for the STEM field as a whole, as the total number of female STEM entrepreneurs in all 12 STEM sectors/industries defined in Chapter 4, Table 4-2. We will also gather this information by specific product manufacturing or service sector/industry in STEM, such as the number of female STEM entrepreneurs nationally for Fabricated metal product manufacturing, or Data processing, hosting, and related services. However, we will not use this sector specific information for the continuous variables approach. Instead, we will use this sector-specific data for the logistic regression approach, as defined in Section 7-2-2.

$W_{PAT}$ = the number of women patentees nationally

VCF = national level venture funding for women STEM entrepreneurs

LF = national labor force

WSG = women STEM graduates in the U.S.

R = A chosen interest rate (such as a 30-year fixed rate mortgage average in the U.S.[cccxxxvi])

PCI = Real per-capita income in the U.S.

D = Dummy with a value of 0 for non-pandemic years (2012 thru 2019) and 1 for the pandemic year 2020)

$\varepsilon$ = random error.

$\Delta$ = denote difference. For variable $y$ which takes the value $y_t$ at time t, and $y_{t-1}$ at time t-1, $\Delta y = y_t - y_{t-1}$.

log = the natural logarithm

Then a continuous variables equation for women STEM entrepreneurs at the national level is as follows. This equation is based on a log-log model, because these models are typically used in models of growth, percentage changes are relatively easy to work with, and elasticities (percent change in the independent variable leading to percent change in the dependent variable) are easy to calculate. If needed, we will use a test such as the Box-Cox test[cccxxxvii] to assess whether a log-log model is appropriate given the data.

$\log(N_{WSTEM}) = \alpha_{00} + \alpha_{01}*\log(W_{PAT}) + \alpha_{02}*\log(VCF) + \alpha_{03}*\log(LF) + \alpha_{04}*\log(WSG) + \alpha_{05}*R + \alpha_{06}*\log(PCI) + \alpha_{07}*D + \varepsilon_1$

Or, alternatively

$\log(N_{WSTEM}) = \alpha_{10} + \alpha_{11}*\log(W_{PAT}) + \alpha_{12}*\log(VCF) + \alpha_{13}*\log(LF) + \alpha_{14}*\log(WSG) + \alpha_{15}*R + \alpha_{16}*\log(PCI) + \alpha_{17}*D + \varepsilon_2$

We could put these equations in difference terms, although we would not difference the interest rates, since the differences are small, in general. We will use the difference approach with the logistic regression by sector described in Section 7-2-2 to show another aspect of this issue.

We will run this equation for the STEM field as a whole, at the national level. We will not run this equation by each of the 12 STEM sectors individually.

We will also run this equation at the national level by demographic characteristics, such as, by race, ethnicity, veteran status etc. For example, instead of analyzing $N_{WSTEM}$, the number of women STEM entrepreneurs nationally, we would regress $N_{WSTEMB}$, the number of black women STEM entrepreneurs nationally on the explanatory variables. We would do this to understand how black female STEM entrepreneurship is dependent on women patentee and STEM graduate numbers, venture funding, labor force, per-capita income, interest rates and the pandemic. These relationships will not be exact, because some of the variables such as patent data are not yet available by a combination of gender and race. However, we could discover underlying trends such as, how does black female entrepreneurship change when the number of women patentees increases nationally. We will make a definitive determination about how to treat these demographic characteristics, after we gather data on all the variables defined above. However, the equations we will use for these demographic related equations will be close to the following:

$\log(N_{WSTEMR}) = \alpha_{00} + \alpha_{01}*\log(W_{PAT}) + \alpha_{02}*\log(VCF) + \alpha_{03}*\log(LF) + \alpha_{04}*\log(WSG) + \alpha_{05}*R + \alpha_{06}*\log(PCI) + \alpha_{07}*D + \varepsilon_1$

$N_{WSTEMR} =$ the number of women STEM entrepreneurs nationally by race, for each of the five races identified in the ABS and NES-D (Chapter 4, Table 4-3A)

$\log(N_{WSTEME}) = \alpha_{00} + \alpha_{01}*\log(W_{PAT}) + \alpha_{02}*\log(VCF) + \alpha_{03}*\log(LF) + \alpha_{04}*\log(WSG) + \alpha_{05}*R + \alpha_{06}*\log(PCI) + \alpha_{07}*D + \varepsilon_1$

$N_{WSTEME} =$ the number of women STEM entrepreneurs nationally by ethnicity, for each of the three ethnicities identified in the ABS and NES-D (Chapter 4, Table 4-3B)

$\log(N_{WSTEMV}) = \alpha_{00} + \alpha_{01}*\log(W_{PAT}) + \alpha_{02}*\log(VCF) + \alpha_{03}*\log(LF) + \alpha_{04}*\log(WSG) + \alpha_{05}*R + \alpha_{06}*\log(PCI) + \alpha_{07}*D + \varepsilon_1$

$N_{WSTEMV} =$ the number of women STEM entrepreneurs nationally by veteran status, for each of the three veteran statuses identified in the ABS and NES-D (Chapter 4, Table 4-3C)

### *7-2-1-B Continuous Variables Approach at the State Level*

We will use the continuous variables approach at the state level as well, since each state is different based on the major state industries and history. For example, STEM graduates in Kentucky where distilleries are very common, might seek employment with them as opposed to starting a STEM related business. The empirical estimation needs to take account of these differences and we will do this by using the state level data (all states within the U.S., Puerto Rico and the Island Areas) in a continuous variables approach at the state level.

Variables at the state level are as follows:

$N_{WSTEMS}$ = the number of women STEM entrepreneurs in a state

$W_{PATS}$ = the number of women patentees in a state. Geographically, the correlation between female patentees and entrepreneurs might not exist, and we could use national figures as opposed to state level numbers in that case.

VCFS = state level venture funding for women STEM entrepreneurs

LFS = state labor force

WSG = women STEM graduates in the U.S. Because of the ease of moving from state-to-state, national numbers represent the most meaningful source of STEM entrepreneurial talent

R = A chosen interest rate (such as a 30-year fixed rate mortgage average in the U.S.[cccxxxviii])

PCIS = Real per-capita income in a state

D = Dummy with a value of 0 for non-pandemic years (2012 thru 2019) and 1 for the pandemic year 2020)

ε = random error.

log = the natural logarithm

Then a continuous variables equation for women STEM entrepreneurs at the state level is:

$$\log(N_{WSTEMS}) = \alpha_{00} + \alpha_{01}*\log(W_{PATS}) + \alpha_{02}*\log(VCFS) + \alpha_{03}*\log(LFS) + \alpha_{04}*\log(WSG) + \alpha_{05}*R + \alpha_{06}*\log(PCIS) + \alpha_{07}*D + \varepsilon_1$$

Or, alternatively

$$\log(N_{WSTEMS}) = \alpha_{10} + \alpha_{11}*\log(W_{PATS}) + \alpha_{12}*\log(VCFS) + \alpha_{13}*\log(LFS) + \alpha_{14}*\log(WSG) + \alpha_{15}*R + \alpha_{16}*\log(PCIS) + \alpha_{17}*D + \varepsilon_2$$

Once again, we could put these equations in difference terms, although we would not difference the interest rates, since the differences are small, in general. We will run this equation at the state level for the STEM field as a whole. We will not run this equation by each of the 12 STEM sectors individually or by demographic factors, at the state level. This is because many times ABS and NES-D data per state is not available at that granular level of detail by sector or demographic breakdown, for all states. Either the estimates don't meet publication standards or estimates are withheld to avoid disclosing data for individual companies.

The model will take account of the fact that women patentees could have patented in one state, but could locate or work in another state. We will first run the model using state level patentee data, but then also run the model using national level female patentee data, given that patentees are free to move across the nation to see which regression run is a better predictor of female STEM entrepreneurship.

In addition to running this state level model, we will calculate the percentage of female STEM firms with respect to all STEM firms within each state, for all the years in the study, 2012 through 2020. We will calculate these percentages for female STEM firms as a whole, and also for female nonemployer and employer firms separately. This report shows these percentages only for the year 2019, in table 4-1B and the figures 5-1B and 5-1C of the report. Based on 2019 data we found that the percent of female nonemployer firms as a percent of all non-employer firms in some southern states (Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas and Louisiana) is above average. We also found that these Southern states except for South Carolina, Alabama and Mississippi, do slightly better than the average rate for female STEM employer firms. By calculating these percentages, for all the years from 2012 through 2020, we will determine if these Southern states are indeed doing better than average over the years, and how significant is their female STEM firm advantage over other states.

### 7-2-2 Logistic Regression Approach by STEM Sector

The continuous variables approach above illustrates how the number of female STEM entrepreneurs at the national and state levels is impacted by changes in female patentee numbers, venture funding, interest rates etc. In the logistic regression approach, we will ask a different question. We will examine specific STEM sectors, and look for a binary (0-1) variable to ask if the number of female STEM entrepreneurs in that sector increases by a certain percentage, when an explanatory variable changes in a certain study year.

One possible way is to look at the probability that the differences by year have led to an improvement of 1% in the number of women entrepreneurs in a specific sector. For example, if in 2012, the number of women entrepreneurs in Fabricated metal manufacturing is 12%, the question is whether the number of women entrepreneurs in this sector is 13% in 2013. In general, if the number of women entrepreneurs in a sector is x% in year t, the question is whether the number is (x+1) % in year (t + 1). The 1% change is somewhat optimistic, and we could use another constant such as 0.5% to answer this question.

We will not perform this approach by sector at the national level. This is because, for the years 2012 through 2020, this approach at the national level will lead to few degrees of freedom, since the differences use two years each. Instead, we will pool the states that have female entrepreneurs in a particular sector, for all the years in the study. This pool times the number of study years (2012 to 2020) provides greater degrees of freedom. We will look at the probability that the differences by year have led to an improvement of 1% in the number of women entrepreneurs in a state, for that particular sector.

For example, suppose we are examining the Fabricated metal manufacturing sector, and there are 20 states that have female entrepreneurs in this sector for all the study years. Then the variables for this approach are as follows:

$LW_{PATSF}$ = log of the number of women patentees in a state for the Fabricated metal manufacturing sector. The PatentsView Annualized Data Tables[cccxxxix] provide information on the inventors, companies and gender of inventors for the patents granted in a particular year and classifies these patents by International Patent Classification (IPC) symbols according to the different areas of technology[cccxl]

$DLW_{PATSF} = \Delta LW_{PATSF}$

LVCFSF = log of the state level venture funding for women STEM entrepreneurs in the Fabricated metal manufacturing sector

DLVCFSF = ΔLVCFSF

LLFS = log of the state labor force

DLLFS = ΔLLFS

LWSG = log of women STEM graduates in the U.S.

DLWSG = ΔLWSG

LPCIS = log of the real per-capita income in a state

DLPCIS = ΔLPCIS

R = A chosen interest rate (such as a 30-year fixed rate mortgage average in the U.S.[cccxli])

D = Dummy with a value of 0 for non-pandemic years (2012 thru 2019) and 1 for the pandemic year 2020)

ε = random error

Pr = Probability that the percentage of women entrepreneurs in Fabricated metal manufacturing in a state has increased by 1% between the years t and t + 1, where t is from 2012 to 2020

Then a logistic regression equation for women STEM entrepreneurs in the Fabricated metal manufacturing sector is:

$\log (Pr^*/(1-Pr^*)) = \gamma_0 + \gamma_1 * DLW_{PATSF} + \gamma_2 * DLVCFSF + \gamma_3 * DLLFS + \gamma_4 * DLWSG + \gamma_5 * DLPCIS + \gamma_6 * R + \gamma_7 * D + \varepsilon_L$

The above logistic regression approach follows the treatment in Stock and Watson (2019) [cccxlii][8].

We will not estimate this equation as in the usual regressions. We will use a nonlinear ("Newton-Raphson") algorithm to estimate the coefficients that maximize the probability ("likelihood") that the data (and the model) appeared as they have[cccxliii]. The algorithm will maximize the log of the likelihood which is easier to work with, and the values will maximize the likelihood as well.

All the statistical packages that we will use to run this model, that are described in Section 7-3-2 below, have Newton-Raphson nonlinear fitting algorithms available. Running this equation using one of these packages, will help us determine the probability that there is an improvement of 1% in the number of women entrepreneurs in Fabricated metal manufacturing in a state from year to year.

## 7-3 Software to Run the Models

There are a number of software packages to run the proposed models. These are described below:

### 7-3-1 Software to Run the Continuous Variables Model

We will use any of the following software: EViews[cccxliv], Stata, R, or Python to run this model. SAS[cccxlv] is another software package for this approach, but it is a very expensive legacy package for government offices and we will not use it.

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[8] The logistic regression, following the treatment in Stock and Watson, is described as follows:
For a dependent variable y, with probability denoted by Pr, with probability density function F, and independent variables $x_1, x_2, x_3, \ldots, x_n$, the probability that y equals 1 for this case is given by
$Pr (y = 1 | x_1, x_2, x_3 \ldots, x_n) = F (\beta_0 + \beta_1 * x_1 + \beta_2 * x_2 + \beta_3 * x_3 + \ldots + + \beta_n * x_n)$
$= 1/ (1 + \exp \{-( \beta_0 + \beta_1 * x_1 + \beta_2 * x_2 + \beta_3 * x_3 + \ldots + + \beta_n * x_n)\})$
Here, $\beta_0, \beta_1, \beta_2, \ldots, \beta_n$ are constants. The term "exp" refers to the natural exponent 2.71828… raised to the power inside the braces. The term log refers to the inverse of this exponent. We do not know these constants, so we add the random error term, εL, to estimate the equation
$Pr (y = 1 | x_1, x_2, x_3 \ldots, x_n) = 1/ (1 + \exp \{-( b_0 + b_1 * x_1 + b_2 * x_2 + b_3 * x_3 + \ldots + + b_n * x_n + \varepsilon L)\})$
where the b's are our estimates for the β's. We define the odds ratio as[8]
Pr (y=1)/(1-Pr(y=1)). It will be understood that Pr always refers to Pr(y=1), so the (y=1) is dropped for simplicity. The log of the odds ratio is then
Log (Pr/(1-Pr)
Here "log" is the natural logarithm, the inverse of the exponent *e* = 2.71828…. Then
$\text{Log} (Pr/(1-Pr) = b_0 + b_1 * x_1 + b_2 * x_2 + b_3 * x_3 + \ldots + b_n * x_n + \varepsilon_L$
is the equation for estimation.

### 7-3-2 Software to Run the Logistic Regression Model

Logistic regression is available from many software packages including Python, Stata, and R. The use of logistic regression in R[cccxlvi]and Stata[cccxlvii] is relatively easier than in Python[cccxlviii] . We will use one of these software packages to run the logistic regression model.

We will test for multicollinearity in both models with variance inflation factors (VIFs measure multicollinearity between explanatory variables)[cccxlix]. The software packages mentioned above include this functionality. The statistical software calculates VIFs for each independent variable. If the VIFs show multicollinearity, we can adjust for that in different ways, one of which is the differencing by mean method.

## 7-4 Model Outputs and Tests

In this section, we use two hypothetical examples to show the results and interpretation from running the two models described above. The examples include model outputs and test results. For the regression coefficient tests, we will use "standard tests" for the two approaches illustrated in the examples, so as not to get conflicting results from other tests.

### 7-4-1 Hypothetical Model Output and Interpretation for Continuous Variables Approach

We describe hypothetical model outputs and test results for running the continuous variables model, for a particular state below. These outputs carry the disclaimer about the results bearing no relation to actual results, when we run the model on real data. They are merely a tool to understand what this approach might yield in terms of understanding the factors that influence female STEM entrepreneurship.

**Table 7-1: Continuous Variables Model Hypothetical Results**

| **Source** | **SS** | **df** | **MS** | **Number of Obs** | **=** | **10** |
|---|---|---|---|---|---|---|
| Model | 72.34321 | 8 | 10.33475 | F (8,10) | = | 2.35 |
| Residual | 247.31082 | 2 | 82.43694 | Prob > F | = | 0.075 |
| Total | 319.65404 | 10 | 31.96540 | R-squared | = | 0.2143 |
| | | | | Adj. R-squared | = | 0.1262 |
| | | | | Root MS | = | 5.6358 |

| **LNWSTEMS** | **Coef.** | **Std. Err.** | **t** | **Pr > \|t\|** | **[95% Confidence Interval]** | |
|---|---|---|---|---|---|---|
| LWPATS | 1.2408 | .9600 | 1.40 | 0.168 | -.5810 | 3.2626 |
| LVCFS | .56424 | .1431 | 2.94 | 0.000 | .2777 | .8507 |
| LLFS | 1.1348 | .9700 | 1.35 | 0.154 | -.4910 | 2.9815 |
| LWSG | .23642 | .4785 | .494 | 0.332 | -.6378 | 4.2427 |
| R | -.11558 | .7689 | -.151 | 0.768 | -.7234 | 2.7823 |
| LPCIS | .32258 | .4880 | .066 | 0.511 | -.6542 | 1.2994 |
| D | -2.1504 | 1.1186 | -1.92 | 0.059 | -4.2895 | 0.8868 |
| Cons | .62689 | .7820 | 0.80 | 0.427 | -.9405 | 2.1943 |

Here, the abbreviations not previously explained, stand for the following:

Obs = Observations

SS = Sum of Squares

df = degrees of freedom

Adj. = Adjusted

MS = Mean Squared Error

Coef. = Coefficient

Std. Err. = Standard Error

t = t-statistic

|t|= absolute value of t

F = F-statistic

Pr = Probability

LNWSTEMS = log of the number of women STEM entrepreneurs in a state

LWPATS = log of the number of women patentees in a state

LVCFS = log of the state level venture funding for women STEM entrepreneurs

Cons = Constant Intercept

The coefficients and the results for this hypothetical model run are explained as follows. The R-square statistic describes how much of the variation of the results the regression explains and is about 21%. The adjusted R-squared adjusts this statistic for the number of variables included, so a more accurate measure is about 13%.

The log of patents and state labor force variables have a relatively strong and statistically exact affect in our hypothetical example. A 1% increase in the number of women patentees produces about a 1.24% increase in the number of women STEM entrepreneurs, with some likelihood. The effect ranges between a 0.58% decrease and a 3.27% increase, with 95% probability. We could interpret this for our Women in STEM policy recommendations. We could recommend that state and local agencies enact policies that increase female inventors' commercialization success, and lead to female STEM entrepreneurship success.

A 1% increase in the state labor force produces about a 1.13% increase in the number of female STEM entrepreneurs, and the effect ranges between a .49% decrease to a 2.98% increase, with 95% probability. We could interpret this to mean that states should implement programs that lead to increased labor force participation.

The venture capital funding and the COVID-19 dummy variables also are relatively statistically strong. Their higher t-statistic measures how likely the probability is that the coefficient is not zero. On the other hand, interest rates, women STEM graduates and per-capita income have the expected signs, but are statistically weak and have high likelihood of not having their effects measured precisely. We would not make recommendations based on these results.

Tests for the individual coefficients are included with the Pr > |t|, numbers in the regression results. F is a test of whether all the coefficients are zero. We are reasonably confident that these coefficients will not be zero, when we run the model with actual data, and that this regression will capture part of what impacts female STEM numbers in a state.

### 7-4-2 Hypothetical Model Output and Interpretation for Logistic Regression Approach

We describe hypothetical model outputs and test results for running the logistic regression model, for a particular sector such as Fabricated metal manufacturing below. These outputs carry the disclaimer about the results bearing no relation to actual results, when we run the model on real data. They are merely a tool to understand what this approach might yield in terms of understanding the probability that there is an improvement of 1% in the number of women entrepreneurs in Fabricated metal manufacturing in a state from year to year.

**Table 7-2: Logistic Regression Model Hypothetical Results**

| **Logit estimates** | | | Number of Obs = | | 180 | |
|---|---|---|---|---|---|---|
| | | | LR chi2 (173) = | | 2.62[cccl] | |
| | | | Prob > chi2 = | | 0.0603 | |
| Log likelihood = -12.33252 | | | Pseudo R2 = | | 0.0315 | |
| **1%** | **Coef.** | **Std. Err.** | **z** | **Pr >\|z\|** | **[95% Conf. Interval]** | |
| $DLW_{PATSF}$ | 0.5432 | 1.9242 | 0.28 | 0.386 | -0.4674 | 1.3546 |
| DLVCFSF | 1.4285 | 0.4474 | 3.31 | 0.001 | 0.6056 | 2.3594 |
| DLLFS | 0.2944 | 1.7848 | 0.16 | 0.421 | -0.6568 | 1.6723 |
| DLWSG | 0.1035 | 2.2301 | 0.05 | 0.438 | -0.8644 | 2.5436 |
| DLPCIS | -0.0948 | 0.5877 | -0.16 | 0.434 | -1.2320 | 3.4533 |
| R | -0.2388 | 0.4992 | 0.48 | 0.415 | -2.2556 | 0.7844 |
| D | 0.1876 | 0.9457 | 0.20 | 0.421 | -0.7884 | 1.2563 |
| Cons | -0.3379 | 1.4636 | -0.23 | 0.371 | -1.4722 | 1.0932 |

Here, the abbreviations not previously explained, stand for the following:

z = z value

chi2 = chi-square test

The first thing to understand in this hypothetical regression is the meaning of the coefficients. Following Kisselev (2021) [cccli] a one unit increase in an independent variable, will result in the log (Pr*/(1-Pr*)) increasing by the coefficient. Suppose there is a one unit increase in the independent variable $DLW_{PATSF}$, implying a one unit increase in the change of the log of women patentees in Fabricated metal manufacturing in a state in some year in the study period. This means that the log (Pr*/(1-Pr*)) increases by 0.5432 or Pr*/(1-Pr*) increases by exp (0.5432) = 1.7215[ccclii]. The odds of a 1% increase in the number of women entrepreneurs in the state grows 72%.

This approach does not refer to all states, just the 20 states that we have assumed have fabricated metal manufacturing data for women entrepreneurs, for all years in the study[cccliii]. Suppose, arbitrarily, that Rhode Island does not have women entrepreneurs in Fabricated metal manufacturing for all the study years, while Pennsylvania does. The regression then describes what will happen in Pennsylvania, but does not depict what will happen in Rhode Island.

If running the regression for this model gives unexpected outcomes, we will tweak the model to account for false predictions[cccliv].

Next, the "z" value is the Coef. divided by its standard error Std. Err., where the Std. Err. is a measure of variability in the sample. This enables a normalized measure, which is tested to see if it is statistically different from zero. The test is "Pr |z| > 0", which is read as "The remaining probability of one minus the probability that the absolute value of z is greater than 0". Here, small numbers for the test are preferred, or, equivalently, high numbers of z are preferred. So, the z value of 3.31 for the DLVCFSF variable, with a Pr |z| > 0 of 0.001 means that it is highly likely that the effect of increasing venture capital funding for women entrepreneurs in Fabricated metal manufacturing is not zero. The corresponding numbers of 0.05 and 0.438 for the DLWSG variable imply that the impact of increasing women STEM graduates could be zero.

The 95% confidence interval indicates that, given the sample and the model, there is estimated to be a 95% probability that the true numbers fall between the limits given. This does not provide absolute certainty that the number is not zero, given the limits described. If the confidence interval does not include zero, as it does not for the change in the log of venture capital funding, the odds are good that the coefficient is not zero.

The LR chi2 (173) and the Prob > chi2 describe different "chi-square" tests, for whether all the coefficients in the model are zero. The 173 in LR chi2 (173) is the df or how many observations can be examined without being predetermined, or fixed. Prob > chi2, is the probability that this statistic could have occurred by chance if the model coefficients are all zero. So, we want high LR chi2 and low Prob > chi2 results. In the hypothetical example above, there is a fairly low chance that all the coefficients are zero, but, because Prob > chi2 is not less than 0.05, some (reasonable) possibility that they are all zero remains[ccclv].

The usual R-square statistic is not available for logistic regression models because they are nonlinear. Instead, the statistic that is used is Pseudo R-square, and is a measure of how well the model fits the data. This statistic is on the lower side for our example.

The Pseudo R-square is measured in a variety of ways. The most common is the McFadden Pseudo R-square[ccclvi]. The McFadden approach looks at how the log-likelihood (the measure that the model has a high probability or likelihood of fitting the data well) differs from a model with just a constant term, and no independent variables. The McFadden pseudo-R-square tends to be quite low, even in models that fit well[ccclvii].

# 8. Conclusion

Our investigation into the entrepreneurship of Women in STEM started with a literature review to understand the current status of Women in STEM. Next, we performed a data analysis of STEM businesses that further enriched our findings from the literature search and helped us start formulating policies to improve the status of women. Following the data analysis, we reviewed policies and programs to gain an understanding of existing orders, legislation and initiatives that impact female STEM entrepreneurs. This policy review helped us identify policy gaps and determine future initiatives for female STEM entrepreneurs, including the key players to implement these initiatives.

Through our literature search, we found that women remain underrepresented in STEM, though there have been improvements in the female workforce, education, and patenting numbers over time. There are barriers that women face in their STEM entrepreneurship journey, starting from school, to college, to academia, to business and beyond. These include lack of exposure to STEM business specific training, fewer resources, less licensing opportunities, limited access to funding, government assistance, and networks. In spite of these barriers, academic women have succeeded in producing quality publications and have the same likelihood as men of reporting inventions. Veteran women are successful in opening and growing STEM businesses. Positive practices on the part of associations, non-traditional funding sources, networking groups, and mentorship programs have helped women in their journey to success.

The COVID-19 pandemic exacerbated already existing gender and demographic disparities in employment, credit, funding, and government assistance. In the future, policies that address these disparities will help prepare female entrepreneurs to face unexpected shocks to the economy. However, even during the pandemic female labor force participation rates for educated women, of whom Women in STEM are a subset, remained similar to pre-pandemic levels. Women entrepreneurs had a greater chance of accessing the second round of PPP funding that was delivered through community organizations. Early-stage female entrepreneurs reported finding new opportunities during the pandemic. The percentage of these entrepreneurs finding new opportunities was 21.5%. Women owners were 84% more likely than male owners to adopt new technologies. Women reached their highest monthly rate of new entrepreneurs in 24 years in 2020.

Our data analysis further confirmed and informed our findings from the literature search. We found that for the year 2019 there were 733,880 fewer female-owned STEM firms than male-owned firms. There is greater STEM entrepreneurship gender disparity amongst employer firms versus nonemployer firms. The percent of female STEM employer firms varies more across states than female nonemployer firms. A large part of the STEM entrepreneurship gender disparity could be because of female employer firm representation, and policies and programs should focus on these STEM firms. In addition, state-specific factors such as, a higher percentage of women working in the STEM fields, or women-owned businesses in general doing better in some states compared to others could influence female STEM entrepreneurship. Policies to promote Women in STEM should account for these differences.

We found that STEM businesses are concentrated in the Professional, scientific, and technical services sector. In this sector total male-owned firms are close to one and a half times female-owned firms, and employer male-owned firms are more than two and a half times employer female-owned firms. Nonemployer male-owned firms outnumber nonemployer female-owned firms by 517,000 firms. This implies that policies and programs that help increase female representation in the professional, scientific, and technical arena could help alleviate overall gender disparity in STEM.

We examined STEM entrepreneurship by race and ethnicity. We found that the majority of STEM firm owners are White. White firm owners are approximately 81% of all STEM firms, close to 85% of employer STEM firms and close to 80% of nonemployer STEM firms. Within the White racial group, the majority of businesses are male-owned. Asians own more STEM firms and STEM employer firms compared to other races except White firm owners. Asian firm owners own 9% of all STEM firms and approximately 10% of STEM employer firms. Asian STEM firm owners are followed by Black or African American, American Indian and Alaska Native, and Native Hawaiian and Pacific Islander firm owners. Excluding White owners, Black or African Americans own more nonemployer firms than other races. Black owners own 10% of STEM nonemployer firms. There are more female-owned than male-owned Black or African American, and American Indian and Alaska Native firm owners.

We also found that non-Hispanic men own 49% of all STEM firms, whereas non-Hispanic women own 38% of all STEM firms. So, most STEM firms in the U.S. are owned by non-Hispanic men. This is also true for STEM employer and nonemployer firms. Amongst firms with Hispanic owners, Hispanic women outnumber the number of firms owned by Hispanic men. Policies and programs designed to serve underserved populations will help address these racial, ethnic and gender gaps in STEM ownership.

While veteran women have recently been successful in opening and growing STEM businesses, the majority of veteran-owned businesses are still male-owned. The number of veteran male-owned businesses is eight times the number of veteran female-owned businesses. Female veterans are only 10% of the veteran population and these population differences could explain some of the disparity in STEM business ownership.

We analyzed STEM entrepreneurs by age and citizenship status. Female STEM owners outnumber male STEM owners in the under 25, 25 to 34, and 35-44 age categories. This implies that early interventions in STEM education and outreach might have made a difference in female STEM entrepreneurship. Hence, entities offering policies and programs focused towards K-12 female outreach and education, should enhance these programs and develop new programs for this segment of the population. For older women, programs that help them find new businesses and grow new businesses are important. These could include more funding and commercialization support, access to networks and partnerships.

Male citizen-owned firms outnumber female-owned citizen firms. There is also a large gap between the number of citizen- versus non-citizen female STEM firms. Programs and policies that assist female non-citizens start STEM businesses could help increase overall female STEM entrepreneurship numbers. The first step in this assistance is to provide these entrepreneurs access to mentors and networks. Academic institutions could enhance their mentorship programs to expose non-citizen STEM faculty to mentors in order to encourage them to start new businesses.

For all STEM sectors, male-owned firms have combined receipts of $5 billion or more. This is not the case for female-owned STEM firms. In addition, female-owned firms have fewer total employees than male-owned firms for all STEM sectors. This implies that female-owned STEM firms need policies that help them grow their businesses, including better funding opportunities and networks.

Some of the key takeaways from our data gathering and analysis are as follows:

**Key Takeaway # 1**
There is greater STEM entrepreneurship gender disparity amongst employer firms versus nonemployer firms.

**Key Takeaway # 2**
STEM businesses are concentrated in the Professional, scientific, and technical services sector, and male-owned firms in this sector outnumber female-owned firms.

**Key Takeaway # 3**
There are more female-owned firms than male-owned STEM firms for the Black or African American, and American Indian and Alaska Native racial groups.

**Key Takeaway # 4**
STEM firms owned by Hispanic women outnumber the number of firms owned by Hispanic men.

**Key Takeaway # 5**
There are noticeable differences amongst states, when it comes to the percentages of STEM firms owned by women.

We conducted this data analysis for the year 2019, the latest year with the most complete information available on female STEM businesses, including employer and nonemployer firms. So, this analysis is a snapshot in time and does not capture changes in female STEM ownership over the years. In order to examine how the representation and success of female STEM businesses has changed over time, a more detailed analysis that gathers and examines data for several years is needed.

This detailed analysis is explained in the previous Preliminary Methodology chapter. The analysis looks at the correlation between female STEM ownership and factors such as, the number of patents, funding and financing levels, education, labor force participation rates, per-capita incomes, and pandemic shocks. The exploration of this relationship at the national level as a whole and by key demographic characteristics could help us understand how different demographic groups are influenced by these factors. In addition, studying this relationship at the state level, will help us understand the influence of these factors for different states that are unique based on major industries and history. Finally, by running this analysis at the sector level, we will determine the probability of a certain percentage change in the number of female entrepreneurs in a state, when a specific factor changes in a particular year.

We conducted a policy review after the data analysis. We found existing federal executive orders, federal legislation, federal agency and department programs, state legislation and programs, academic institution policies, and private organization programs that act as resources for female STEM businesses. Some of these initiatives are directed towards all small businesses, some are for women-owned businesses, others specifically address STEM issues and yet others have equity goals. We broke these initiatives down by different resource areas that they address. These include:

- Procurement and Contracting Opportunities
- Education, Skills, Training, Workforce, and Innovation
- Resources to Encourage Diverse Faculty Entrepreneurship
- Patenting, Licensing, and Commercialization
- Grant Funding, such as, SBIR/STTR Grants, Emergency Grants, Other Grants
- Funding and Financing in the form of Loans, Investments, Emergency Funding, etc.
- Networking and Mentoring
- Government Taxes and Payments Assistance

We found that while these initiatives addressed several resource areas, there were challenge areas that needed reinforcement, or where there were gaps that new policies needed to address. These challenge areas are:

- Lower enrollment & less exposure to STEM learning, research and patenting for female students
- Lack of seniority and resources for female faculty
- Lower conversion of female faculty inventions into patents & licensing
- Limited success of female entrepreneurs in obtaining grant funding, such as SBIR/STTR funding
- Unfavorable financial sector evaluation of women's business plans, inhibiting business growth

- Lack of role models, partnerships & networks
- Lower government assistance in times of unprecedented economy-wide shocks

We developed potential policy solutions for each of these areas and described the benefits from the implementation of these policies.   These solutions include

- Educational and training programs by schools and institutions
- Promotion and tenure policies by universities
- Licensing offices support by universities
- Commercialization support by state governments
- Grant Support by federal agencies
- Funding support by lending institutions, federal agencies, and state governments
- Networking and mentoring support by federal agencies and institutions
- Tailored financial and application in times of economy-wide shocks

The benefits from these policies include:

- Preparation of skilled female STEM workers and entrepreneurs
- Female STEM faculty success in academia and business
- Commercialization and licensing success for non-academic STEM entrepreneurs
- Increase in the number of grant applications and awards for female STEM entrepreneurs
- Improvements in the financial standing and growth of female STEM entrepreneurs
- Access to greater knowledge and current business information for Women in STEM, through networks and mentors
- Increase the financial stability and resilience of female STEM entrepreneurs during unexpected shocks to the economy

Women in STEM would realize these benefits, and society as a whole would benefit. Saksena et al. (2022) in a USPTO study show that if the gender disparity in patenting is removed, commercialized patents could increase by 24%, and GDP per capita could go up by 2.7%.  If women, people of color, and people from low-income families invented at the same rate as other groups, U.S. innovation could increase four times (Bell et al. 2019).  The quantity and quality of innovation could improve, and families, communities, states and countries could experience a multiplier effect from female success.  Women entrepreneurs in STEM could bring ESG values to their businesses, and build better relationships with customers and employees.

# 9. Glossary

| | |
|---|---|
| **High-growth industries** | STEM-adjacent industries. |
| **High-yield industries** | STEM industries. |
| **Sector** | Industry associated with a particular NAICS code. |
| **STEM industries** | Defined as science, technology, engineering and mathematics industries, and others such as data processing, medicine, and pharmaceuticals that yield high profits for entrepreneurs. |
| **STEM-adjacent** | Industries such as AEC, and industries that have come into focus recently such as, infrastructure, supply chain, sustainability, etc. These industries are growing rapidly but do not yield profits comparable to classic STEM industries. |
| **Undervalued industries** | Care providing Industries such as, home healthcare, nursing care, childcare, elder care, adult care, and others such as arts and education related industries. |
| **Women in STEM** | Women entrepreneurs in the high-yield and high-growth industries. |

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## Endnotes – Links to websites used in the study and other notes

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[xvi] [xvi] 1) Employer (2019 ABS data) is a survey-based dataset and nonemployer estimates are developed solely from administrative records and have no survey component (2019 NES-D)
2) Business ownership is defined as having more than 50% of the stock or equity in the business.
3) Estimates by firm demographics are based on classifiable firms.
4) Documentation for ABS: https://www.census.gov/programs-surveys/abs/technical-documentation.html
5) Documentation for NES-D: www.census.gov/programs-surveys/abs/technical-documentation/NESDmethodology.html
6) S- Estimate did not meet the Census reporting standards so it is unreported.
7) D- Estimate is withheld to avoid disclosing data for individual companies; data are included in higher level totals.
8) X- Estimates that were identified as " Not applicable" by the Census.
9) Estimates that were identified as N < 15 are not available or not comparable.

10) Details may not add to the totals due to rounding rules. Example: employer and nonemployer number of STEM firms do not add to total row in Table 4-1A.
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# Appendix A

## STEM Three-digit NAICS Codes Used for Year 2019 Data Analysis

| NAICS | Sector |
|---|---|
| 325 | Chemical manufacturing |
| 332 | Fabricated metal product manufacturing |
| 333 | Machinery manufacturing |
| 334 | Computer and electronic product manufacturing |
| 335 | Electrical equipment, appliance, and component manufacturing |
| 336 | Transportation equipment manufacturing |
| 339 | Miscellaneous manufacturing |
| 518 | Data processing, hosting, and related services |
| 541 | Professional, scientific, and technical services |
| 551 | Management of companies and enterprises |
| 621 | Ambulatory health care services |
| 622 | Hospitals |

# Appendix B

## STEM Four-digit NAICS Codes Used for Year 2020 Data Analysis

| NAICS | Sector |
|---|---|
| 3253 | Pesticide, fertilizer, and other agricultural chemical manufacturing |
| 3254 | Pharmaceutical and medicine manufacturing |
| 3329 | Other fabricated metal product manufacturing |
| 3332 | Industrial machinery manufacturing |
| 3333 | Commercial and service industry machinery manufacturing |
| 3335 | Metalworking machinery manufacturing |
| 3336 | Engine, turbine, and power transmission equipment manufacturing |
| 3341 | Computer and peripheral equipment manufacturing |
| 3342 | Communications equipment manufacturing |
| 3344 | Semiconductor and other electronic component manufacturing |
| 3345 | Navigational, measuring, electromedical, and control instruments manufacturing |
| 3346 | Manufacturing and reproducing magnetic and optical media |
| 3359 | Other electrical equipment and component manufacturing |
| 3364 | Aerospace product and parts manufacturing |
| 3391 | Medical equipment and supplies manufacturing |
| 5182 | Data processing, hosting, and related services |
| 5415 | Computer systems design and related services |
| 5416 | Management, scientific, and technical consulting services |
| 5417 | Scientific research and development services |
| 5419 | Other professional, scientific, and technical services |
| 5511 | Management of companies and enterprises |
| 6211 | Offices of physicians |
| 6212 | Offices of dentists |
| 6213 | Offices of other health practitioners |
| 6221 | General medical and surgical hospitals |
| 6222 | Psychiatric and substance abuse hospitals |
| 6223 | Specialty (except psychiatric and substance abuse) hospitals |

## STEM-adjacent Four-digit NAICS Codes Used for Year 2020 Data Analysis

| NAICS | Sector |
|---|---|
| 2361 | Residential building construction |
| 2362 | Nonresidential building construction |
| 2371 | Utility system construction |
| 2372 | Land subdivision |
| 2373 | Highway, street, and bridge construction |
| 2379 | Other heavy and civil engineering construction |
| 2381 | Foundation, structure, and building exterior contractors |
| 2382 | Building equipment contractors |
| 2383 | Building finishing contractors |
| 2389 | Other specialty trade contractors |
| 4811 | Scheduled air transportation |
| 4812 | Nonscheduled air transportation |
| 4831 | Deep sea, coastal, and great lakes water transportation |
| 4841 | General freight trucking |
| 4842 | Specialized freight trucking |
| 4882 | Support activities for rail transportation |
| 4883 | Support activities for water transportation |
| 4885 | Freight transportation arrangement |
| 4931 | Warehousing and storage |
| 5413 | Architectural, engineering, and related services |
| 5414 | Specialized design services |

# Appendix C
# Standard Errors of Estimates

## Total Number of STEM Firms by Owner Sex (2019) with Standard Error (SE) of Estimates

| | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable | Total SE | Female SE | Male SE | Equally Male/Female SE |
|---|---|---|---|---|---|---|---|---|---|
| **Total** | 6,678,411 | 2,797,342 | 3,531,222 | 197,834 | 6,526,398 | 120,767.9 | 297,217.6 | 180,092.3 | 16,143.3 |
| **Employer** | 1,475,795 | 356,826 | 926,606 | 139,529 | 1,422,961 | 40,338.4 | 57,538.2 | 60,383.8 | 10,848.4 |
| **Nonemployer** | 5,202,600 | 2,440,500 | 2,604,600 | 57,400 | 5,102,500 | * | * | * | * |

## Total Number of STEM Firms By Sector and Owner Sex (2019) with SE of Estimates

| Sector | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable | SE Total | SE Female | SE Male | SE Equally Male/Female |
|---|---|---|---|---|---|---|---|---|---|
| **Total (Employer + Nonemployer)** | | | | | | | | | |
| Total for All Sectors | 6,678,411 | 2,797,342 | 3,531,222 | 197,834 | 6,526,398 | 120,767.9 | 297,217.6 | 180,092.3 | 10,749.0 |
| Ambulatory health care services | 1,705,637 | 949,660 | 678,397 | 46,761 | 1,674,818 | 2,849.0 | 2,849.0 | 4,070.4 | 115,964.4 |
| Chemical manufacturing | 25,717 | 8,154 | 13,910 | 1,335 | 23,399 | 308.6 | 122.3 | 222.6 | 100.1 |
| Computer and electronic product manufacturing | 18,603 | 2,456 | 13,153 | 1,236 | 16,845 | 186.0 | 86.0 | 197.3 | 91.5 |
| Data processing, hosting, and related services | 56,966 | 22,155 | 30,852 | 1,455 | 54,462 | 341.8 | 110.8 | 339.4 | 101.9 |
| Electrical equipment, appliance, and component manufacturing | 11,447 | 1,807 | 7,889 | 638 | 10,334 | 137.4 | 110.2 | 142.0 | 114.8 |
| Fabricated metal product manufacturing | 90,350 | 9,352 | 70,073 | 7,659 | 87,084 | 542.1 | 439.5 | 770.8 | 543.8 |
| Hospitals | 1,789 | 63 | 361 | S | 424 | 200.4 | 57.0 | 157.0 | * |
| Machinery manufacturing | 35,061 | 3,532 | 26,146 | 2,984 | 32,662 | 315.5 | 158.9 | 444.5 | 453.6 |
| Management of companies and enterprises | 25,777 | 2,463 | 12,681 | S | 15,144 | 928.0 | 290.6 | 862.3 | * |
| Miscellaneous manufacturing | 90,721 | 28,162 | 53,925 | 5,443 | 87,530 | 362.9 | 450.6 | 377.5 | 168.7 |
| Professional, scientific, and technical services | 4,595,410 | 1,766,815 | 2,608,284 | 129,020 | 4,504,119 | * | 3,533.6 | 2,608.3 | 2,193.3 |
| Transportation equipment manufacturing | 20,933 | 2,723 | 15,551 | 1,303 | 19,577 | 146.5 | 62.6 | 108.9 | 149.8 |

# Total Number of STEM Firms By Sector and Owner Sex (2019) with SE of Estimates for Employer Firms

| Employer | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable | SE Total | SE Female | SE Male | SE Equally Male/Female |
|---|---|---|---|---|---|---|---|---|---|
| Total for All Sectors | 1,475,795 | 356,826 | 926,606 | 139,529 | 1,422,961 | 40,338.4 | 57,538.2 | 60,383.8 | 7,457.7 |
| Ambulatory health care services | 487,637 | 138,660 | 294,397 | 39,761 | 472,818 | 2,911.9 | 2,911.9 | 4,416.0 | 1,431.4 |
| Chemical manufacturing | 10,217 | 1,554 | 6,310 | 1,035 | 8,899 | 316.7 | 119.7 | 214.5 | 100.4 |
| Computer and electronic product manufacturing | 10,203 | 1,156 | 7,053 | 1,036 | 9,245 | 345.4 | 113.2 | 323.5 | * |
| Data processing, hosting, and related services | 10,466 | 1,155 | 7,352 | S | 8,507 | 137.7 | 110.3 | 143.5 | 114.7 |
| Electrical equipment, appliance, and component manufacturing | 4,747 | 707 | 2,989 | 488 | 4,184 | 542.1 | 124.8 | 464.1 | 768.0 |
| Fabricated metal product manufacturing | 50,350 | 5,652 | 36,573 | 6,559 | 48,784 | 503.5 | 440.9 | 768.0 | 544.4 |
| Hospitals | 1,781 | 55 | 353 | S | 408 | 199.5 | 56.6 | 156.7 | * |
| Machinery manufacturing | 20,061 | 1,932 | 14,146 | 2,534 | 18,612 | 321.0 | 158.4 | 452.7 | 451.1 |
| Management of companies and enterprises | 25,769 | 2,455 | 12,673 | | 15,128 | 927.7 | 292.1 | 861.8 | * |
| Miscellaneous manufacturing | 23,221 | 3,662 | 15,425 | 3,543 | 22,630 | 348.3 | 443.1 | 370.2 | 170.1 |
| Professional, scientific, and technical services | 822,410 | 198,815 | 523,284 | 83,520 | 805,619 | 1,644.8 | 3,777.5 | 3,139.7 | 2,171.5 |
| Transportation equipment manufacturing | 8,933 | 1,023 | 6,051 | 1,053 | 8,127 | 134.0 | 62.4 | 102.9 | 149.5 |

# Total Number of STEM Firms by Owner Race and Sex (2019) with SE of Estimates

| | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable | Total SE | Female SE | Male SE | Equally Male/Female SE |
|---|---|---|---|---|---|---|---|---|---|
| **Total** | 6,659,261 | 2,797,342 | 3,524,912 | 197,834 | 6,520,088 | 120,421.6 | 297,217.6 | 179,476.8 | 13,452.7 |
| White | 5,372,497 | 2,201,749 | 3,001,238 | 166,505 | 5,369,492 | 258,775.3 | 249,531.6 | 159,065.6 | 10,864.5 |
| Black or African American | 562,875 | 347,415 | 207,480 | 3,714 | 558,609 | 29,691.7 | 6,311.4 | 14,022.2 | 126.9 |
| American Indian and Alaska Native | 57,491 | 29,931 | 26,984 | 847 | 57,762 | 3,250.9 | 1,765.9 | 1,310.0 | 24.8 |
| Asian | 601,609 | 258,497 | 324,471 | 15,570 | 598,538 | 23,212.1 | 14,325.0 | 17,872.9 | 2,840.8 |
| Native Hawaiian and Other Pacific Islander | 15,142 | 7,938 | 7,170 | S | 15,108 | 574.0 | 68.6 | 885.8 | * |
| | | | | | | | | | |
| **Employer** | | | | | | | | | |
| Total | 1,456,645 | 356,826 | 920,296 | 139,529 | 1,416,651 | 26,219.6 | 57,538.2 | 59,972.6 | 10,848.4 |
| White | 1,235,681 | 298,183 | 813,522 | 120,505 | 1,232,210 | 73,111.1 | 49,871.1 | 54,980.5 | 9,821.2 |
| Black or African American | 41,867 | 16,420 | 23,364 | 1,956 | 41,740 | 10,571.4 | 1,555.8 | 6,179.8 | 135.1 |
| American Indian and Alaska Native | 6,673 | 2,323 | 4,136 | 287 | 6,746 | 1,707.7 | 546.7 | 1,231.8 | 19.0 |
| Asian | 139,501 | 43,297 | 85,696 | 10,334 | 139,327 | 17,321.4 | 8,984.1 | 16,903.5 | 3,860.2 |
| Native Hawaiian and Other Pacific Islander | 1,821 | 4 | 741 | S | 745 | 509.9 | 0.2 | 206.7 | * |

## Total Number of STEM Firms by Ethnicity and Owner Sex (2019) with SE of Estimates

| All | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable | Total SE | Female SE | Male SE | Equally Male/Female SE |
|---|---|---|---|---|---|---|---|---|---|
| **Total** | 6,678,411 | 2,797,342 | 3,531,222 | 197,834 | 6,526,398 | 120,767.9 | 297,217.6 | 180,092.3 | 13,452.7 |
| Hispanic | 584,165 | 291,557 | 283,459 | 5,469 | 580,485 | 9,979.5 | 26,337.3 | 27,991.6 | 736.0 |
| Equally Hispanic/non-Hispanic | 17,102 | 874 | 3,512 | 11,066 | 15,452 | 1,978.1 | 11.3 | 274.5 | 1,298.4 |
| Non-Hispanic | 5,924,555 | 2,500,992 | 3,243,679 | 178,479 | 5,923,150 | 285,366.1 | 269,690.3 | 172,996.2 | 12,567.9 |
| | | | | | | | | | |
| **Employer** | | | | | | | | | |
| Total | 1,475,795 | 356,826 | 926,606 | 139,529 | 1,422,961 | 40,338.4 | 57,538.2 | 60,383.8 | 10,848.4 |
| Hispanic | 69,357 | 22,265 | 42,789 | 2,651 | 67,705 | 8,409.5 | 4,714.6 | 8,418.7 | 492.4 |
| Equally Hispanic/non-Hispanic | 10,784 | 374 | 1,682 | 7,444 | 9,500 | 1,914.2 | 11.2 | 286.4 | 1,589.3 |
| Non-Hispanic | 1,344,839 | 333,476 | 881,763 | 127,161 | 1,342,400 | 79,009.3 | 53,522.9 | 59,445.5 | 10,066.9 |

## Number of STEM Firms by Veteran Status and Owner Sex (2019) with SE of Estimates

| | Total | Majority Female-Owned | Majority Male-Owned | Equally Male/Female-Owned | Total # Classifiable | SE Total | SE Female | SE Male | SE Equally Male/Female |
|---|---|---|---|---|---|---|---|---|---|
| **Total** | 6,678,411 | 2,797,342 | 3,531,222 | 197,834 | 6,526,398 | 120,767.9 | 296,351.2 | 179,382.9 | 13,452.7 |
| Veteran | 381,817 | 41,088 | 339,676 | - | 380,764 | 21,031.8 | 956.2 | 18,597.3 | * |
| Equally veteran/non-veteran | 34,803 | - | 11,014 | 21,893 | 32,907 | 5,422.9 | * | 2,463.1 | 3,729.1 |
| Non-veteran | 6,105,233 | 2,755,005 | 3,173,712 | 172,821 | 6,101,538 | 322,051.0 | 293,408.0 | 185,662.2 | 10,412.5 |
| | | | | | | | | | |
| **Employer** | | | | | | | | | |
| Total | 1,475,795 | 356,826 | 926,606 | 139,529 | 1,422,961 | 40,289.7 | 57,287.6 | 59,972.6 | 10,848.4 |
| Veteran | 100,059 | 5,742 | 93,568 | - | 99,310 | 10,381.1 | 704.7 | 9,473.8 | * |
| Equally veteran/non-veteran | 26,003 | - | 8,264 | 16,283 | 24,547 | 5,283.3 | * | 2,588.9 | 3,517.1 |
| Non-veteran | 1,296,617 | 350,589 | 822,096 | 121,771 | 1,294,456 | 83,847.9 | 56,999.9 | 61,383.2 | 9,356.1 |

## Total Number of STEM Owners by Owner Age and Sex (2019) with SE of Estimates

| | Total Reporting | Female | Male | Total SE | Female SE | Male SE |
|---|---|---|---|---|---|---|
| **Owners of All Firms** | | | | | | |
| Under 25 | 183,452 | 96,113 | 87,339 | * | * | * |
| 25 to 34 | 863,220 | 469,879 | 393,341 | * | * | * |
| 35 to 44 | 1,321,794 | 668,434 | 653,360 | * | * | * |
| 45 to 54 | 1,421,116 | 661,995 | 759,121 | * | * | * |
| 55 to 64 | 1,417,347 | 607,026 | 810,321 | * | * | * |
| 65 or over | 1,174,842 | 379,232 | 795,610 | * | * | * |
| Total | 6,381,771 | 2,882,679 | 3,499,092 | * | * | * |
| | | | | | | |
| **Owners of Employer Firms** | | | | | | |
| Under 25 | 2,002 | 563 | 1,439 | 984.4 | 182.7 | 851.9 |
| 25 to 34 | 43,920 | 16,029 | 27,891 | 9,962.1 | 5,661.5 | 6,244.9 |
| 35 to 44 | 189,644 | 68,184 | 121,460 | 22,014.4 | 11,771.5 | 15,883.2 |
| 45 to 54 | 282,466 | 98,945 | 183,521 | 26,525.8 | 11,571.2 | 17,550.0 |
| 55 to 64 | 314,597 | 96,976 | 217,621 | 23,938.3 | 12,706.3 | 16,119.9 |
| 65 or over | 229,792 | 52,082 | 177,710 | 15,312.6 | 5,691.2 | 16,180.7 |
| Total | 1,062,421 | 332,779 | 729,642 | * | * | * |

## Total Number of STEM Owners by Owner Citizenship and Sex (2019) with SE Estimates

| | Total | Female | Male | **Total SE** | **Female SE** | **Male SE** |
|---|---|---|---|---|---|---|
| **Owners of All Firms** | | | | | | |
| Owner is a citizen of the U.S. | 5,784,049 | 2,603,594 | 3,180,555 | * | * | * |
| Owner is not a citizen of the U.S | 596,943 | 279,458 | 317,584 | * | * | * |
| Total reporting | 6,380,992 | 2,883,052 | 3,498,139 | * | * | * |
| | | | | | | |
| **Owners of Employer Firms** | | | | | | |
| Owner is a citizen of the U.S. | 1,038,449 | 325,594 | 712,855 | 38,941.8 | 22,031.9 | 68,758.1 |
| Owner is not a citizen of the U.S | 24,043 | 7,208 | 16,834 | 5,704.7 | 2,191.9 | 3,258.1 |
| Total reporting | 1,062,492 | 332,802 | 729,689 | * | * | * |

Notes:

1. Individual sector Relative Standard Errors (RSEs) are available and individual sector SEs were calculated by multiplying the respective RSE percentages and the numerical estimates. However, the covariances between sectors are not available. So, calculating the SEs for the STEM estimates as a whole by taking sums is not possible. Instead to calculate SEs for STEM estimates, we calculated average RSEs.
2. Average RSEs are the averages of the sector RSEs and are calculated as percentages.
3. SEs were calculated by multiplying average RSEs by the numerical estimates.
4. No RSEs were available for nonemployer firms and the SEs for nonemployer estimates were not calculated.
5. There were some instances where an estimate was available, but its RSE was not available. In this case we assumed a zero RSE value to calculate the average RSE. In these instances, SEs could be underestimated. If both the estimate and its RSE were unavailable, we did not impute any values.
6. We used * to denote instances where RSE’s corresponding to an estimate were not available and SEs were not calculated.