

Girls and Women as Innovators

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Abstract

In this brief, we analyze a gender-disaggregated dataset of patent applications from the United States Patent and Trademark Office (USPTO) and compare this with international data. We find that, while women's participation in patenting has risen steadily over the last two decades, women's leadership in patenting has risen at a much slower rate. We also find that the majority of multi-inventor patents still come from all-male teams. To remedy the gender disparity in patenting, we recommend repairing the "leaky pipeline" by incentivizing the hiring and retention of women innovators and investing in women-focused incubation labs and grant programs.

Science and technological innovations provide the foundation on which countries can build their industrial and development futures. Science can also ensure that economic progress takes place in balance with the environment and without putting excessive pressure on ecosystems and the planet.

Countries have progressed in science and technology to varying degrees. Rich countries have a large advantage in terms of research and development expenditure, their innovation ecosystems, and the share of intellectual property they own¹. Accelerating progress on achieving the Sustainable Development Goals (SDGs) will require developing and emerging economies to have access to the latest technologies and operate in a level playing field with opportunities to develop their own innovation pipelines and industrial capacities.

Women and girls, and underserved communities including migrants, must participate in innovation on an equal footing, as developers, and not just as passive users of technology. Only about a third of female students in higher education opt for Science, Technology, Engineering and Mathematics (STEM) fields. Attrition is also high. Women leave STEM disciplines in disproportionate numbers during their studies, during transition to work and during the career cycle. Only 30 percent of the world's researchers are women². Women owned startups receive 23 per cent less funding³.

This is indicative of the broader terms that women face in the labor market, especially the top echelons. Women earn only a third of labor income globally, which means men earn about double of what women earn. Examining the top 10% of the US wage distribution, women's share rose from 22% in 1995 to 30% in 1999. However,

women's representation in the top 1% is substantially lower than in the top 10%. This is also in other cases that have been studied - Spain, Brazil and France⁴. Clearly, women do not end up with industry "leadership" roles as much as men do.

In this brief, we examine gender gaps in innovation. Patent filings are one useful way of measuring innovation. We ask if women are participating in filing patents as equals. We further examine where the gaps are, if any, paying attention to leadership roles.

Data on patents including socioeconomic indicators for women is often missing, but recent work on correlating names with genders has allowed for the emergence of gender-disaggregated datasets on patent applications for some regions. In this brief, we analyze such a dataset from the United States Patent and Trademark Office (USPTO) and compare the results with previous analysis using international data.

Our results show that science, technology and innovation continue to be dominated by men. Women are chipping away at this dominance but the changes are very slow. Systemic change is the only way to give women the same career choices as anyone else. We make policy recommendations to close the gender gap in innovation. In our recommendations, there is significant overlap with policy that would support women claiming their equal stake in the broader economy.

Data Source

To better understand the trajectory of women's participation in patenting in the United States (US), we

¹ Bostrom & Nayyar, 2023 (forthcoming)

² *Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM)*, n.d.

³ *Bridging the Gender Divide*, n.d.

⁴ Chancel et al., 2021

used publicly available data from the PatentsView database⁵. This resource provides annual datasets about patenting, including information such as the names and genders of the inventors, the city and country of the assignee, and the IPC codes that specify the technological field of the patent. Data are available from the years 1976 through 2020. However, up to 2001, the data recorded represent *granted* patents, while those from 2002 onward represent patent *applications*. Fitting a single linear regression to the full dataset (1976-2020) yielded significant residuals for the years before the policy change, so we restricted our analysis to 2002-2020.

Findings

How much do women participate in patenting?

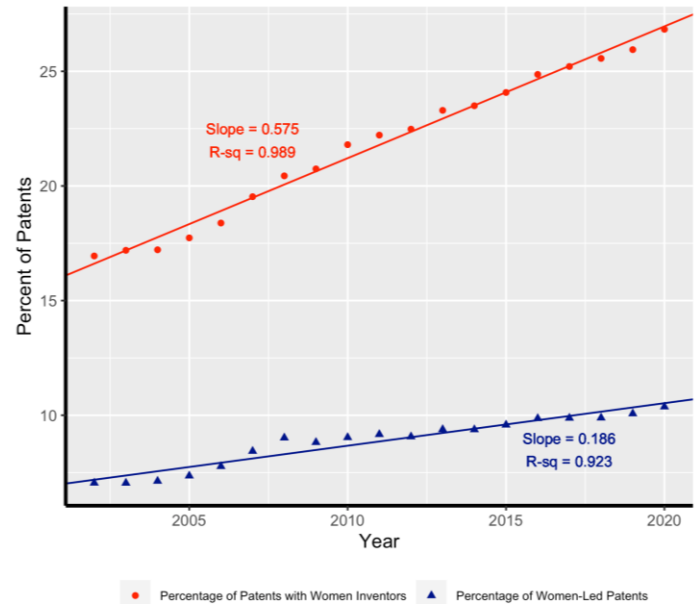
In our analysis, we find that, **although the proportion of US patent applications that list at least one woman inventor has increased steadily since 2002, it is still only 26.8%. Worse, the proportion of patents in which a woman is the first inventor is just 10.4%.** Given that the first inventor listed on a patent tends to be regarded as the leader⁶ (though this has no special legal status), this has implications for the perception of women as innovators and leaders in the field of technology.

Based on a linear regression analysis, we find that the proportion of women-led patents has risen at a slower rate than the overall proportion of patents with women listed as inventors (see Figure 1). **While the proportion of patents listing at least one woman inventor rose at an average rate of .575 percentage points per year between 2002 and 2020, the proportion of women-led patents rose by just 0.186 percentage points per year.** These results suggest that even as women participate more, they are less likely to do so as leaders. This gap points to a need to empower women and girls not only to pursue STEM fields, but also to lead their own projects.

Such a striking result reflects the “leaky pipeline” phenomenon. At each career stage in STEM fields, the proportion of women drops⁷. The data in patenting at the USPTO suggests a similar effect and signals that policymakers should focus not only on recruiting more female innovators, but on retaining those who enter the field. Notably, this finding is also consistent with WIPO

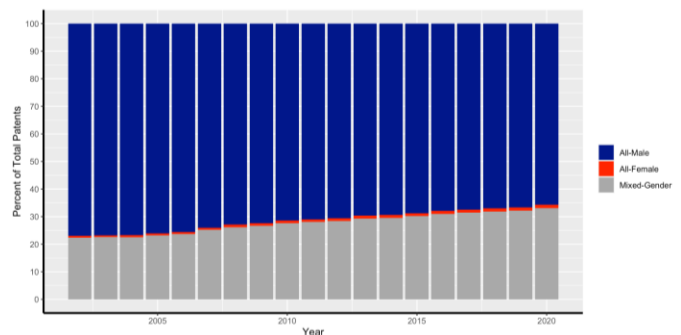
(World Intellectual Property Organization) reporting that the proportion of women who publish papers is smaller than those working as researchers, and that the proportion of women who patent is smaller still⁸.

Figure 1. Women’s Participation in Patents Filed at USPTO, 2002-2020



Data source: PatentsView

Figure 2. Percent of All-Male and All-Female Teams for Patents Filed at USPTO, 2002-2020



Data source: PatentsView

How common are mixed-gender innovation teams?

Next, we examined the percentage of patents whose inventor teams were either all male or all female. We first filtered out patents that had a single inventor, then separated them by their teams’ gender composition. As shown in Figure 2, the proportion of all-male teams has declined, while the proportion of all-female and mixed-

⁵ <https://patentsview.org/data/annualized>

⁶ *Inventorship Vs Authorship: Who Has the “Write” to Patent?*, 2005

⁷ Miranda, 2021

⁸ Lefevre et al., 2018

gender teams has risen. However, the pool of patent applications in 2020 was still overwhelmingly dominated by all-male teams, a testament to the fact that the majority of patent inventors are men. **Only 33.0% of the patent applications in 2020 came from mixed-gender teams, signifying the need for more diverse collaborations.**

Are women more likely to lead mixed-gender teams?

Finally, using the 2020 data, we found that **while only 11.1% of woman-led multi-inventor patents were filed by all-female teams, 79.7% of male-led multi-inventor patents were filed by all-male teams.** It is possible that this is merely a product of the abundance of male innovators, meaning that both male and female team leaders have more men than women to choose from. However, it is also possible that there may be a deeper reason for this. For example, women's experience with implicit bias throughout their careers may lead them to choose a mixed team to mitigate the effect of negative perceptions of women's capacity for innovation. Implicit bias may play a role as well, leading both male and female inventors to avoid selecting female teammates. This would be an interesting area for further study. Regardless, incentivizing all innovation leaders, especially men, to bring more women onto their teams could be an important component of a program aiming to reduce the gender divide in patenting.

International Comparison

Some of the findings here confirm those of a United Kingdom Intellectual Property Office (UKIPO) study⁹, particularly the relatively small number of all-female innovation teams, which that study found to hold true for global data in aggregate. However, we were able to add on to this analysis by examining the incidence of female leadership on patents in the US. In particular, we demonstrated that the rate of progress on female leadership is lagging behind that of overall female participation, thus reinforcing the need to patch the leaky pipeline.

For 2015, the latest year available at the time, the UKIPO study also found that the global proportion of mixed-gender teams was 22.56%, while we found that proportion to be 30.2% for USPTO data in the same year (rising to 33.0% in 2020). This suggests that the US may be ahead of the global average on this statistic.

In 2018, WIPO released a report analyzing the patents filed via the Patent Cooperation Treaty (PCT), an international filing system. When broken down by origin country, WIPO found that the proportion of patents with at least one woman inventor ranged from 17% (Africa) to 35% (Asia), with a global average of 31%. North America sat slightly above the average, at 33%. Assuming that the US is consistent with North America as a whole, this would indicate that women's participation in international patenting is actually somewhat higher than at the USPTO (given our result of 27% for 2020).

Interestingly, WIPO found that women's participation did not correlate strongly with traditional economic indicators such as GDP. Latin America and the Caribbean, for example, had a higher percentage of patents with women inventors than Europe and Oceania. This points to probe more deeply; for example, examining the relationship between geography, gender, and different technology sectors could be fruitful.

Policy recommendations / conclusions

Analyzing the case of patents in the US, we see that only 26.8% of US patent applications list a woman inventor. Only 10.4% list a woman as the first inventor. For gender equality in innovation roles, there is a ways to go. Yet, we find that the leadership role of women has been growing much slower than the participation of women in this area.

We suggest policies to address both the participation and the leadership gap in innovation.

1. To address the participation gap in patent applications:
 - a. Addressing beliefs and social norms that impede girls' and women's participation in STEM education.
 - b. Active pathways from higher education in STEM to careers in technology and innovation.
 - c. Women-focused innovation incubators and grant programs to foster female entrepreneurship and prevent dropout.
 - d. Flexible work conditions, family leave and parental leave for women and men, to encourage fair sharing of family care across genders.

⁹ UK Intellectual Property Office Informatics Team, 2016

2. To address the leadership gap in patent applications:
 - a. Mentorship programs to connect girls and young women with female innovator role models.
 - b. Incentives for universities and firms to hire and retain more women innovators in senior roles.

References

- Bostrom, A., & Nayyar, S. (2023 (forthcoming)). Fit for Purpose? The Patents Regime, the Fourth Industrial Revolution and Sustainable Development. *Data & Policy. Bridging the gender divide*. (n.d.). ITU. Retrieved March 12, 2023, from <https://www.itu.int/en/mediacentre/backgrounders/Pages/bridging-the-gender-divide.aspx>
- Chancel, L., Piketty, T., Saez, E., & Zucman, G. (2021). *World Inequality Report 2022*. Retrieved March 12, 2023, from <https://wir2022.wid.world/>
- Cracking the code: girls' and women's education in science, technology, engineering and mathematics (STEM)*. (n.d.). UNESCO Digital Library. Retrieved March 12, 2023, from <https://unesdoc.unesco.org/ark:/48223/pf0000253479>
- Inventorship vs Authorship: Who has the "write" to patent?* (2005, April). Research at Johns Hopkins Medicine. Retrieved March 12, 2023, from https://www.hopkinsmedicine.org/webnotes/newsletter_draft/licensing/0504.cfm
- Lefeuivre, B., Raffo, J., Saito, K., & Lax, G. (2018, April). *Women and the international patent system: encouraging trends*. WIPO. Retrieved March 12, 2023, from https://www.wipo.int/wipo_magazine/en/2018/02/article_0008.html
- Miranda, E. A. (2021, August 13). *Actions and behaviors that thwart the advancement of women and people of color in academe (opinion)*. Inside Higher Ed. Retrieved March 12, 2023, from <https://www.insidehighered.com/advice/2021/08/13/actions-and-behaviors-thwart-advancement-women-and-people-color-academe-opinion>
- UK Intellectual Property Office Informatics Team. (2016). *Gender Profiles in Worldwide Patenting: An analysis of female inventorship*. GOV.UK. Retrieved March 12, 2023, from <https://www.gov.uk/government/publications/gender-profiles-in-uk-patenting-an-analysis-of-female-inventorship>