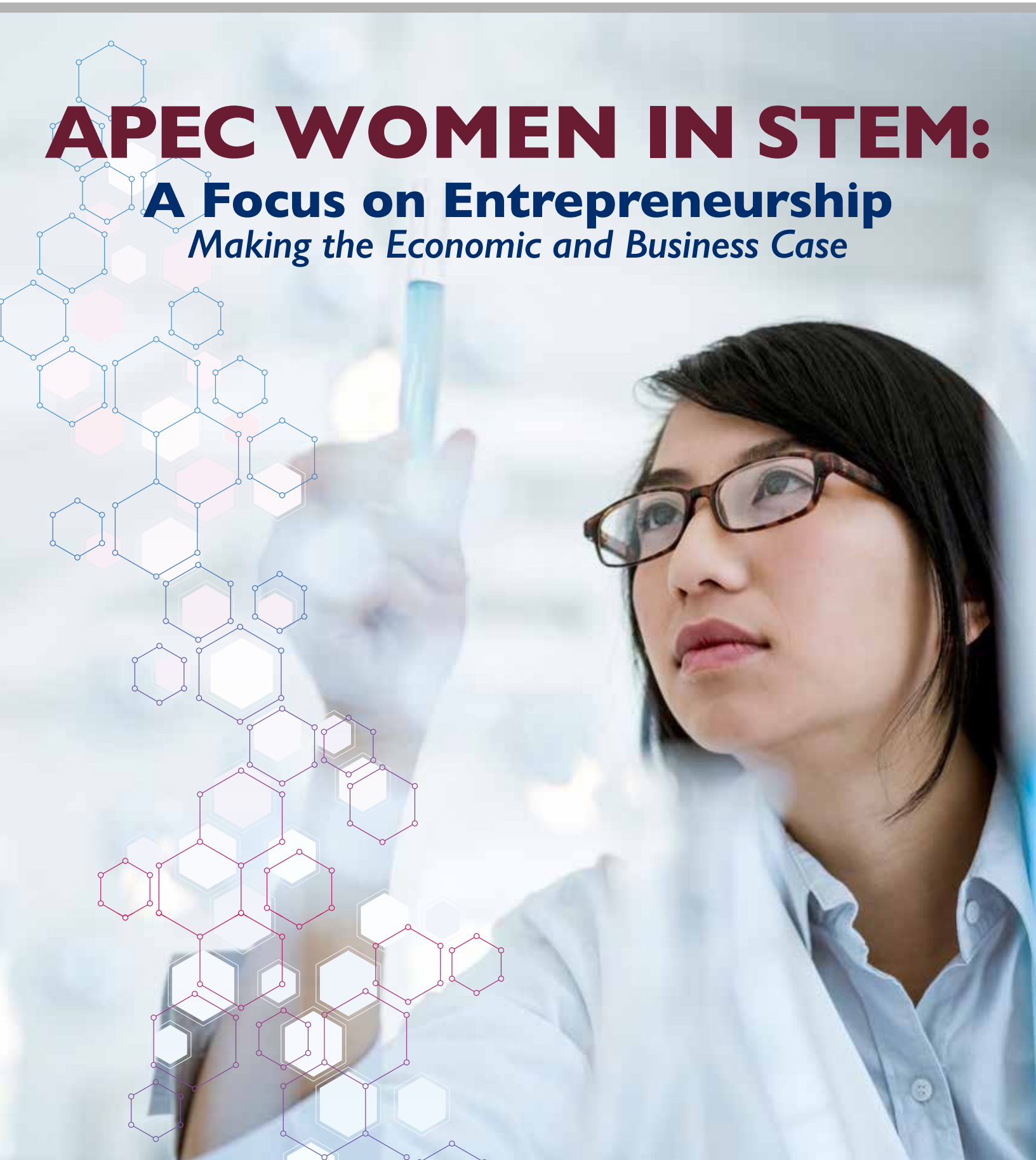
Asia-Pacific Economic Cooperation

USAID FROM THE AMERICAN PEOPLE

# APEC WOMEN IN STEM:

## A Focus on Entrepreneurship

*Making the Economic and Business Case*



# Contents

# Acknowledgments

The US-APEC Technical Assistance to Advance Regional Integration (US-ATAARI) is grateful for the contributions of several individuals and organizations especially for their helpful insights on the topic of women in STEM entrepreneurship. This follow-up report builds on the report, APEC Women in STEM: A Framework for Dialogue, Learning and Action, released in November 2016 and carried out by US-ATAARI, as implemented by Nathan Associates Inc.

Shamarukh Mohiuddin served as principal author with significant contributions from Pooja Singh, both Principal Associates at Nathan Associates. Assistance and valuable comments were also provided by other Nathan Associates team members Ram Tamara, Manal Farah and Caroline Rubin.

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While the report draws from the APEC Women in STEM Framework Report (November 2016) and a STEM workshop convened in 2017, further feedback and input were gathered from participants at a recent workshop on women's STEM entrepreneurship jointly hosted by the United States and Australia in Brisbane. This workshop was convened during the APEC Chief Science Advisors and Equivalents meetings and a meeting of the Policy Partnership on Science, Technology and Innovation (PPSTI). Public and private sector leaders and innovators, and representatives from research institutes and universities, across APEC presented views on their economy's efforts to promote women in STEM entrepreneurship; this input provided further context and information for this report.

# Abbreviations

APEC . . . . . Asia-Pacific Economic Cooperation

KFS . . . . . Kauffman Firm Survey

NBER . . . . . National Bureau of Economic Research

STEM . . . . . Science, Technology, Engineering, and Math

# Executive Summary

The gender disparity in Science, Technology, Engineering and Math (STEM) entrepreneurship continues to remain a feature of the majority of APEC economies. However, this report finds that there are clear business and economic cases for supporting women in STEM entrepreneurship that should be considered when making policy to support economic progress. Policies and programs should be informed not only by the moral reasons to promote gender parity but also by the economic imperatives.

This report is a follow-up to the report, APEC Women in STEM: A Framework for Dialogue, Learning and Action, released in 2016, which covered the main topics of research and discussion that arose since the launch of the US-ATAARI initiative on APEC Women in STEM. The 2016 report identified the main barriers to women in APEC and explored areas of intervention including education, employment, and entrepreneurship.

The aim of this report is to build on the work to date, with the United States as an example. It uses existing U.S. data to provide a clearer picture of the economic and business cases to support women as STEM entrepreneurs, and the potential interventions needed. The report's findings also reflects input from two most recent workshops on APEC Women in STEM attended by a number of APEC economy representatives, which helped to provide additional examples of policies and programs that could be implemented by governments, businesses, and civil society across APEC. While input was received from a number of economies, the authors of this report recognize that STEM and entrepreneurship ecosystems vary greatly across all economies. Therefore, the recommendations of this report must be adapted accordingly.

The report takes a closer look at the U.S., presenting the results as a case study, given that data availability and metrics on women's STEM entrepreneurship, or women's entrepreneurship overall, are not consistent across all APEC economies. For example, many economies do not correct regular data on the number of women-owned businesses. This report maps U.S. women entrepreneurs in STEM, analyzes the barriers inhibiting women, employs regression analysis to understand the broader economic impact, and brings together several relevant case studies.

Below are some of the key findings:

- Of all STEM jobs in the U.S. workforce, women hold less than one-quarter (24 percent) of STEM jobs.
- Women-owned businesses make up approximately one-third of all businesses.
  Of these, women-owned employer firms comprise only about 16 percent of the total employer firms.
- Even when women are the "primary inventor" on a patent, most are concentrated in patent technologies associated with less high tech sectors, such as jewelry and apparel.
- In STEM fields, women are more likely to launch businesses providing research and consulting services, which may be less scalable than STEM-based manufacturing industries like semiconductor, aerospace, or communications equipment.
- Some key constraints for women entrepreneurs include access to educational opportunities, skills, networks, mentors, and role models as well as access to capital and markets.
- According to Kauffman Firm survey data, a clear business case exists for investing in enterprises with at least one female owner. Businesses that fit this criterion generate more revenues, profits, and jobs than their all-male owned counterparts.
- The authors' analysis indicates that compared to wholly male-owned firms, the firms with at least one female owner in a sample set have, on average, **US$60,257** more in annual revenue and **$46,471** more in annual profit.[1]
- Based on analysis by this report's authors of data from 5,000 multi-owner, high technology firms (tracked by the Kauffman Firm Survey), the U.S. can, (a) potentially add an additional **1,886** more jobs for this set of firms and (b) increase their total revenues by more than **$145 million** annually, if at least one woman is represented in the ownership.
- According to the Boston Consulting Group's study of start-ups, female founders **generate more revenue** than their male counterparts despite systemic lack of access to equal amounts of capital: **for every dollar raised**, they generate **78 cents** in revenue, compared to **31 cents for male-run start-ups** (Abouzahr et al. 2018).
- Research from the Kauffman Foundation in 2013 showed that firms which have women-led teams have a **35 percent** higher return on investment and **12 percent** higher revenues compared to firms with all-

1. All dollar amounts are in U.S. dollars unless otherwise indicated.

male teams (Mitchell and Wadhwa 2013).

- First Round Capital's research shows that among their portfolio of about 300 start-ups, firms with a woman cofounder performed **63 percent** better, when measured by valuation (First Round Capital 2015).
- According to calculations by the authors of this report from Kauffman Foundation statistics collected from 2004-2011, **only about 7 percent of total losses** incurred by high technology start-ups were by enterprises that have at least one female owner. This number was even lower, **3 percent,** for start-ups with an all-female ownership structure (Kauffman Firm Survey Data 2004-2011; see appendix for calculations).
- Some of the largest companies have begun to actively provide access to markets for women entrepreneurs by sourcing from them — and as a result, these companies are reaping financial benefits from being able to offer a wider diversity of products and services.
- A National Bureau of Economic Research 2018 analysis of highly skilled occupations in the U.S. (in fields such as law, medicine, science, academia, and management) shows a positive relationship in the U.S. between diversity within companies and the value of goods and services produced (Gompers and Kovvali 2018).

Given the above findings and the business and economic case for the United States, some programs are showcased from across economies that provide women STEM entrepreneurs much-needed support. US-ATAARI also suggests some policy and program ideas for decision-makers across APEC to be adapted for local ecosystems and contexts.

# Mapping Women Entrepreneurs in STEM and Key Barriers

The Asia-Pacific region still represents unmet potential in terms of women's participation in STEM (Science, Technology, Engineering, and Math). Even in developed economies like the US, while women held 47 percent of all jobs in the U.S. in 2017, they held just 24 percent of STEM jobs, according to a recent report from the U.S. Department of Commerce.

The underrepresentation of women in STEM fields — not only as students and researchers but also as innovators, leaders, and entrepreneurs — significantly hinders sustainable economic growth and prosperity throughout APEC. Women in APEC economies continue to face barriers in entering, remaining in, and advancing in STEM fields as employees and entrepreneurs.

The APEC Women in STEM initiative was launched to lay out a strategy for APEC economies to identify the best policies and programs to support women in STEM. The initiative draws from the APEC Women in the Economy Dashboard, a project of APEC's Policy Partnership on Women and the Economy. The Dashboard is a groundbreaking tool that tracks key metrics across the Asia-Pacific region under the premise that meaningful, consistently maintained data should underpin all of APEC's work to address the deficits faced in women's economic participation.

In 2015, the APEC Secretariat's Policy Support Unit reported for the first time on the Dashboard's 75-plus indicators of women's economic empowerment. The report revealed significant gaps across APEC in education and career advancement of women and girls in the STEM fields and in STEM entrepreneurship.

The multiyear Women in STEM initiative was launched in February 2016 by the United States, beginning with a study of active initiatives and best practices in the APEC region. As part of this initiative, in November 2016, APEC economies, through the APEC Policy Partnership on Women and the Economy, endorsed a framework for dialogue, learning, and action for APEC Women in STEM through research, consultation, workshops, and projects that would explore conditions and experiences across all 21 APEC economies.

The framework contained a shared vision for how APEC and its member economies can most effectively promote and support women in STEM and an assessment of the key barriers for women and girls in entering STEM fields. The framework also contained policy recommendations for APEC member economies on how to accelerate the engagement of women and girls in STEM education, employment, and entrepreneurship as well as on how to address the overarching enabling environment.

In 2017, the United States supported a workshop aimed at building out implementation of the framework across APEC's rich women in STEM stakeholder community, with a focus on women's entrepreneurship. The workshop highlighted the untapped potential for public-private sector partnerships and cross-fora collaboration to implement these interventions to strengthen, advance, and sustain the pipeline. It also emphasized the lack of data that both governments and businesses need to build on the emphasis and investment at all stages of the STEM pipeline.

This report builds on the outcomes from the 2017 workshop and responds to the call to examine more closely what, if any, data exists to begin to build the business and economic cases for investing in women as STEM entrepreneurs. Specifically, it identifies the key barriers that exist for potential and current women-owned businesses in STEM, the economic and business case for supporting and accelerating women as STEM entrepreneurs with existing U.S. data, and the specific actions that can support women's STEM entrepreneurship in the APEC region.

US-ATAARI has developed this report as a guide for policymakers and businesses on how to build the business and economic cases for accelerating women entrepreneurs in STEM, using the United States as a case study.

The selection of entrepreneurship, for purposes of this analysis, resulted from the fact that (a) the Women in STEM initiative in 2018 is focusing on this pillar and (b) 2017 discussions revealed that women's STEM entrepreneurship had potential for more economy-level engagement and support in the region. This report aims to better equip government, private sector, and civil society stakeholders to understand the barriers as well as the economic and business cases to justify investments in policies and programs.

Given the sparse data on the economic and business case for women's STEM entrepreneurship, this report will also provide guidance to policymakers and businesses on what type of data to collect to make the economic and business case. APEC could take up this additional analysis moving forward.

The indicators and data justifying suggested interventions have been drawn from a range of data sources, including the United Nations, World Bank Group, U.S. Department of Commerce, and private sector sources. All sources that are generally recognized for their reliable, objective, and high-quality data.

This report is organized as follows:

- A mapping of U.S. women entrepreneurs in STEM, and a brief summary of the major barriers to women's STEM entrepreneurship
- The economic case for women's STEM entrepreneurship
- The business case for women's STEM entrepreneurship
- Policies and programs that lead to impact in supporting more women in STEM entrepreneurship

## *Women's Representation in STEM*

While there are significant data gaps in women's participation as STEM entrepreneurs, the Asia Pacific region lags behind other global regions in women's participation as science researchers, with only 22.9 percent of women in science research in East Asia and the Pacific and 19 percent of women in South and West Asia, according to UNESCO.

However, there is wide variation in women's participation in science and technology fields across APEC economies. For example, according to UNESCO, women make up 52 percent of science researchers in Thailand, and are close to parity in Malaysia and Viet Nam. However, in Indonesia and Singapore, only one in three researchers is a woman. In Japan and the Republic of Korea, two economies where there are higher researcher densities and greater technological sophistication, as few as 15 percent and 18 percent of science researchers respectively are women. Women are also heavily under-represented as engineers, with less than 10 percent engineers being female in these two economies.

In developed economies such as Australia, New Zealand, the Republic of Korea, there has been a steady decrease in female graduates in computer science. Meanwhile, the Malaysian information technology (IT) sector is comprised equally of women and men, with large numbers of women employed as university professors and in the private sector. Given the dearth of economy-wide sex disaggregated data on founders of STEM-based enterprises across APEC, leading the authors of this study to turn to the U.S. as a case study.

*Even when women are the "primary inventors" of a patent, most are concentrated in patented technologies associated with less high tech sectors, such as jewelry design patents and fabric patents for apparel. Patent registrations of women inventors, however, span a greater variety of patent classes.*

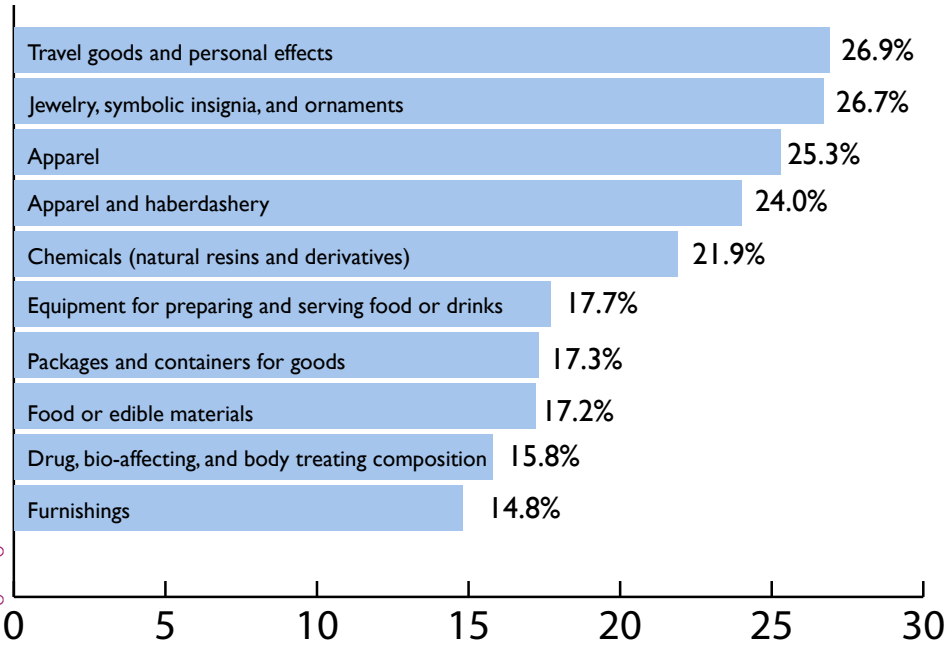
## *U.S. Case Study*

The evidence in the United States shows that training in STEM fields is only part of the problem. For example, when focusing on employees in STEM fields, 40 percent of men with STEM degrees work in technical careers — compared with only 26 percent of women. That means that qualified women are proportionally less represented in STEM fields because of the lack of an enabling environment or systemic barriers to entry beyond qualifications.

Although women in STEM jobs earn about 35 percent more than women of similar professional levels in non-STEM jobs, women make up 47 percent of the U.S. workforce and hold only one-quarter of STEM jobs (U.S. Department of Commerce 2017).

The same goes for entrepreneurship — where women are heavily under-represented when it comes to entrepreneurship in STEM fields. In the U.S., women with STEM qualifications are less likely than men to start their own business (Jennings and Brush 2013). As of 2010, 5.4 percent of women and 7 percent of men with STEM doctorates were participating in entrepreneurial ventures.

**Figure 1: Top 10 patent classes by share, with a woman as primary inventor, 2010**




Source: Delixus, Inc (2012) and National Women's Business Council (2012)

According to a U.S. study by Blume-Kohout (2014), civil engineering, materials science, bioengineering, and mechanical engineering PhDs are more likely than other PhDs to engage in entrepreneurship. Mathematics and statistics, agricultural sciences, and earth/environmental sciences have the lowest rates of (a) industry-funded university R&D and (b) entrepreneurship among PhDs. Female graduate students in chemical engineering and mechanical engineering more often enroll in programs with no industry-funded R&D. Therefore, encouraging women toward disciplines with higher industry-funded R&D could lead to better rates of STEM entrepreneurship in the U.S.

The number of overall women entrepreneurs in the U.S., also lags behind that for men. Women-owned businesses make up a little more than one-third of all businesses (U.S. Census Bureau 2017). Of these, women-owned employer firms are only about 16 percent of the total (Robb et al. 2014). According to estimates, only about 2 percent of women-owned firms generate more than 1 million dollars and fewer than 1 million women-owned firms in the U.S. hire employees (Robb et al. 2014).

One observation is that women-owned enterprises, whether STEM-focused or not, are generally smaller. Even in high-tech industries, women are more likely to found firms providing research and consulting services, which may be less scalable than STEM-oriented manufacturing industries like semiconductor, aerospace, or communications equipment. Moreover, women-owned high-tech businesses are less often located in geographic regions where they can take advantage of the regional clustering of highly skilled labor, knowledge spillovers, and so on.

***Start-up of new STEM enterprises requires critical skills, networks, champions, and connections that, relative to men, women often have fewer opportunities to utilize. The lack of women in STEM higher education and entrepreneurship means that future women entrepreneurs have fewer women from whom to take guidance or inspiration.***

## *Key Barriers to Women's STEM Entrepreneurship*

The 2016 report, APEC Women in STEM: A Framework for Dialogue, Learning and Action, laid out three main areas where women in STEM face barriers in trying to join STEM occupations or founding their STEM enterprise. Each of these barriers are each discussed very briefly in this section.

### Opportunities, Networks, and Skills

In many economies around the world, girls grow up without sufficient opportunities for education and skill -building as well as encouragement, guidance and information on how to join STEM fields as employees and entrepreneurs. According to the U.S. Census Bureau 2012 Survey of Business Owners, there are significant differences in educational attainment and previous entrepreneurial experience between men and women STEM entrepreneurs. Male owners of single-owner businesses more often hold advanced degrees

*For professional, scientific, and technical services industries — the closest proxy for STEM industries — in 2015, only 9,077 female-owned enterprises received start-up funding of $100,000 or more, while four times as many male-owned enterprises raised comparable start-up capital.*

than women owners in all industries, a disparity that increases in higher education degrees (i.e., master's, doctorate) among STEM fields, in particular. Across genders, entrepreneurs in STEM fields attain higher educational degrees than owners in non-STEM fields, highlighting the importance of education in STEM entrepreneurship.

Additionally, male business owners are also more likely than women owners, across STEM and non-STEM businesses, to have previously been self-employed or owned their own business. In STEM and non-STEM fields, previous entrepreneurial experience is less common among female business owners than male owners. A Kauffman Foundation study found that women-owned, high-tech firms are also less likely to have intellectual property protection compared to those owned by men. All of these statistics point to potential constraints women entrepreneurs face in the high-tech industry, in comparison to their male counterparts, in establishing and expanding their businesses.

The absence of strong role models or mentors can reinforce young women's perception of STEM fields as not being conducive to their familial or social commitments. Starting an enterprise adds to the perceived risks of failure and uncertainty, which may itself deter women from venturing into STEM entrepreneurship.

### Access to Capital

Numerous studies suggest that access to capital is a major impediment to the growth of women-owned firms and that women are more reliant on personal rather than external sources of financing (Robb et. al 2014). Growth-oriented STEM enterprises typically require substantial external capital, both in debt and equity, and this lack of access to sufficient financing is a critical hindrance to its growth. The amount of start-up capital available has implications on the growth trajectory of the enterprises and is a factor in explaining the smaller sizes of women-owned businesses. In the U.S., for example, women entrepreneurs begin with one-eighth the funding compared to male-owned ventures and women operate only 5 percent of tech start-ups (Hill 2018).

In 2017, the average funded business loan for firms owned by women was $57,097, compared to $103,604 for male-owned businesses, according to Biz2Credit's annual State of Women-Owned Small Business Finance Study (Biz2Credit 2018).

According to Pitch Book, female-founded firms raised only $10.5 billion in venture capital in 2017, out of the estimated $90 billion raised by all firms (Clark 2018). A separate study by Babson and Wellesley colleges showed that

just 3 percent of venture capital funding was raised by female CEOs between 2011 and 2013, or $1.5 billion out of $50.8 billion, in a study of 7,000 companies (Balachandra et al. 2014).

Both unconscious and conscious biases play parts in preventing women STEM entrepreneurs from securing funding. In the U.S., the gatekeepers of the investor world are primarily men — white men who rely on their own networks for leads. In 2016, the CrunchBase Women in Venture Capital Report found that less than 10 percent of full-time investing partners in venture capital firms worldwide are women. In the meantime, evidence suggests that on an industry-wide basis, investing firms with male partners are less likely to invest in startups with a female founder than are firms with female partners (Desmond and Teare 2016).

Even the presence of a woman on a start-up's executive team correlates to lower funding levels. Researchers have found that executive teams comprised entirely of men were four times more likely to get venture capital funding than those that had even one woman on their team (O'Brien 2017).

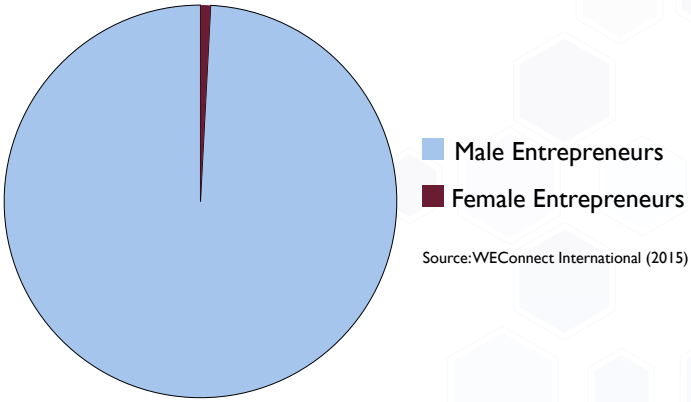
Start-ups in STEM require even greater capital. Beyond relatively contained enterprises, such as consultancies, traditional STEM-related companies tend to require large sums of capital that most women have difficulty in accessing. This is attributable to many factors, including the low representation of women in the venture capital industry. In developing economies, women face restrictions regarding ownership of property and unequal treatment in divorce or inheritance laws, adding to their hindrances in accessing capital.

## Access to Markets

In addition to opportunities, networks, and capital, accessibility to markets remains another hindrance to growth for women entrepreneurs. The lack of STEM education opportunities, a greater burden of care duties at home, as well as curtailed freedom of movements in many economies, all limit women's access to networks and information — and thus, the potential of their enterprises.

As detailed through the WE-APEC initiative, opportunities to access markets arise from an ecosystem of support, including education related networks, formal and informal business networks, opportunities through potential private-sector value chains, government procurement activities, and other direct interventions to support entrepreneurs. There can be greater opportunity for women to access markets through corporate value chains, as shown in Figure 2. Currently, women entrepreneurs are served by only one percent of the total sourcing done by the private sector across the world. In the U.S., women entrepreneurs are able to access only five percent of public procurement opportunities owing to constraints in skills, access to capital, and networks and in meeting adequate requirements.

**Figure 2: Women entrepreneurs benefit from only 1 percent of global corporate procurement**




Source: WEConnect International (2015)

Women who launch STEM-oriented firms need support in developing their markets, both through direct capacity building as well as initiatives by the private sector and government through their procurement channels.

Access to markets is an area that could also use further unpacking to develop solutions and activities that more effectively connect women-owned businesses to revenue-generating buyers and clients. The proof of an intervention's effectiveness is whether women-owned STEM enterprises can attract new customers and grow.

# Making the Economic Case

Since women are under-represented as STEM in APEC economies and beyond, it is very important to make the economic case for accelerating women in STEM employment and entrepreneurship in order to catalyze public and private investments in support of women, which will in turn will have a broader impact on the economy. A report issued by the Office for the Chief Scientist in Australia suggests that advanced physical and mathematical sciences directly contribute to the Australian economy an amount of about $145 billion a year, or about 11 percent of GDP. When the associated impacts of the sciences are considered, the benefit to the economy increases to approximately $292 billion a year, or 22 percent of economic activity (Fiddis 2017). Research also suggests that economies with a higher proportion of engineering graduates tend to grow faster than economies with a higher proportion of other degrees (Castillo et al. 2014).

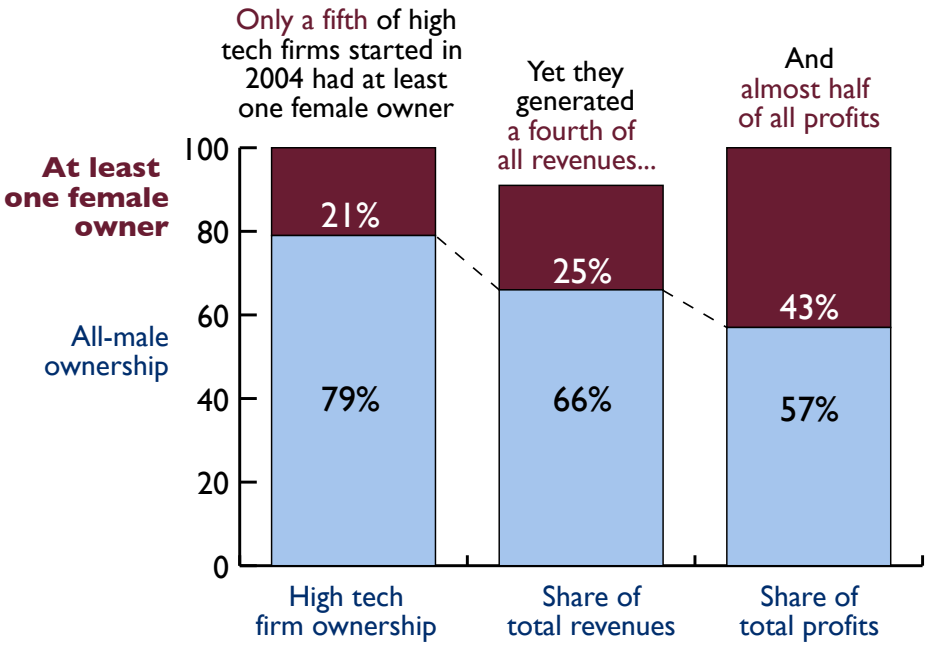
However, overall, the research and quantification of the potential economic impact of STEM participation and entrepreneurship is very limited. Most APEC economies do not seem to have adequate data or research to be able to make informed statements and decisions about this topic. Because of the growing importance of STEM industries for economic growth, it is imperative to collect data that pertain to STEM entrepreneurship to help economies justify actions that will address key barriers to entry and operation.

This chapter particularly aims to contribute to the closing of that data gap. For the purpose of this study, primarily owing to the availability of disaggregated firm-level data for a period of time, the analysis focuses on the United States as a case study and utilized data from Kauffman Firm Survey (KFS). The KFS is the largest longitudinal study of new businesses in the United States. It tracked nearly 5,000 businesses founded in 2004 through their early years of operation until 2011 and focused on the nature of new business formation activity; characteristics of the strategy, offerings, and employment patterns of new businesses; the nature of the financial and organizational arrangements of these businesses; and the characteristics of their founders. According to the KFS website, "the panel of businesses was created by using a random sample from Dun & Bradstreet's database list of new businesses started in 2004, which totaled roughly two hundred fifty-thousand such businesses."

Considering its focus on the dynamics of high-tech firms and woman-owned businesses, the study analyzed this data series to understand the potential economic impact of women-owned high technology firms (as a proxy for women-owned STEM enterprises). In particular, it examined the revenue and employment generation dynamics of women-owned high technology firms.

In the appendix, Table A1 presents a summary of the KFS firm-level data for high-technology firms. The data shows that 21 percent of all high-tech enterprises established in 2004 had at least one female owner (nearly 11 percent were wholly owned by women). That is, there were at least four times as many high-tech start-up firms with all male ownership in 2004 in the U.S. Yet, as shown in Figure 3, below, enterprises with at least one female owner generated one-fourth of total revenues and almost one-half of all profits generated by this set of enterprises.

**Figure 3: U.S. high tech firms in 2004 with at least one female owner generated more revenues and profits than all-male owned firms**




Source: Kauffman Firm Survey (2004)

The authors of this report also used the cross-sectional yearly KFS data from 2004 through 2011 to run linear regression models to understand the impact of having more female owners of STEM enterprises. They looked at what the KFS data says about the effect of having at least one female owner on the following independent variables in high-technology firms: number of employees, revenue, and amount of profit. The equations in Table A2 (in the appendix) show that having at least one female owner has a positive relationship with all three variables and that all coefficients are statistically significant. This suggests that having at least one female owner in a high-tech firm is associated with a higher number of employees, revenues, and profit.

The KFS data also shows that while, on average, both types of firms start off hiring about 1.5 employees, over the course of seven years, firms with at least one female owner employ about 7 employees, compared to about 5 employed by those with an all-male ownership.

This report's analysis also shows that having at least one female owner in a high-technology firm is associated not only with higher revenues and profits, but also more employees. According to the regression analysis, having at least one female owner is associated with employing nearly two more employees,

***Having at least one female owner in high-technology firm is associated with a higher number of employees, revenues, and profit. Compared to wholly-male owned firms, firms in the data set with at least one female owner have on average $60,257 more in annual revenue and $46,471 more in annual profit. This translates into more job growth and a larger impact on the economy.***

versus having complete male ownership. Such findings translate to more job growth and a larger impact on the economy.

The authors note, however, that these correlations may be biased by omitted variables, such as other owner characteristics (e.g., race, years of industry experience) and firm characteristics (e.g. industry type). To correct for these, they ran firm-fixed effects regression models that look at variations over time within a firm and at controls for time-invariant owner and firm characteristics (see Table A3 in the appendix).

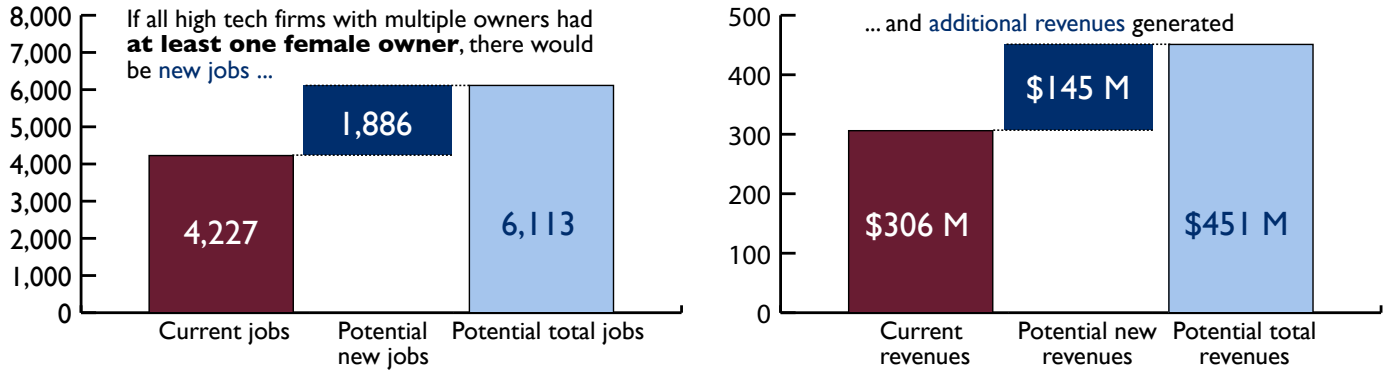
These results were then used to contemplate a scenario in which women are better represented in high-tech firms' ownership structures. For all firms with two or more owners, assuming that at least one owner is a female, the total impact on the number of employees and total revenue can be estimated, as presented in Figure 4.

Having at least one female owner in high-tech firms that already have more than one owner results in annual revenues that are about 47 percent higher and increased employment that is 44 percent higher than in wholly male multiple-owner firms.

The analysis in this report suggests that encouraging women to join the high-tech industry as business owners, particularly in businesses with multiple owners, has a higher positive economic impact than having just male owners.

The KFS data also shows that wholly women-owned high tech firms have a greater chance of failure than firms with at least one female owner. While this points to the need to understand the constraints facing the startup and operations of all-women owned high tech firms, the analysis here also suggests a short-term, win-win solution for high-tech start-ups. Specifically, bringing in at least one-female owner with decision-making power in a multiple-owner structure improves the likelihood of higher revenues, profits, and employment.

**Figure 4: Potential annual gains in employment and revenue by having at least one female owner in high-tech firms**




Source: 2018 US-ATAARI analysis from sample data from 2004-2011

***In other words, based on this analysis, the U.S. could add an additional 1,886 jobs for this sample set of 5,000 multi-owner, high-tech firms and increase total revenues by more than $145 million annually, if ensured that at least one woman is represented in the ownership.***

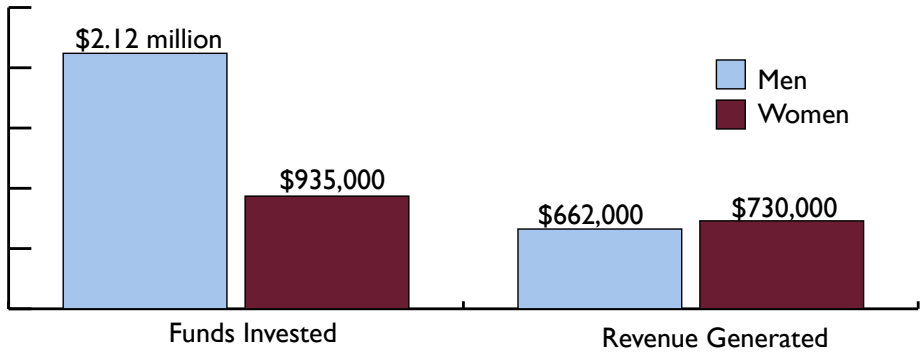
# Making the Business Case

The previous chapter shows how women participation in enterprise ownership can have an impact on that enterprise's revenues, profitability, and jobs, and as a result, on the economy. This chapter looks more deeply at the returns to investment for investors, banks, asset holders, and corporations, and whether they are also able to benefit financially from investing in, or sourcing from, women. Notwithstanding the moral argument for leveling the playing field for women entrepreneurs, if there is also a case to be made that having more women entrepreneurs or women STEM entrepreneurs can have an impact on the stakeholder's bottom line, the easier it becomes to justify policies and programs in support of women.

## *Business Case for Investor Support for Women Entrepreneurs*

Recent research by the Boston Consulting Group shows that there is a clear business case for funding women-led technology-based start-ups. This consulting group's study looked at the experiences of 350 technology-based companies that had completed an entrepreneurship capacity-building program offered by MassChallenge, a U.S.-based global network of accelerators. Ninety-two of the start-ups studied by Boston Consulting Group had at least one female founder. Although the female founders were able to raise much less money than were men (i.e., an average of $935,000 compared to $2.12 million for all-male executive teams), these women were generating more revenue: $730,000 for the women versus $662,000 for the men (Abouzahr et al. 2018). This means that for every dollar raised, women-run start-ups generated 78 cents in revenue compared to 31 cents for men.

**Figure 5: Startups founded or cofounded by women receive less investment but generate more revenues**




Source: Abouzahr et al. (2018). Note: Of the 350 companies included in the analysis, 258 founded by men, and 92 were founded or cofounded by women.

*For investors, this means that there is a clear, positive bottom-line impact of investing in women-owned firms. If they invest the same amount of capital into women-run companies as they did into the ones run by men, they would have helped generate an additional $85 million in revenue.*

Research from the Kauffman Foundation, in 2013, also showed that women-led teams among those firms studied had a 35- percent higher return on investment as well as 12-percent higher revenues than all male teams (Kauffman Fellows 2016).

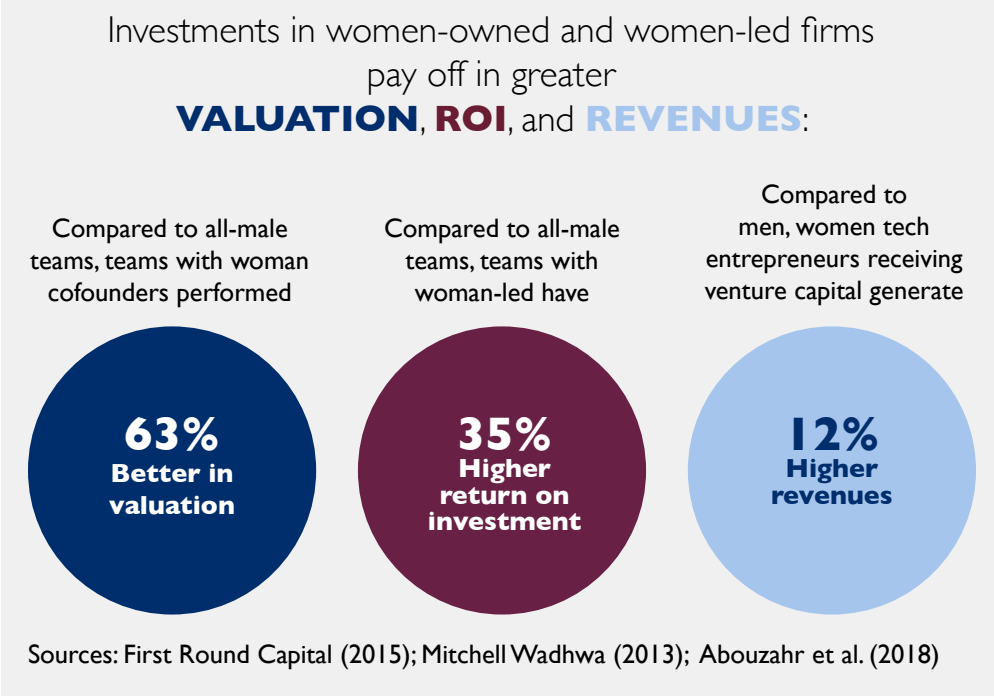
A study by Illuminate Ventures also shows that women founders do more with less: Women-led venture-backed firms, in their early stages, had revenues that were comparable to those of men-led firms. But they used an average of one-third less capital to get there (Padnos 2018). These findings have clear implications for investors who are interested in boosting their bottom line.

A female-led venture capital firm called Rethink Impact invests in startups with gender-diverse leadership teams that use technology to generate social impact. With $112 million in capital, Rethink Impact is the largest U.S.-based impact venture capital firm to apply a gender lens to investments. It has invested in more than a dozen STEM-based startups with female founders and cofounders, providing coaching and guidance as well.

The venture firm First Round Capital has also found that among their portfolio of about 300 start-ups, the teams with a woman cofounder performed 63 percent better — as measured by valuation — than all-male teams. These findings are consistent with numerous studies, including those showing that companies with more diverse leadership teams perform better than companies with less diversity leadership. According to a Credit Suisse report, which tracked 3,000 companies in 40 economies and 28,000 executives, companies with more gender balanced executive leadership have a higher return on equity. A study by Catalyst also shows that U.S. Fortune 500 companies that had at least three women board directors for at least five years, outperformed those with zero women on the board by an 84-percent return on sales (ROS), 60-percent return on invested capital (ROIC), and 46-percent return on equity (ROE) (Carter and Wagner 2011).

The calculations of this report's authors from Kauffman Foundation Firm Survey data from 2004-2011 reveals that only about 7 percent of total losses incurred by the high-tech start-ups were by enterprises that has at least one female owner. This number was even lower (3 percent) for start-ups with an all-female ownership structure (see appendix for calculations).

**Figure 6: Investors gain when they support women entrepreneurs**




Sources: First Round Capital (2015); Mitchell Wadhwa (2013); Abouzahr et al. (2018)

## *Loan Capital for Women Entrepreneurs*

As discussed in detail in the APEC Women in STEM Framework report, there are structural biases built into funding decisions of venture capitalists, banks, and other asset holders when it comes to funding women entrepreneurs. However, this study finds through the authors' review of several studies that the business case for financing women entrepreneurs is clear because they represent a high rate of return. This is also the case when it comes to loan capital for women entrepreneurs.

An example from a non-APEC economy, Lebanon, illustrates this case. BLC Bank in Lebanon has generated significant profits from focusing on women as a market for loan products, as an example. While 51 percent of Lebanon's 4 million inhabitants are women, and women make up more than half of its university graduates, they own only 33 percent of businesses. Yet, only 3 percent of bank loans were extended to female entrepreneurs.

Observing this gap, BLC Bank partnered with the International Finance Corporation to find new ways to reach this untapped market. The bank launched a new women empowerment program, WE Initiative, in 2012 to position itself as the bank of choice for women in Lebanon and as a global

*"Twenty years ago, female founders got a higher percentage of venture capital dollars than they do today. This is surprising when you consider the fact that data now shows that companies with gender-diverse management teams perform better financially. Our team believes that the next generation of extraordinary companies will find success through their diversity, coupled with a relentless pursuit of mission, for the benefit of all communities."*

*— Jenny Abramson, Founder, Rethink Impact*

example for women's market best practices. The first step was to conduct market research of the needs for women-owned businesses and their repayment rates and then to test new product concepts. The bank began to offer collateral free loans as well as mentorship programs for promising women entrepreneurs. The bank also integrated the women's market value proposition across all departments. In the process, cultural barriers and conscious and unconscious biases also had to be eliminated through extensive training at all levels.

By 2014, BLC's WE Initiative generated significant business returns, representing more than 18 percent of the bank's profits, with double-digit growth projected over the next 3 years. The WE Initiative also allowed BLC Bank to be creative in designing new products for women, such as collateral-free loans and non-financial services. As a result, the Initiative saw a 33-percent rate of return on its women's market portfolio.

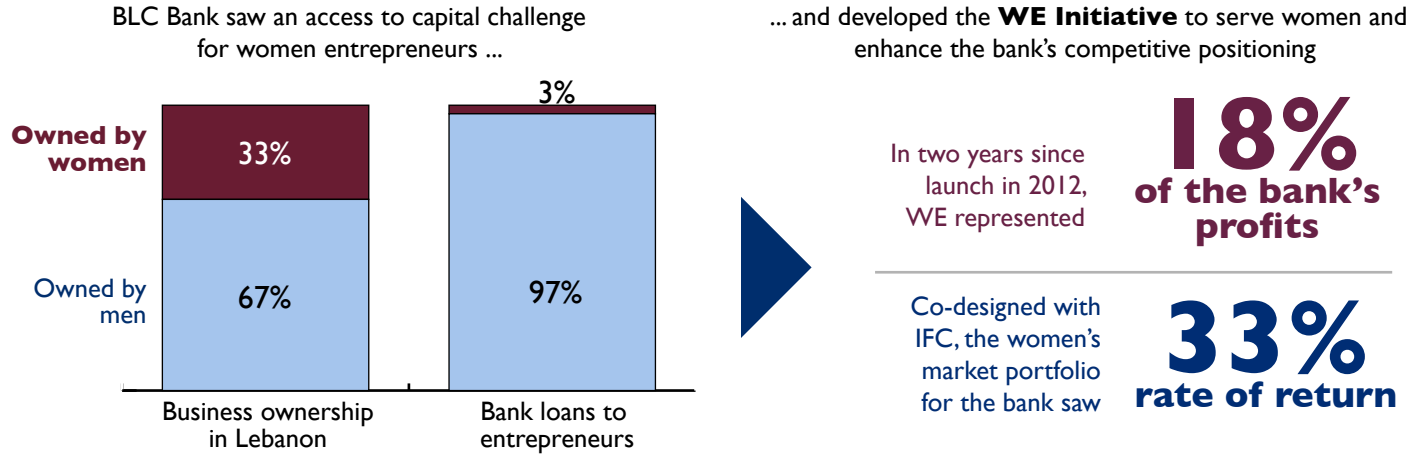
Given that access to equity as well as debt capital is a major barrier for women entrepreneurs owing to biases, it is important to socialize these findings about the business case to banks in APEC economies. By establishing a comprehensive performance management system and utilizing sales targets, banks can incentivize internal stakeholders to consider women as a valuable and profitable segment.

## *More Women Entrepreneurs in the Value Chain*

There is a business case not only for supporting women entrepreneurs with access to debt and equity finance but also to enable their greater access to markets. Research shows that if given the opportunity, women bring unique skills and perspectives to the design and production of goods and services, resulting in meeting wider consumer preferences and thus greater value for companies.

A 2018 National Bureau of Economic Research (NBER) analysis of highly skilled occupations (in fields such as law, medicine, science, academia, and management) shows a positive relationship between diversity within companies and the value of goods and services produced in the United States (Gompers and Kovvali 2018). The study looks at GDP trends beginning in 1960, when significant barriers prevented white women, black women, and black men from entering those professions. Using a model that assumes innate skills are evenly distributed across gender and racial groups, the NBER analysis attributes about 25 percent of the GDP growth per capita to the uptick in the labor force of white women and black Americans of both genders. The authors argue that diversity leads to more talented teams and better product quality.

**Figure 7: Case study of BLC Bank in Lebanon: Banks can benefit from the market of women entrepreneurs**




Source: International Finance Corporation (2017)

Some large companies have also recognized that providing a market for women entrepreneurs by actively sourcing from them leads to better product quality and diversity. Greater market access can help them gain greater market share. As one of the world's largest and most diversified companies, Walmart recognizes this, and as such, actively sources items from women entrepreneurs, including STEM-related products that it sells to its market. According to a Walmart executive, being mindful of sourcing from women entrepreneurs makes the company more competitive because women understand the needs of female customers (Thorn et al. 2016).

Ultimately, half of the world's consumers are women, and women and men each bring a unique understanding of consumer preferences. Women also control the vast majority of household spending. As a result, Walmart is better able to offer a greater diversity and quality of products and services to its customers. Walmart also finds that consumers respond more positively when they learn through the company's branding that some products with the "women-owned" logo are sourced from women entrepreneurs.

When large companies break down customer segments not only by income and age but also by gender, it often reveals differences in consumer needs or preferences, even for a product that may initially seem gender-neutral. Large technology companies in APEC economies should recognize the business case for sourcing from women entrepreneurs and consider the opportunity to source from female STEM entrepreneurs.

***Large companies have the power to enable greater market access for women STEM entrepreneurs by sourcing from them as well as by gaining an opportunity to profit from unique, diverse products and services that respond to market needs and preferences.***

# What Works in Supporting Women STEM Entrepreneurs

To provide more support for women entrepreneurs in STEM, a number of programs are being supported in APEC economies by both the government and the private sector. Although not a comprehensive list, a sample of programs below may provide APEC economies with ideas to think about additional ways to support women with setting up and growing their STEM enterprises.

## *Government-supported Programs*

### Government of Australia

The Australian federal government adopted the National Innovation and Science Agenda in 2015, one of whose four main pillars is to provide entrepreneurs with new sources of finance to encourage them to take risks and commercialize innovative ideas.

### Government of Canada

Despite their overall contribution to Canada's economy, only about 5 percent of female start-up founders obtain the funding they seek. Startup Canada's Women Founders Fund in STEM aims to help close that gap by providing grants worth each between $1,000 and $5,000. To qualify, applicants must be female entrepreneurs or women-led businesses owners based in Canada, operate in a STEM-related sector, and use the funds to support business operations or access professional growth opportunities.

### Government of Chile

The "S Factory" is a program sponsored by the Chilean government and open to women with an approximate budget of US$690,000 (460 million Chilean pesos). The objective of the program is to support women who are developing start-ups with high-growth potential (which are often in STEM). Beneficiaries receive about $15,000 (10 million Chilean pesos) and have the opportunity, during a 12-week period, to meet with vibrant entrepreneurs from all over the world in a multicultural and collaborative workspace and access learning opportunities through courses, mentorships, and pitch training, among others.

### Governments of the United States and Viet Nam

The Building University-Industry Learning and Development through Innovation and Technology (BUILD-IT) program was launched in 2016 as a collaboration between USAID, Arizona State University, and the government of Viet Nam. The program exercises the goal of connecting STEM instruction in Vietnamese higher education institutions to students, who then can advance inclusive, technology-based growth. To this end, the program commissions studies and organizes women in leadership forums.

## *Non-Government Programs*

### ArcAngels, New Zealand

A member-based angel investment organization, ArcAngels focuses on building investor knowledge and investing in early-stage businesses that are led or managed by women in New Zealand. ArcAngels focuses on for-profit organizations with a female founder or a woman in an executive management position. Sometimes an organization is also considered if it was founded by or is led by a diverse management team. ArcAngels is most interested (but not solely) in businesses in the following sectors: IT and communications (digital, media, mobile, and web); clean tech and renewable energy; biotech; medical devices; food and beverage; financial services; and agriculture.

### Business Woman (Usaha Wanita)

In Indonesia, Usaha Wanita is a mobile information service that delivers relevant business setup and management information to female entrepreneurs. It reaches over 14,000 women and 98 percent of mentee graduates have built business skills that can be leveraged to grow a business (Yu 2017).

### Dell's Women Powering Business initiative

Dell connects a reported 10,000 female entrepreneurs

across the globe with networks, sources of capital, knowledge, and technology. Through social media platforms, women connect and share advice, stories, and concerns. Participating women have access to Dell for Entrepreneurs, which provides information on technology, marketing, capital, and markets.

## Girls in Tech

Girls in Tech™ is a U.S.-based global nonprofit focused on the engagement, education, and empowerment of girls and women who are passionate about technology. Girls in Tech aims to accelerate the growth of innovative women advance their careers in STEM fields by entering into the high-tech industry and building start-ups. As such, they are provided with the required access and community. With headquarters in San Francisco and more than 100,000 members located around the globe, this nonprofit relies on volunteer efforts to lead each of the 60 local chapters. Programming and events vary by chapter based on local interests and needs.

## National Association of Women Entrepreneurs of Malaysia

In Malaysia, the National Association of Women Entrepreneurs of Malaysia (NAWEM) is an NGO that unites female entrepreneurs in the fields of manufacturing, IT, aerospace, engineering, and more. The organization fosters both personal growth and business networking connections, and it provides members with opportunities to participate in international and community-based conventions, conferences and mentorship events (Walden 2016).

## Vodafone Americas Foundation

Vodafone Americas Foundation supports mobile technology for social good. In this role, the foundation works with women in the U.S. who are turning their tech skills and passion for social impact into tools that change lives and improve outcomes in the global community. Through their annual competition, Wireless Innovation Project® Competition, they fund promising start-ups and nonprofits that build socially minded technology. For example, competition winner Nithya Ramanathan, CEO and cofounder of Nexleaf Analytics, develops sensor technologies to improve lives in low-income economies; and for another example, Shivani Saroyan, competition winner and founder and CEO of Tala, a mobile technology and data science company, works to bring financial access to underserved people around the world.

# The Way Forward

Based on this case study, as well as on the feedback derived from discussions at the recent workshops, there are a number of ways in which APEC economies can formulate policies to support an enabling environment for women entrepreneurs. The authors have outlined these recommendations below. It is also important to consider where data collection can be strengthened in order to provide a clearer picture in the future of the status of women's STEM entrepreneurship.

## *Key Recommendations*

Below are some key recommendations for policymakers and the business community in APEC economies to consider that could help create a more enabling environment for women entrepreneurs in STEM.

### For Policymakers, Educators, and Civil Society Groups

- Collect more data on the number of women in STEM entrepreneurship and the key barriers faced by them.
- Provide scholarships for women and girls in STEM fields.
- Help connect STEM women and girls with entrepreneurial opportunity and skills.
- Integrate entrepreneurialism into STEM education generally, including secondary and university levels. Help women and girls navigate the connection between their innovations and the opportunities for entrepreneurship.
- Encourage women toward STEM disciplines with higher industry-funded R&D as this leads to greater propensity for entrepreneurship.
- Train women STEM entrepreneurs in accessing finance, including through business plans, connections to lenders, and so forth.
- Advocate for improved laws and regulations pertaining to women's access to credit.
- Support start-up weekends for women or similar intensive training programs that offer focused coaching and training on starting a STEM enterprise or developing a STEM business model.
- Connect women STEM entrepreneurs with networks that will help increase their awareness of resources, build their resilience, and expand their contacts.
- Build the capacity of incubators, business associations, chambers of commerce to serve women entrepreneurs in STEM to share skills and market information.
- Conduct a wide range of in-person networking opportunities in which woman-owned STEM enterprises may become aware of, and introduced to, potential buyers.
- Link women-owned STEM enterprises with the private sector and appropriate government agencies to educate them about of quality standards and key certifications required to market their goods and services at home and abroad.
- Provide information and training oriented toward supplier readiness, standards, timing, consistency, and communication that must be met in order to reach larger domestic and cross borders value chains.
- Advocate for increased market opportunities for woman-owned STEM enterprises, including accessible, transparent public and private sector procurement mechanisms.
- Integrate gender bias issues associated with entrepreneurship into the curriculums of major business schools.
- Among business networks and trade associations, share information and develop tools that can benefit woman-owned STEM enterprises seeking to market their goods and services in other economies.

- Set up public-private scholarship programs aimed specifically at girls interested in pursuing careers in high-demand STEM fields of today.

### For Corporations and Investors

- Collect better data on the amount of capital being accessed by women STEM entrepreneurs. Also, address discrepancies that may be resulting from gender biases and preventing the realizations of greater returns.
- Promote gender diversity among lenders and investors, so that the value of the STEM enterprises developed by women is more likely to be noticed and taken seriously.
- Increase the number of women working for venture capital firms, and ensure gender diversity on funding panels or committees.
- Require gender diversity among STEM entrepreneurs who are invited to pitch their ideas with investors.
- Understand and socialize the business case for investing in women-owned STEM enterprises.
- Make both debt and equity financing available to women STEM entrepreneurs.
- Advocate inside the company for strategically sourcing from women owned STEM enterprises, and collect data on the number of women STEM entrepreneurs in the value chain.
- Partner directly with women STEM entrepreneurs to provide capacity-building assistance.

## *Additional Recommendations to Advance Business and Economic Cases*

In addition to taking the above steps, APEC economies should also consider three important issues to track the status of women STEM entrepreneurs and help make a stronger economic and business case for their support. These recommendations are discussed below in detail.

- ***Tighten definition of STEM enterprises.*** Although many economies want to encourage STEM entrepreneurship, a standard definition of a *STEM enterprise* remains quite elusive. In the United States, for example, different government agencies used varying definitions for what qualifies as a STEM occupational position. A working group of representatives from U.S. government agencies and offices identified 96 STEM occupations and then divided them into two domains with two subdomains each.

  The first domain was the Science, Engineering, Mathematics, and Information Technology Domain, with the subdomains (a) Life and Physical Science, Engineering, Mathematics, and Information Technology Occupations and (b) Social Science Occupations.

  The second domain was the Science- and Engineering-Related Domain, with the subdomains Architecture Occupations and Health Occupations. (This list of STEM occupations included relevant education fields and social science as STEM careers. This was, however, in contrast to the U.S. Department of Commerce definition, which used four categories of STEM occupations: computer and math, engineering and surveying, physical and life sciences, and STEM management, and excluded education and the social sciences.) Lack of a clearly defined STEM field confounds the problem of meaningful data collection over time. Therefore, the first step for APEC economies is to clearly define what kinds of enterprises are included in the definition of STEM. Such a definition must then be socialized and accepted at the economy level, across all government agencies, to be able to be used effectively in data collection, analysis, and policymaking. Of course, owing to the rapidly changing nature of STEM fields, economies must also be cognizant of the need to remain flexible with the definition of STEM as technology evolves and STEM encapsulates previously unoccupied fields.

- ***Increase effective data collection.*** Existing research delves either into women's participation in STEM fields as students or employees or tends to look at women's entrepreneurship more broadly. Sparse research exists that looks into the question of women's STEM entrepreneurship, in particular. There is an even less research when it comes to analyzing the economic impact of women's entrepreneurship in STEM. As a first step to understanding women's STEM entrepreneurship and its overarching economic impact, it is crucial for APEC economies to start systematically collecting some pertinent information. Many economies already collect some form of data on enterprises and businesses through surveys, business registries, or other means. In these cases, extending information gathered for STEM fields would be helpful. In other cases, developing surveys or data collection methodologies that encompass entrepreneurship more broadly, with a focus on women-owned enterprises and those that work in the STEM field, would be effective. Surveys that track specific start-ups over the course of a few years (like the KFS data used in this section) offer insights into business start-up and operations constraints. But, data on yearly start-ups also offer unique perspectives into the overall trend of STEM enterprises. The type of data to be collected depends on what the purpose of the data collection may ultimately be, and this must consider the cost that may be associated with the data collection.

  Below are some ideas for key indicators on which APEC economies might consider collecting data on as a first step.

  - Number of new registered enterprises, disaggregated by sex, and further by industry (STEM as an option)
  - For STEM-based enterprises
    - Number that is either wholly owned or partially owned by women
    - Type of enterprise (sole proprietorship, partnership, limited liability company, etc.)
    - Number of owners
    - Characteristics by owner: age, sex, ethnicity, highest degree attained, field or degree, number of years of prior industry experience
    - Specific STEM industry
    - Annual turnover in revenue
    - Average annual operating cost
    - Annual profit or loss
    - Number of employees and gender ratio
    - Gender ratio of board of directors
    - Year enterprise started (and in cases where businesses closed, year enterprise ended)
    - Initial start-up capital
    - Source of start-up capital (personal, external debt such as bank financing, venture capital, etc.)
    - Number of patents, trademarks, or copyrights held by enterprise
    - Amount of debt and equity capital accessed by women entrepreneurs
    - Particular market access challenges faced by women entrepreneurs
    - A yearly study of the returns to investors from investing in women-owned STEM enterprises
    - The gains (for large companies) from sourcing from these enterprises
    - Data on the impact of capacity building for women entrepreneurs in STEM: on company growth, job creation, productivity, and innovation.

- ***Take a wider policy strategy to promote women's STEM participation.*** From publishing sex-disaggregated data on women's entrepreneurship to devising interventions to allow greater access to start-up financing for women STEM entrepreneurs, APEC economies can be proactive in devising methods

to increase women's participation in STEM and cross-fertilize across issues. In the late 1990s, the role of women in science emerged as a major issue in Europe, and in fact, promoting gender equality in science was considered as "an essential condition for building the European Research Area." If more women are to be encouraged into STEM entrepreneurial activity, this kind of concerted push as all levels of policy and legislation is imperative.

To encourage more women STEM entrepreneurs, a wider policy lens that encompass implicit biases right through the early educational systems through tertiary education and beyond is necessary. Encouraging early interest in STEM fields in both boys and girls during primary education, educating teachers about roping in more female students, devising social media and other innovative ways to engage more women in STEM subjects all help to cultivate future leaders in STEM. Therefore, while targeting current constraints, such as access to financing for women, is a critical step, APEC economies must view STEM entrepreneurship as a longer term policy prospect, and one that requires multi-disciplinary approach to tackle.

# Conclusion

There is enormous growth potential that can be realized through policies and practices that engage women in the economy and in STEM entrepreneurship in particular, and both governments and the business community have a powerful incentive and opportunity to empower women. The under-representation of women in STEM fields — not only as students and researchers, but also as managers, leaders, and entrepreneurs — significantly hinders sustainable economic growth and prosperity throughout APEC.

Scientific and technological innovation has the potential to substantially boost productivity, competitiveness, and job creation for all economies and expanding women and girls' access to STEM education, careers, and entrepreneurship should be a priority. The effectiveness of policy to promote economic growth relies on the broad participation of both men and women in all aspects of the economy.

Promoting gender equality in STEM fields and encouraging women's participation in STEM entrepreneurship is not simply about fairness or gender balance; it is also about attracting the most talented resources to drive economic growth. Injecting ideas and creativity from individuals with diverse backgrounds can nurture and accelerate innovation and technological advancement in a way that excluding a large section of the population cannot. Additionally, expanding untapped labor means that the government benefits from an expanded taxpayer base as well as from increased contributors to their society protection systems. Change will come if governments and private sector leaders are able to build consensus to invest in all people, including women and girls.

Part of that process of building consensus will involve socializing some of the data and research which show the economic and business returns from investing in women as STEM entrepreneurs. Even in the United States, where the research exists, showing that firms with women founders or cofounders yield significant revenue and profits, women entrepreneurs receive on average $1 million less than male entrepreneurs when they pitch their ideas to investors for early-stage capital. Investors and financial institutions will need to be made more aware of new data that shows that women-owned enterprises are, in fact, profitable investments. Policymakers will need to be made aware of the prospect of new jobs and a wider tax base.

The hope is that APEC leaders will take this data and calls to action and remove the barriers that prevent female STEM entrepreneurs from matching the success of their male counterparts. Promotion of women STEM entrepreneurs is about promoting an economy's scientific and technological distinction in an increasingly competitive globalized world.

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# Appendix

## *KFS Survey Data Results*

### Table A1. KFS Survey Data Results, 2004–2011 (Selected Years)

| | 2004 | 2007 | 2011 | Change (over 7 years) |
|---|---|---|---|---|
| **Wholly female-owned high-tech firms** | | | | |
| Number | 431 | 158 | 105 | -76% |
| Revenue (in millions) | 49.4 | 26.6 | 44.0 | -11% |
| Employer firms | | | | |
| Employees (average no.) | 1 | 2 | 3 | |
| Revenue (average) | 65,261 | 116,185 | 367,990 | |
| Profit (average) | 44,591 | 30,219 | 21,638 | |
| Loss (average) | 7,274 | 1,184 | 8,488 | |
| **High-tech firms with at least one female owner** | | | | |
| Number | 860 | 647 | 472 | -45% |
| Revenue (in millions) | 139.0 | 284.0 | 248.0 | 78% |
| Employer firms | | | | |
| Employees (average no.) | 2 | 3 | 7 | |
| Revenue (average) | 109,151 | 376,897 | 419,116 | |
| Profit (average) | 32,199 | 126,044 | 87,845 | |
| Loss (average) | 8,726 | 11,722 | 8,543 | |
| **All high-tech firms** | | | | |
| Number | 4093 | 2869 | 2134 | -48% |
| Revenue (in millions) | 547.0 | 988.0 | 823.0 | 50% |
| Employer firms | | | | |
| Employees (average no.) | 2 | 3 | 5 | |
| Revenue (average) | 88,450 | 289,270 | 307,881 | |
| Profit (average) | 15,271 | 72,840 | 72,635 | |
| Loss (average) | 27,121 | 31,297 | 35,146 | |
| **All firms** | | | | |
| Number | 73278 | 50452 | 32681 | -55% |
| Revenue (in millions) | 8150.0 | 13600.0 | 10400.0 | 28% |
| Employer firms | | | | |
| Employees (average no.) | 2 | 2 | 4 | |
| Revenue (average) | 78,195 | 218,027 | 257,334 | |
| Profit (average) | 11,982 | 52,326 | 63,645 | |
| Loss (average) | 15,148 | 17,858 | 13,861 | |

Source: US-ATAARI calculations based on Kauffman Firm Survey Data (2004-2011)

## *Linear Regression Results*

Using cross-sectional yearly KFS data from 2004 through 2011, the US-ATAARI team ran linear regression models to understand the impact of encouraging more female owners in STEM entrepreneurship. Team members looked at what the KFS data says about the effect of having at least one female owner on the following independent variables in high-tech firms: the number of employees and the level of revenue and profit. The following regression models were applied:

$$Emp_{i,t} = \beta_0 + \beta_1 OneFemOwn_{i,t} + \varepsilon_{i.t} \quad (1)$$

$$Rev_{i,t} = \beta_0 + \beta_1 OneFemOwn_{i,t} + \varepsilon_{i.t} \quad (2)$$

$$Prof_{i,t} = \beta_0 + \beta_1 OneFemOwn_{i,t} + \varepsilon_{i.t} \quad (3)$$

Where, $OneFemOwn_{i,t}$ is a dummy variable for firm i at time t which takes the value 1 if at least one of the owners is a female and 0 otherwise; $Emp_{i,t}$ is the number of employees for firm i at time t; $Rev_{i,t}$ is firm i's level of revenue at time t; $Prof_{i,t}$ and is the amount of profit for firm i at time t.

The results of the regressions are presented in Table A2 below.

### Table A2. Linear Regression Results

| | (1) | | (2) | | (3) | |
|---|---|---|---|---|---|---|
| *Variables* | *Employees (no.)* | | *Revenue* | | *Profit* | |
| At least one female owner | 0.80 | ** | 60,256.77 | *** | 4,6471.3 | *** |
| | (.3199) | | (14,970.27) | | (13,683.67) | |
| Constant | 3.16 | *** | 295,433.4 | *** | 118,272 | *** |
| | (0.1144) | | (7,036.17) | | (5,846.96) | |
| Observations | 3,082 | | 3,095 | | 1,823 | |
| *R*-squared | 0.0030 | | 0.0055 | | 0.0077 | |
| Prob > *F* | 0.0120 | | 0.0001 | | 0.0007 | |

Source: US-ATAARI calculations based on Kauffman Firm Survey Data (2004-2011)

Significance level: * * * p < 0.01, * * p < 0.05, * p <0.1. Standard errors in parenthesis.

## *Firm Fixed-Effect Regression Results*

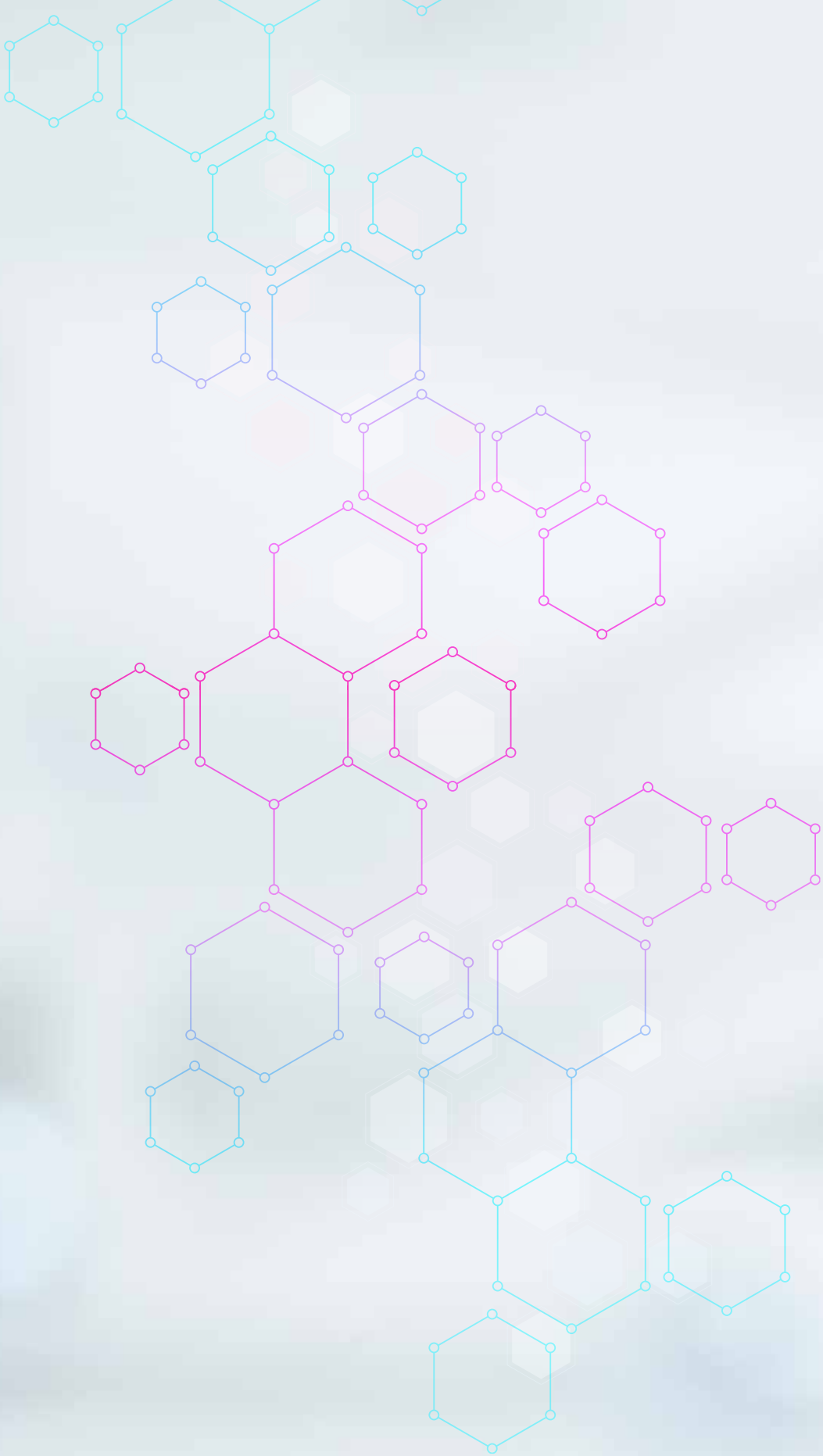
### Table A3. Firm-Fixed Effect Regression Results

| | (4) | | (5) | | (6) | |
|---|---|---|---|---|---|---|
| *Variables* | *Employees (no.)* | | *Revenue* | | *Profit* | |
| At least one female owner | 1.70 | * | 131041 | *** | 3413.63 | |
| | (.8716) | | (38998.52) | | (28729.51) | |
| Constant | 2.94 | *** | 278623.5 | *** | 129019 | *** |
| | (.2053) | | (9261.361) | | (7170.557) | |
| Observations | 3082 | | 3095 | | 1823 | |
| *R*-squared (overall) | 0.0030 | | 0.0055 | | 0.0077 | |
| Prob > *F* | 0.0513 | | 0.0008 | | 0.9055 | |

Source: US-ATAARI calculations based on Kauffman Firm Survey Data (2004-2011)

Significance level: * * * p < 0.01, * * p < 0.05, * p < 0.1. Standard errors in parenthesis.

Note: The variable *OneFemOwn* has a positive relationship with all three independent variables, employees, revenues and profit, and all coefficients are statistically significant at least the 90-percent confidence level. Compared to wholly male-owned firms, firms with at least one female owner earn, on average, US$60,257 more in annual revenue and $46,471 more in annual profit. Even if the regression controls for these observed variables from the dataset, there may be unobserved variables that may introduce endogeneity. To correct for these, the US-ATAARI team ran firm-fixed effects regression models that look at variations over time within a firm and controls for time-invariant owner and firm characteristics. The results of the firm fixed-effect regressions models are presented in Table A3 above.



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