



Innovation Council Summary

**Closing Innovation and Intellectual Property
Diversity Gaps:
A Global Literature Review**

WIPO Economic Working Paper Series no. 86

Authors

Elodie Carpentier, Jennifer Brant, Utsav Bahl, Aikaterini Kanellia

This academic paper explores the underrepresentation of women and people from other historically underrepresented groups in patenting and innovation. It highlights the economic and societal benefits of closing these gaps through an extensive review of existing research on the topic. The authors share insights for fostering more inclusive and equitable innovation ecosystems, making recommendations for a wide range of stakeholders.

1.	Introduction	3
2.	Patent diversity gaps	5
2.1.	Data collection	5
2.2.	What do we know about the gender patent gap?.....	8
2.2.1.	The extent of the gender gap in patenting.....	9
2.2.2.	Exposure to innovation.....	10
2.2.3.	Access to STEM, invention and patent education	11
2.2.4.	Family and career decisions.....	12
2.2.5.	Differential access to capital	13
2.2.6.	Cultural and institutional factors	13
2.3.	Additional patent diversity gaps.....	14
2.3.1.	Race	15
2.3.2.	Income.....	16
3.	Initiatives promoting greater engagement by women in innovation ecosystems	17
3.1.	Boosting women’s access to STEM education.....	17
3.2.	Empowering Women Entrepreneurs.....	18
3.3.	Financial support for women entrepreneurs, innovators and scientists	20
3.4.	Data collection, sharing and analysis	21
4.	Conclusions	22

1. Introduction

Innovation is a key driver of economic growth and competitiveness. Patents, a form of intellectual property, play a vital role in protecting inventions and fostering the innovation we need to fuel economic growth and solve pressing societal challenges. Patents benefit both individuals and businesses where inventors can use patents to commercialize their ideas, attract funding, and collaborate with partners while getting the appropriate credit for their inventions. For businesses, particularly startups, patents can help secure financing, enhance their market reputation, and stimulate growth.

Countries and regions with strong patent systems often report higher levels of economic activity and job creation. In the European Union, industries with effective patent protection are responsible for more than 75 per cent of intra-EU trade and companies with a high number of patents generate almost 40 per cent of jobs in the EU Member States, pay higher salaries and account for nearly 50 per cent of total economic activity (GDP).¹

Patents benefit both individuals and businesses. Inventors use patents to commercialize their ideas, attract funding, and collaborate with partners. For businesses, particularly startups, patents can help secure financing, enhance their market reputation, and stimulate growth.

There is growing concern about disparities in patent ownership among different demographic groups. Women, people of color, and individuals from lower-income backgrounds are often underrepresented in the patenting process. This inequality is slowing down the pace of innovation. It diminishes opportunities for individual inventors and also deprives society of their ideas and talents.

To address this issue, it's crucial to understand the underlying causes of these disparities. By collecting reliable data and collaborating with various stakeholders, we can develop effective strategies to promote a more inclusive and equitable innovation ecosystem.

¹ EPO and EUIPO, 2022.

This paper delves into the growing concern about disparities in access to intellectual property rights, particularly patents, among women and other demographic groups. Key research questions were:

1. What are the key financial, institutional, cultural, and familial barriers that women and underrepresented groups face in the patenting process?
2. What existing global policies and programs effectively promote the participation of women in innovation and patenting?

Building on previous research by Shapanka and Fechner (2018) and Fechner et al. (2022) that highlight significant differences in patenting rates between women, people of color, and lower-income individuals in the United States (US), the authors broaden the scope of analysis to 1. examine patent diversity gaps globally; 2. strengthen the analysis by leveraging a wider range of peer-reviewed academic research; and 3. Provide recommendations for stakeholders – companies, educational institutions, governments, and other organizations worldwide – to increase participation from these historically underrepresented groups in innovation and patenting.

This paper contributes to the discussion by reviewing the existing innovation literature about the different gaps and documenting policies attempting to address them.

2. Patent diversity gaps

Historically, women and individuals from marginalized groups have been underrepresented among inventors and patent holders. While much of the research on patent diversity has focused on gender disparities, it's important to acknowledge that other factors, such as race, ethnicity, and socioeconomic status, also play a significant role.

To better understand the extent and causes of these disparities, it is crucial to have accurate data. Here, the authors cover the importance of data collection, review research on the gender gap in patenting, and explore the limited information available on other diversity gaps.

In recent years, several intellectual property offices, including the United States Patent and Trademark Office (USPTO), United Kingdom Intellectual Property Office (UKIPO), Canadian Intellectual Property Office, World Intellectual Property Office (WIPO), Australian Patent Office, European Patent Office, and European Union Intellectual Property Office have taken steps to assess and, in some cases, quantify these disparities. For instance, in addition to published reports on the global gender gap in patenting, WIPO has developed tools to analyze gender trends in patent data.²

These studies have consistently shown a significant gender gap in patenting across various jurisdictions. There is less insight into the other gaps for reasons that will be discussed below. These gaps are not only a matter of fairness; they also have economic implications because they limit the potential for innovation and economic growth.

2.1. Data collection

Collecting data is foundational for good policymaking. To accurately measure and address diversity gaps in patenting, reliable data is essential. While patent application forms did not typically collect demographic information, this is

² Martinez et al., 2021, 2016; Raffo, 2021; United Kingdom Intellectual Property Office, 2016; Canadian Intellectual Property Office, 2017; Miguelez et al., 2019; Saksena et al., 2022; Toole et al., 2020; European Patent Office, 2022; European Union Intellectual Property Office, 2023; Huang et al., 2022.

changing. Also, researchers are employing three fundamental approaches to measure the gender gap in innovation and intellectual property ownership.

Data collection methods:

- **Surveys:** Researchers can gather data through the traditional method of surveys, which involves asking respondents about their gender, race, ethnicity, and other relevant demographics.³ However, surveys can be resource-intensive and limited in scope, and they may not capture the full picture due to bias embedded in the design.
- **Employee and civil servant data:** By analyzing demographic data from organizations and government agencies, researchers can link individuals to their patent filings.⁴ This method can provide more comprehensive data, but it is often constrained by data privacy regulations and access limitations in certain geographies.
- **Predictive algorithms:** Researchers have used algorithms to infer the most likely gender of individuals based on their first names and locations, relying on tools like WIPO's World Gender Name Dictionary.⁵ Algorithms can be used to infer the gender of inventors based on their names. While this approach can be useful for large-scale analysis, it has limitations and may not accurately capture data for geographies at a global scale beyond WIPO's data nor cover all demographic groups.
- While none of the strategies described above are considered a definitive best practice, they offer options to better understand the patent diversity gaps landscape.

The encouraging news is that more and more data is becoming available so we can better understand diversity gaps in intellectual property, particularly in the realm of patents. This progress is driven by two main factors:

³ In the United States, the SUCCESS Act endorsed this approach.

⁴ This approach was adopted by Bell et al. (2019) and Carayol and Carpentier (2022), among others.

⁵ Martinez et al., 2021, 2016; Raffo, 2021.

- Improved access to government data: Researchers are gaining better access to government data, allowing for more in-depth analysis of patent trends.⁶
- Direct data collection on patent applications: Some countries, including Argentina, Chile, Colombia, Cuba, Israel, Peru, and the Dominican Republic, have started collecting demographic information directly from patent applicants. This can provide more accurate and detailed data on diversity gaps.

Additionally, international organizations like WIPO are taking steps to improve data collection and analysis. After WIPO published its latest gender patent gap report in 2023, the WIPO Committee on Standards XML4IP Task Force proposed the inclusion of a gender category in WIPO Standard ST.96. This is a significant development that could facilitate global comparisons of patent diversity.⁷

However, data privacy regulations can pose challenges to data collection efforts. Striking a balance between privacy and research needs is crucial to ensure that we can effectively address these disparities. In the United States, lawmakers have proposed legislation, such as the Inventor Diversity for Economic Advancement (IDEA) Act, to encourage the USPTO to collect demographic data from patent applicants.⁸ While this would provide valuable data for future analysis, it would not allow for historical comparisons.

Overall, the increasing availability of data and ongoing efforts to improve data collection methods offer hope for a better understanding of diversity gaps in patenting. By leveraging these advancements, researchers and policymakers can work together to create a more inclusive and equitable innovation ecosystem.

⁶ Fechner et al., 2022.

⁷ WIPO Standard ST.96 is a set of XML schemas to capture industrial property and copyright orphan work data. The latest version is published on the WIPO website at: <https://www.wipo.int/standards/en/st96/v8-0/>

⁸ United States Congress, 2021.

Data Privacy: A Double-Edged Sword for Gender IP Gap Research

While Regulations governing access to personal data are undeniably crucial for protecting citizens' privacy and rights, they can also slow down research progress. This is because they often restrict access to data that could be used to identify the underlying causes of these disparities. One major challenge is the uncertainty surrounding data availability for research purposes. These regulations often provide grounds for denying requests to access data from governments and other organizations. This can make researchers hesitant to pursue this approach, hindering their ability to analyze trends and develop effective solutions.

GDPR: A Case Study

For instance, the European Union's General Data Protection Regulation (GDPR) sets strict guidelines for collecting and processing personal information. It requires organizations to have clear and legitimate reasons for collecting data and dictates how organizations store personal information, affecting entities worldwide that target or collect data from EU citizens.

Potential penalties for violating GDPR can be significant, including fines of up to €20 million or 4 per cent of a company's global turnover. These hefty consequences may make organizations and institutions less likely to share employee and civil servant data with researchers, fearing data breaches and hefty fines with the risk of data breaches or their unauthorized use.

Data privacy regulations play an essential role in safeguarding individual rights. They can also create hurdles for research on patent diversity gaps. Finding the right balance between data protection and research needs is key to achieving a more inclusive and equitable innovation ecosystem.

2.2. What do we know about the gender patent gap?

Research increasingly provides insights into women's participation in patenting and the reasons behind their underrepresentation. Barriers to equal participation in

patenting include women's lower exposure to innovation; more limited access to innovation-related education, family and career decisions; relatively limited access to capital; and certain cultural and institutional factors.

2.2.1. The extent of the gender gap in patenting

Data confirms that women remain significantly underrepresented among patent holders and a significant effort would be required to reach gender parity.

Research highlights:

- All studies that quantify women's patenting activities at the national and international levels show that women's participation is lower than that of men but rising over time.⁹

Despite a gradual increase in women's participation in patenting over time, it's currently estimated that we will only reach parity in 2061 based on current trends.¹⁰

- In 2020, only 16 per cent of international patent applications were filed by women through the Patent Cooperation Treaty (PCT).

While more women filed patents in regions like Latin America, the Caribbean, and Asia, there's still a significant gap to bridge.

- In alignment with the proportion of women represented in the specific fields, industries such as biotechnology and pharmaceuticals tend to have higher female inventor rates, while electrical and mechanical engineering have lower rates.¹¹
- Women inventor rates are higher in the academic sector compared to corporate and public sectors.¹²

⁹ Ding et al., 2006; Jung and Ejermo, 2014; Martinez et al., 2016; Miguelez et al., 2019; United Kingdom Intellectual Property Office, 2019; Frietsch et al., 2009.

¹⁰ WIPO 2023,

¹¹ Huyer, 2015; World Intellectual Property Organization, 2023.

¹² Sugimoto et al., 2015; World Intellectual Property Organization, 2023.

Exposure to innovation

Exposure to role models and mentors is crucial for aspiring inventors. Studies have shown that children who are exposed to inventors are more likely to pursue innovation themselves. However, women often have less access to such role models and mentors, which can influence whether they view themselves as inventors and limit their opportunities.

Research highlights:

- Children exposed to inventors are nine times more likely to become inventors themselves. Researchers estimate that if girls were exposed to female inventors at the rate that boys are exposed to male inventors, the gender gap in patenting could shrink by half.
- Parents play a role. Researchers found that when inventor parents have a second-born son instead of a daughter, they are less likely to encourage their first-born daughter to become an inventor herself.
- Mentoring is crucial, particularly for women in STEM fields. PhD students whose supervisor is a prolific inventor are more likely to become inventors, but female students are less often supervised by prolific inventors and remain underrepresented among inventors.
- In addition, researchers report that the gender of supervisors doesn't play a role in the transmission of inventorship.
- Social interactions play an important role in invention. Gender differences in social interactions, such as networking patterns and geographic constraints, can disadvantage women in terms of accessing information, collaborating with peers, and identifying potential opportunities.

2.2.2. Access to STEM, invention and patent education

Certain skills and knowledge have become essential for invention. These include training in the relevant disciplines, as well as understanding of the process of invention itself and the complex administrative procedures involved in obtaining a patent. While women are increasingly pursuing STEM degrees in advanced economies, they often face challenges in advancing to higher levels of education and research positions.

Research highlights:

- Women earn fewer PhD degrees and obtain even fewer tenured research positions than men. This "leaky pipeline" (Huyer, 2015) phenomenon contributes to underrepresentation in innovation fields.
- Many women lack formal education and training on the patenting process. This includes understanding patentability criteria, navigating complex procedures, and responding to USPTO patent office rejections.¹³
- Some research suggests that women may be less likely to identify themselves as inventors, even if they possess the necessary skills and creativity. This could be due to societal stereotypes and a lack of female role models in the field.¹⁴
- Academic institutions can play a crucial role in supporting women inventors. Technology transfer offices can provide valuable resources and guidance, helping women navigate the patenting process and commercialize their inventions.¹⁵ Research shows that providing women with additional assistance during this process increases their chances of obtaining a patent by 11 percentage points relative to the grant rate for male inventors who also received assistance.

¹³ Shaw and Mariano, 2021.

¹⁴ Perry, 2011.

¹⁵ Giuri et al., 2020.; Aneja et al., 2024; Pairolero et al. 2022.

- Studies have shown that patent applications filed by women are less likely to be granted, even when controlling for factors like novelty and inventive steps. This may be due to implicit biases in the patent examination process or a lack of understanding of the challenges faced by women inventors.¹⁶

Knowledge of the patenting process, self-perception and identity, and institutional support and bias in the patenting process remain crucial factors for enabling inclusivity.

2.2.3. Family and career decisions

Women often face significant challenges balancing family and career responsibilities, which can impact their ability to pursue innovation and patenting. Societal expectations and gender roles continue to influence these disparities. Until gender equality becomes a reality in all spheres of society, we should expect that the trade-offs that women must make as they pursue their careers will prevent them from contributing equally to invention and patenting. Further research is needed to explore the role of factors like childcare availability, work-life balance policies, and gender-sensitive workplace cultures in shaping women's participation in innovation.

Research highlights:

- Studies have shown that mothers, particularly those in academia, are less likely to engage in patenting activities compared to childless women or mothers in industry.
- Women are often expected to prioritize family responsibilities, leading to reduced time and energy for career pursuits. In dual-earner households, long working hours tend to drive women out of work but do not affect men's workforce participation.
- The structure of organizations can exacerbate these challenges. Women in hierarchical organizations such as those found in the private sector may face greater obstacles to innovation compared to those in more flatter and more

¹⁶ Jensen et al., 2018; Madan et al., 2021.

flexible work environments generally found in the biotechnology or life sciences industries.

2.2.4. Differential access to capital

Women entrepreneurs face significant challenges in securing funding, particularly venture capital. This gender gap in funding limits their ability to invest in research, development, and patent protection.

Research Highlights:

- Patents can be a powerful tool for attracting investment, but the initial costs of obtaining patent protection can be prohibitive, especially for women entrepreneurs who often have limited access to capital. This creates a vicious cycle where women struggle to secure funding due to a lack of patents, and the lack of funding hinders their ability to obtain patents.¹⁷
- Women founders in the United States receive less than 3 per cent of all venture capital funding.¹⁸
- In Europe, all-women-founded startups raised on average just 1.8 per cent of investment in 2021; the percentage ranged from 0 to 14 per cent depending on the country.¹⁹

The authors are not aware of statistics for other regions of the world.

2.2.5. Cultural and institutional factors

Cultural and institutional factors can significantly impact women's participation in innovation and patenting. Even today, subtle biases and stereotypes can hinder their progress.

¹⁷ Milli et al., 2016.

¹⁸ Hinchliffe, 2021.

¹⁹ European Women in VC, 2022.

Research highlights:

- Removing historical formal barriers enabled women to take ownership of their inventions and patent rights.²⁰
- Research indicates that the spoken language of a country, and in particular its grammatical gender marking, affects that country's patenting rates.²¹
- Inventions are only assessed relative to the masculine, publicly known body of knowledge about science and invention, because certain feminine knowledge is maintained in the private sphere, often in oral form. As a result, the definition and interpretation of "non-obviousness," a key criterion for patentability, can be influenced by gender bias. This can lead to disproportionately lower success rates for women inventors.²²
- The complex and often costly process of obtaining patent protection can be a barrier for women, particularly those from marginalized groups who may have fewer resources and are the target of (negative) prejudice.²³

2.3. Additional patent diversity gaps

While the gender gap in patenting has been extensively studied, it's important to recognize that diversity in innovation encompasses a broader range of factors. Race, ethnicity, socioeconomic status, disability, and indigenous identity are among the dimensions that can influence access to the patent system.

Policymakers and researchers are increasingly focusing on these other diversity gaps. In the United States, for example, there is growing attention to ensuring access to patents for individuals with disabilities and veterans.²⁴ In other countries, including Australia and India, the relationship between indigenous knowledge and the patent system is a significant concern.²⁵

²⁰ Khan, 1996.

²¹ Berman et al., 2022.

²² Burk, 2011; Lai, 2020, 2021; Yanisky-Ravid, 2011.

²³ Marcowitz-Bitton and Morris, 2020.

²⁴ Fechner et al., 2022; Shapanka and Fechner, 2018.

²⁵ Graham and McJohn, 2005; Gupta, 2006.

As data collection and analysis techniques improve, researchers are gaining a better understanding of the experiences of inventors from diverse backgrounds.²⁶ This knowledge is essential for developing effective policies and interventions to promote a more inclusive and equitable innovation ecosystem.

2.3.1. Race

While research into the race patent gap remains limited to the United States, research into the ethnic origins of inventors has been carried out in other countries.

Research highlights:

- Pioneering research on the race gap in patenting has documented that in the 1980s African Americans appeared as inventors on 4.5 patents per million African-American people, compared to 278 patents per million people for the non-African-American population.²⁷
- More recent studies confirm that racial and ethnic minorities in the United States, including African Americans, American Indians, Alaska Natives, and Hispanics, continue to be underrepresented in patenting in relation to their corresponding share of the United States population – unlike Asian inventors. In the 2010s, African American people accounted for 1.2 per cent of inventors (population ratio of 0.1) while Asians have an inventor share 2.6 to 4.6 times higher.²⁸
- Since the 1990s, we have seen the rising contribution of foreign-born inventors living in the United States, in particular Chinese and Indian scientists.²⁹
- In the United Kingdom, a study shows that inventors from ethnic minorities are geographically concentrated, identifying a positive correlation between

²⁶ Aghion et al., 2017; Bell et al., 2019; Cook, 2014; Cook and Kongcharoen, 2010; Niggli, 2023.

²⁷ Cook and Kongcharoen, 2010); Cook (2014).

²⁸ Akcigit and Goldschlag, 2023.

²⁹ Kerr, 2008.

inventors' ethnic diversity and patenting rates.³⁰

- A global study of the ethnicity of inventors named on patents, worldwide, reveals that inventors' ethnic composition has become more diverse over time, mostly due to a relative increase in inventors of Asian origin.³¹
- Research indicates that ethnic diversity can positively impact patenting rates, particularly in highly innovative countries. The evidence is less clear for lower-ranked countries in international innovation rankings such as Italy or Croatia.³²
- While the impact of ethnic diversity on patenting at the organizational level is less definitive, it is generally recognized that diversity can contribute to innovation and problem-solving. This includes a study demonstrating the positive correlation of invention with the participation of foreigners in patenting, increasing the social and economic value of innovations in three Eastern European countries.³³

2.3.2. Income

Research on the income gap has examined in particular how parental income relates to the chances that individuals will become inventors. Parental income and education levels are factors influencing the rate of patents.

Research highlights:

- In the United States, children born to families in the top 1 per cent of the income distribution are 10 times more likely to become inventors than those from below-median-income families.³⁴
- In Finland, where income inequality is less pronounced and education is free, researchers found a similar correlation between parental income and

³⁰ Nathan, 2015.

³¹ Niggli, 2023.

³² Bahar et al., 2020; Hunt and Gauthier-Loiselle, 2010; Kerr, 2010; Nathan, 2015; Bratti and Conti, 2018; Stojčić et al., 2016.

³³ Wachowska and Homa, 2020.

³⁴ Bell et al., 2019.

individuals' chances of becoming inventors. However, controlling for parental education and individuals' IQ greatly diminishes the extent of this effect.³⁵

3. Initiatives promoting greater engagement by women in innovation ecosystems

3.1. Boosting women's access to STEM education

Initiatives and legal frameworks have been put in place to create a more diverse community of inventors and to ensure equal access for people from historically underrepresented groups to quality education, particularly in STEM fields.

The appendices to the full paper provide an extensive list of programs being conducted around the world that address factors that contribute to the underrepresentation of women and minority groups in innovation. Here are the broad challenges that they tackle.

Access to Education

Ensuring equal access to quality STEM education is crucial for creating a diverse pipeline of future innovators. Initiatives at the school age, tertiary and graduate levels have sprung up to address this concern. An example is Qualcomm's Thinkabit Lab, which provides free, daylong STEM programs for primary and secondary school students, to expose children to careers in science and engineering in the United States and provide young women, in particular, with the skills and confidence to pursue careers in technology.

Mentorship and Role Models

Mentorship programs can provide invaluable guidance and support to aspiring inventors, particularly those from marginalized groups. In Brazil, the Digital Girls Program, managed by the Brazilian Computer Society, incentivizes girls in high school and in the final years of elementary school to pursue careers in computer science and STEM fields by connecting them with field experts and practitioners through workshops and lectures.

³⁵ Aghion et al., 2017.

Financial Barriers

Access to funding is a significant challenge for many women and minority entrepreneurs. The Australian government runs two flagship programs that address gender inequalities in STEM fields. Through the Women in STEM Ambassador initiative, business leaders, educators and policymakers work together to mobilize resources and create tools that help women and girls to undertake STEM-related research and career development projects. Initiatives that foster the participation of women and girls in STEM-related fields, and that enable more inclusive access to intellectual property systems, are by no means limited to high-income countries. In Rwanda, for instance, private sector associations such as the Rwandan Association for Women in Science and Engineering, provide workshops for girls to hone their research and learning skills so they can thrive in STEM educational subjects.

Cultural and Institutional Barriers

Societal biases and institutional barriers can hinder the progress of women and minority inventors. The Inventor's Patent Academy (TIPA) is a notable initiative, launched in the United States and available worldwide, that democratizes knowledge about patenting and intellectual property. Offered as a free online course, TIPA is designed to help inventors understand intellectual property and the United States patenting process. The program also explores certain challenges that inventors from historically underrepresented groups – such as women, people of color, individuals with lower incomes, and people with disabilities – may face during their invention and patenting journey, and it provides ideas and tools to overcome them.

3.2. Empowering Women Entrepreneurs

Over 30 per cent of micro-, small-, and medium-sized enterprises (MSMEs) are owned by women, underscoring the importance of gender parity in enabling societies to benefit from the full contribution of these companies³⁶. This means that programs targeted at improving IP rights for MSMEs can be effective in addressing gender equity. While there are many talented women and underrepresented group inventors, systemic barriers, including limited access to networks, societal

³⁶ Muckerheide, Mark. 2023.

expectations and biases and academia and industry can create challenges for underrepresented inventors.

To address these challenges and empower women entrepreneurs, various strategies are being explored:

- **Guidance for companies to implement strategies such as modifying the invention disclosure process to reduce bias** or making it easier for all inventors to navigate the internal intellectual property creation and management processes.
- **Specialized training and mentorship programs** like WIPO's "Training, Mentoring and Matchmaking Program on Intellectual Property for Women Entrepreneurs from Indigenous Peoples and Local Communities" that targets a very specific subset of underrepresented inventors for capacity building and awareness raising about intellectual property rights.
- **Setting up broad gender equality initiatives within governmental bodies** and institutions that foster inclusivity and diversity in various fields, including science and innovation. For instance, Spain established the Women, Science, and Innovation Observatory group, an interministerial body dedicated to promoting gender equality within the realm of science.
- **Leadership of national intellectual property offices enacting positive reforms** to ensure that the requirements for becoming a patent practitioner are inclusive and do not inadvertently exclude qualified candidates from diverse backgrounds.³⁷
- **Efforts by national intellectual property offices to ensure their staff are sufficiently diverse.** For example, India has launched an initiative to re-train unemployed female engineers to become patent examiners, leveraging their already advanced technical skills.
- **Dedicated programs and centers can further bolster women's entrepreneurship** like the Technology Innovation and Entrepreneurship

³⁷ United States Patent and Trademark Office, Department of Commerce, 2021.

Center (TIEC) under the Information Technology Industry Development Agency (ITIDA) in Egypt that supports early-stage women entrepreneurs operating in the ICT sector.

3.3. Financial support for women entrepreneurs, innovators and scientists

While addressing the funding gap for women entrepreneurs remains a global challenge, initiatives such as fee reductions for patent applications, targeted loans, and other specialized funding programs show promise in facilitating access to capital and intellectual property rights for women-led ventures. Fostering collaboration between governments, financial institutions and non-profit organizations can be expected to contribute to a more supportive ecosystem for women in entrepreneurship.

To level the playing field for women entrepreneurs, various initiatives have emerged. These include:

Financial Support: Programs like the Cyprus Women's Cooperative Bank offer loans, mentorship, and networking opportunities to women entrepreneurs to address women's unequal access to venture capital for patenting.

Government Initiatives: Governments worldwide are investing in programs to support women entrepreneurs who may not have knowledge of the patenting process or the resources to pursue STEM PhDs. For instance, the US Department of Energy's Phase 0 Assistance Program provides funding and support to women inventors.

Incentivizing Innovation: Fee reductions for intellectual property rights, such as those offered by India and the Philippines, can encourage women to protect their innovations even when they have fewer financial resources to do so.

International Collaborations: Organizations like the European Bank for Reconstruction and Development provide financial and technical assistance to women-led businesses to narrow the knowledge gap for women seeking patents.

Mentorship and Networking: Programs that connect women entrepreneurs with mentors and peers can provide invaluable support and guidance. This addresses

women's lower exposure to innovation ecosystems leading them to fall behind on knowledge of the patenting process.

These initiatives aim to empower women entrepreneurs and drive economic growth by addressing financial barriers, providing mentorship, and creating supportive ecosystems. However, social and cultural expectations for women persist as barriers to female inventors. An extensive list of programs worldwide is listed in the appendix to this paper.

3.4. Data collection, sharing and analysis

By improving data collection and analysis, we can gain a deeper understanding of the factors that contribute to diversity gaps and develop more effective strategies to address them.

Key steps to improve data collection and analysis:

- Implementing consistent data collection practices across different countries and organizations can facilitate comparisons and analysis.
- Utilizing advanced data analysis techniques, such as machine learning and AI, can help extract valuable insights from large datasets.
- Fostering collaboration between researchers, policymakers, and industry stakeholders can facilitate data sharing and knowledge exchange.

Some key initiatives to move the mission to access more accurate data include:

The US IDEA Act: This legislation would mandate the USPTO to collect and analyze data on patents held by underrepresented groups, following the 2018 SUCCESS Act.

The European Patent Office's Gender Gap Study: In 2022, the EPO published "Women's participation in inventive activity" which provides valuable insights into the gender disparity in European patenting.

WIPO's initiatives, such as the World Gender Name Dictionary, facilitate data collection and analysis on a global scale supplemented by built-in commands in STATA and Python, assisting researchers in assessing the likely gender of inventors. WIPO continues to work with IP offices and governments to expand the linguistic coverage of the dictionary.

4. Conclusions

Women's equal participation in intellectual property systems is not merely a matter of representation. It has the potential to catalyze a broader, dynamic cultural shift within the most innovative sectors and fields of technology. We can unlock women's full potential in innovation. By increasing the visibility of successful women inventors, we can inspire future generations of innovators. When young women see role models who have achieved great things in STEM fields, they are more likely to pursue their own innovation ambitions.

Improving equity in intellectual property access amongst women and people from other historically underrepresented groups can drive economic growth and encourage better approaches to public policy challenges and societal progress.

Fortunately, closing the gender intellectual property gap has emerged as a shared concern for the global intellectual property community. This paper focuses on patents, but access to all types of intellectual property rights is valuable. Efforts to address the gender gap are expected to deliver substantial benefits at the individual, organizational and national economic levels – but there is a long way to go before we can achieve these outcomes. Moreover, we must acknowledge that marginalized groups apart from gender, such as race and low-income groups face barriers in accessing intellectual property rights. Further steps need to be taken to improve access to intellectual property systems for people from all underrepresented groups.

To make the goals a reality, further research on the extent and reasons behind patent diversity gaps beyond gender is needed. Also, existing literature largely focuses on the United States; future research into the gender and other intellectual property diversity gaps should consider other countries as well. Innovative collaborations and concerted action by policymakers, companies, industry groups,

academics and nongovernmental organizations will enable the intellectual property community to achieve true progress.

Works Cited

For the complete list of works consulted in this literature review refer to the original paper.

Aghion, Philippe, Ufuk Akcigit, Otto Toivanen, and Ari Hyytinen. 2017. "The Social Origins of Inventors." Technical report. National Bureau of Economic Research.

Akcigit, Ufuk, and Nathan Goldschlag. 2023. Measuring the Characteristics and Employment Dynamics of US Inventors. Technical report. National Bureau of Economic Research.

Aneja, Arun, Ofir Reshef, and Girish Subramani. "Attrition and the Gender Patenting Gap." *Review of Economics and Statistics* (2024): 1–31.

Bahar, Dany, Prithwiraj Choudhury, and Hillel Rapoport. "Migrant Inventors and the Technological Advantage of Nations." *Research Policy* 49, no. 9 (2020): 103947.

Bell, Alex, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenen. "Who Becomes an Inventor in America? The Importance of Exposure to Innovation." *The Quarterly Journal of Economics* 134, no. 2 (2019): 647–713.

Berman, Amalya, Ram Mudambi, and Amit Shoham. "Linguistic Structures and Innovation: A Behavioral Approach." *Journal of International Management* 28, no. 4 (2022): 100943.

Bratti, Massimiliano, and Chiara Conti. "The Effect of Immigration on Innovation in Italy." *Regional Studies* 52, no. 7 (2018): 934–47.

Burk, Dan L. "Do Patents Have Gender?" *American University Journal of Gender, Social Policy, and Law* 19 (2011): 881.

Canadian Intellectual Property Office. 2017. Women's Participation in Patenting: An Analysis of PCT Applications Originating in Canada. Technical report. CIPO.

Carayol, Nicolas, and Emilie Carpentier. "The Spread of Academic Invention: A Nationwide Case Study on French Data (1995–2012)." *The Journal of Technology Transfer* 47, no. 5 (2022): 1395–1421.

Cook, Lisa D. "Violence and Economic Activity: Evidence from African American Patents, 1870–1940." *Journal of Economic Growth* 19, no. 3 (2014): 221–57.

Cook, Lisa D., and Chaleampong Kongcharoen. 2010. "The Idea Gap in Pink and Black." Technical Report. National Bureau of Economic Research.

Ding, Waverly W., Fiona Murray, and Toby E. Stuart. "Gender Differences in Patenting in the Academic Life Sciences." *Science* 313, no. 5787 (2006): 665–67.

EPO and EUIPO. "IPR-Intensive Industries and Economic Performance in the European Union: Industry-Level Analysis Report." 2022.

European Patent Office. 2022. "Women's Participation in Inventive Activity: Evidence from EPO Data." Technical Report, EPO.

European Union Intellectual Property Office. 2023. Women in Design. Technical report. EUIPO.

European Women in VC. "Analyzing the Role and Importance of Women as Cheque Writers and Start-Up Founders." Technical report, 2022.

<https://www.europeanwomenvc.org/files/ugd/de30d652430eabd0fc4714872ca67265f83b6b.pdf> (accessed August 3, 2023).

Fechner, Helena, Mary Schreurs, and Eva Chung. "Increasing Inventor Diversity: US Public Policy Recommendations." *Technology & Innovation* 22, no. 3 (2022): 407–22.

Frietsch, Rainer, Isa Haller, Margret Funken-Vrohling, and Hariolf Grupp. "Gender-Specific Patterns in Patenting and Publishing." *Research Policy* 38, no. 4 (2009): 590–99.

Giuri, Paola, Rosa Grimaldi, Anastasia Kochenkova, Federica Munari, and Lara Toschi. "The Effects of University-Level Policies on Women's Participation in Academic Patenting in Italy." *The Journal of Technology Transfer* 45, no. 1 (2020): 122–50.

Graham, Laura, and Steven McJohn. "Indigenous Peoples and Intellectual Property." *Washington University Journal of Law and Policy* 19 (2005): 313.

Gupta, Anil K. 2006. "From Sink to Source: The Honey Bee Network Documents Indigenous Knowledge and Innovations in India." *Innovations: Technology, Governance, Globalization* 1, no. 3: 49–66.

Hinchliffe, Emma. 2021. "Female Founders' Share of Venture Capital Funding Shrank to 2.2% in 2020." *Fortune*. February 8, 2021. <https://fortune.com/2021/02/08/female-founders-venture-capital-funding-2020/>.

Huang, Vivian, Scott Finch, and Claire Patrick. "Patents and Gender: A Big Data Analysis of 15 Years of Australian Patent Applications." *University of New South Wales Law Journal*, 2022.

Hunt, Jennifer, and Marjolaine Gauthier-Loiselle. "How Much Does Immigration Boost Innovation?" *American Economic Journal: Macroeconomics* 2, no. 2 (2010): 31–56.

Huyer, Sophia. 2015. "Is the Gender Gap Narrowing in Science and Engineering?" In *UNESCO Science Report: Towards 2030*, 85–103.

Jensen, Kyle, Balazs Kovacs, and Olav Sorenson. "Gender Differences in Obtaining and Maintaining Patent Rights." *Nature Biotechnology* 36, no. 4 (2018): 307–10.

Jung, Taehyun, and Olof Ejeremo. "Demographic Patterns and Trends in Patenting: Gender, Age, and Education of Inventors." *Technological Forecasting and Social Change* 86 (2014): 110–24.

Kerr, William. "The Ethnic Composition of US Inventors." 2008.

———. "Breakthrough Inventions and Migrating Clusters of Innovation." 2010. *Journal of Urban Economics* 67, no. 1: 46–60.

Khan, B. Zorina. "Married Women's Property Laws and Female Commercial Activity: Evidence from United States Patent Records, 1790–1895." *The Journal of Economic History* 56, no. 2 (1996): 356–88.

Lai, Jennifer C. "Patents and Gender: A Contextual Analysis." *Queen Mary Journal of Intellectual Property* 10, no. 3 (2020): 283–305.

———. "The Role of Patents as a Gendered Chameleon." 2021. *Social & Legal Studies* 30, no. 2: 203–29.

Madan, Nirupama, Deepak Mani, and R. N. Vrajesh. "Gender Disparities in Patent Review Outcomes Are More Pronounced for More Novel Patent Applications." SSRN, 2021.

Marcowitz-Bitton, Michal, and Emily M. Morris. "The Distributive Effects of IP Registration." *Stanford Technology Law Review* 23 (2020): 306.

Martinez, G. L., de Juano-i Ribes, H. S., Yin, D., Le Feuvre, B., Hamdan-Livramento, I., Saito, K., and Raffo, J. 2021. "Expanding the World Gender-Name Dictionary: WGND 2.0." Technical report, World Intellectual Property Organization.

Martinez, Guadalupe L., Julio Raffo, and Koji Saito. 2016. "Identifying the Gender of PCT Inventors." WIPO Economic Research Working Paper No. 33.

Miguelez, Ernest, Andrew Toole, Adam Myers, Stefano Breschi, Ernesto Ferruci, Francesco Lissoni, Valerio Sterzi, Giulia Tarasconi, et al. 2019. "Progress and Potential: A Profile of Women Inventors on US Patents." Technical report.

Milli, Jessica, Emma Williams-Baron, Meika Berlan, Jenny Xia, and Barbara Gault. 2016. "Equity in Innovation: Women Inventors and Patents." Institute for Women's Policy Research. 29.

Muckerheide, Mark. "The Finance Gap for Women Entrepreneurs Is \$1.7 Trillion. Here's How to Close It." World Economic Forum, October 26, 2023.
<https://www.weforum.org/stories/2023/10/women-entrepreneurs-finance-banking/>.

Nathan, Max. 2015. "Same Difference? Minority Ethnic Inventors, Diversity and Innovation in the UK." *Journal of Economic Geography* 15, no. 1: 129–168.

Niggli, M. 2023. "Moving On: Investigating Inventors' Ethnic Origins Using Supervised Learning." *Journal of Economic Geography* 23, no. 4: 921–47.

Pairolero, Nicole, Andrew Toole, Pan-Alejandro Pappas, Christopher DeGrazia, and Mihai Horia Teodorescu. 2022. "Closing the Gender Gap in Patenting: Evidence from a Randomized Control Trial at the USPTO." USPTO Working Paper.

Perry, M. 2011. "Survey Reveals Potential Innovation Gap in the US: Young Women Possess Characteristics of Inventors, but Do Not See Themselves as Inventive." MIT News, January 20, 2011. <https://news.mit.edu/2011/lemelson-invention-index>.

Raffo, J. 2021. "WGND 2.0." <https://doi.org/10.7910/DVN/MSEGSJ>.

Saksena, Mukta, Nadia Rada, and Linda Cook. 2022. "Where Are Us Women Patentees? Assessing Three Decades of Growth." Technical Report.

Shapanka, M. S., and H. Fechner. 2018. "Closing Diversity Gaps in Innovation: Gender, Race, and Income Disparities in Patenting and Commercialization of Inventions." *Technology & Innovation* 19 (4): 727–734.

Shaw, Erin, and Hiram Mariano. 2021. "Tackling the Gender and Racial Patenting Gap to Drive Innovation." Institute for Women's Policy Research.

Stojčić, Nenad, Maja Bečić, and Petar Vojinić. 2016. "The Impact of Migration Movements on Innovation Activities in Croatian Counties." *Društvena Istraživanja: Časopis za Opća Društvena Pitanja* 25 (3): 291–307.

Sugimoto, Cassidy R., Chaoqun Ni, J. D. West, and Vincent Larivière. "The Academic Advantage: Gender Disparities in Patenting." *PLOS ONE* 10, no. 5 (2015): e0128000.

Toole, A. A., Saksena, M. J., deGrazia, C. A. W., Black, K. P., Lissoni, F., Miguelez, E., and Tarasconi, G. 2020. "Progress and Potential: 2020 Update on US Women Inventor–Patentees."

United Kingdom Intellectual Property Office. Gender Profiles in Worldwide Patenting: An Analysis of Female Inventorship. 2019. Technical report.

United Kingdom Intellectual Property Office. 2016. "Gender Profiles in UK Patenting: An Analysis of Female Inventorship." Technical report.

United States Congress. 2021. "Inventor Diversity for Economic Advancement (IDEA) Act of 2021, H.R. 1723, 117th Cong., 1st sess."

United States Congress. SUCCESS Act of 2018. Public Law No. 115–273, 2018.

United States Patent and Trademark Office, Department of Commerce. 2021. "Administrative Updates to the General Requirements Bulletin for Admission to the Examination for Registration to Practice in Patent Cases Before the United States Patent and Trademark Office." Federal Register 86, no. 181.

Wachowska, Monika, and Magdalena Homa. "The Role of Ethnic Diversity in Stimulating Innovation Processes: Comparative Analysis of Poland, the Czech Republic, and Hungary." European Research Studies Journal 23, no. 4 (2020): 1157–1176.

World Intellectual Property Organization. The Global Gender Gap in Innovation and Creativity: An International Comparison of the Gender Gap in Global Patenting over Two Decades. Geneva, Switzerland, 2023. <https://www.wipo.int/publications/en/details.jsp?id=4653>.

