Women in Creative Labor: Inventors, Entrepreneurs and Academics

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ABSTRACT

This article provides an overview of the latest empirical research on the gender gap in knowledge-intensive occupations from an economics perspective. It studies contributing factors both from an institutional and behavioral perspective, and considers potential solutions. The persisting gender gap is not only an issue of social fairness; it also hampers innovation and has direct negative implications for individual productivity as well as economic growth. The overview of the existing gender literature, as well as our own research, emphasize that it is imperative to fight the gender gap with well-tailored policies and to support gender equality at the institutional and personal level.

When talking about gender equality, one usually first thinks about the equal rights movements in the 1970s that promoted equal rights regardless of sex. During that time, major legal breakthroughs were achieved. Recently, the topic of gender equality has seen a revival of interest among the general public and researchers in connection with labor market disparities. In the past two decades, the progress of women on the labor market has stalled—despite the attention of the media and policymakers. The period of strongest convergence in labor market outcomes between men and women took place in the 1980s and progress has been slower and more uneven thereafter. Since the 1990s, the increase in female labor force participation has slowed down and occupational segregation by sex and the resulting pay gap persist, with disproportionally few women assuming lead-

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ership positions.[1] Strikingly, different labor market outcomes can no longer be explained by conventional human capital measures such as level of education, job experience and working hours.

Today, women are still severely under-represented in inventive professions, among entrepreneurs, and in academia. They represent between 7 per cent and 18 per cent of the inventors' population in the US and in Europe, depending on cohorts and technological field.[2] In 2014, women constituted only 29 per cent of start-up entrepreneurs in Europe.[3] Additionally, only one third of the researchers in the EU are women—a share that has not seen an improvement since 2015.[4]

Under-representation of women in knowledge-intensive jobs is not purely a concern of social fairness. It has negative economic consequences. By employing talents regardless of gender, firms could become more innovative and, consequently, more productive. An increase in diversity, both among management and workers, has a positive effect on innovation and productivity.[5]

The gender gap in knowledge-intensive jobs is an important topic on the research agenda of the Max Planck Institute for Innovation and Competition. We study behavioral factors that contribute to different manifestations of the gender gap, document gender disparities in certain occupations and test potential solutions. In this chapter, we focus on the gender gap in the inventive profession, in entrepreneurship and academia.

UNDERSTANDING THE GENDER GAP

When economists talk about the gender gap, they do not only refer to differential pay but to any systematic differences in the outcomes that men and women achieve in the labor market. Examples are differences in the percentages of men and women in the labor force, in the types of occupations they choose, in their positions on the career ladder, their relative incomes, or hourly wages.[6]

To understand gender-based disparities in occupation and pay, it is helpful to distinguish between *demand-side effects*, which refer to actions of the

1 *Blau/Kahn* 2017.
2 *Hoisl/Mariani*, 2019; *Bell/Chetty/Jaravel/Petkova/Reenen*, 2019.
3 *European Commission,* 2014.
4 *European Commission*, 2019.
5 *Hoogendoorn/Oosterbeek/van Praag*, 2013; *Vegt/Janssen*, 2003.
6 *Goldin*, 2008.

employers and *supply-side effects*, which refer to individual choices and behavior.[7]

A demand-side effect typically means greater demand for men when filling desirable jobs;[8] that is, discrimination of women. Discrimination may be statistical. If employers have imperfect information about employees, they may infer their productivity from statistical information. In the case where women had been less productive in the past due to historic discrimination, this triggers a self-reinforcing process.[9] Discrimination may also be taste-based, meaning that some have prejudices against female workers regardless of their productivity.[10] Importantly, both statistical and taste-based discrimination may not be rooted in actual performance of groups or personal traits of the members but in the beliefs on performance of the group and stereotypes.[11] Both statistical and taste-based discrimination is well documented in the literature.[12] Apart from directly harming the outcomes of the discriminated, discrimination on the demand-side influences the supply side of the problem: A person who anticipates that they will be discriminated against may be less willing to invest in human capital. Notably, even in an environment without existing stereotypes and entrenched gender roles, the discriminatory dynamics, where one group is systematically preferred to another, are fast to emerge.[13]

The literature on supply-side effects explains gender gaps by the preferences or aspirations men and women develop for different kinds of work.[14] Whereas early literature assumed that women have intrinsically lower levels of career aspirations than men, more recent literature showed that their experiences with gender inequality on the labor market induces lower expectations about career success.[15]

Significant effort has been extended to detect behavioral features that could explain differences in labor market outcomes. It has been found that

7 *Fernandez-Mateo/Kaplan*, 2018.
8 *Reskin/Roos*, 1990.
9 *Arrow*, 1973; *Phelps*, 1972.
10 *Neilson/Ying*, 2016.
11 *Bohren/Imas/Rosenberg*, 2019; *Bordalo/Coffman/Gennaioli/Shleifer*, 2016; *Reuben/Sapienza/Zingales*, 2014.
12 *Milkman/Akinola/Chugh*, 2012.
13 *de Haan/Offerman/Sloof*, 2017.
14 *Correll*, 2004.
15 *Gibson/Lawrence*, 2010.

women are less competitive,[16] less willing to take risks,[17] less optimistic,[18] less confident,[19] as well as less achievement-oriented and growth-oriented[20] than men.

Notably, women seem to behave differently if they are in a male-dominated environment. Since most prestigious and highly paid jobs are currently considered to be male-dominated, these behavioral changes are of particular importance. Male-majority environments sometimes impact women's performance negatively[21] and may induce women to behave in a more stereotypically female way. For example, women tend to take fewer risks[22] and opt out of competition to a greater extent when around men.[23] There is growing evidence that it is difficult for women to go up the ranks in environments with many men. There are several reasons for this. Men tend to undervalue women's expertise and leadership skills to a larger extent than women do.[24] Further, the larger the share of men in a group, the less credit women get for their ideas[25] or leadership[26], the more backlash they experience[27] and the more likely they are to quit.[28] In a laboratory experiment, Born et al. documented that female participants are less likely to volunteer for leadership roles in male-majority teams.[29] The main driving forces behind this finding are that women in male-majority teams are less confident, less influential, more swayed by others, and correctly expect less support from team members than women in female-majority teams.

In the following, we will focus on gender gaps in inventive professions, in entrepreneurship and in academia. The above-mentioned mechanisms seem to explain at least part of the gender gap we can observe for these three groups of knowledge workers.

16 *Niederle/Vesterlund*, 2007.
17 *Vandegrift/Yavas*, 2009.
18 *Jacobsen/Lee/Marquering/Zhang*, 2014.
19 *Wilson/Kickul/Marlino*, 2007.
20 *Schwartz/Rubel*, 2005.
21 *Booth/Yamamura*, 2018.
22 *Booth/Nolen*, 2012.
23 *Burow/Beblo/Beninger/Schröder*, 2017.
24 *Mengel/Sauermann/Zölitz*, 2018.
25 *Coffman/Flikkema/Shurchkov*, 2019.
26 *Gloor/Morf/Paustian-Underdahl/Backes-Gellner*, 2020.
27 *Chakraborty/Serra*, 2021.
28 *Bostwick/Weinberg*, 2018.
29 *Born/Ranehill/Sandberg*, 2018.

WOMEN IN INVENTIVE PROFESSIONS

The very low presence of women among inventors (i.e., individuals who made technical inventions for which a patent was filed) points to an underutilization of women's innovative potential. Bell et al. are among the few that analyzed the factors that determine whether an individual becomes an inventor or not.[30] They found that women become inventors only if exposed to innovation during childhood or through role models. Female inventors are treated differently than men (demand-side effect). As in many other fields, women inventors have a lower status; that is, the perceived quality of their inventions in relation to the perceived quality of men's inventions is lower.[31] Women face challenges in attracting critical resources, such as money or lab space, needed for their inventive activity.[32] Additionally, they typically do not get the appreciation they deserve for their merits. Jensen et al. analyzed US inventors and found that patents held by women—all else being equal—receive 11 per cent less citations from subsequent patents than those held by men, even after accounting for the technological area.[33] The residual differences may well be explained by discrimination or neglect of women's inventions by male competitors or colleagues. If women have fewer chances to demonstrate their potential, this could lead to gender-induced productivity differences in male-dominated jobs.

In addition, preconceived ideas about women's potential could generate different returns on similar competences and job performance. Toivanen and Väänänen, for example, showed that women inventors receive the same immediate returns on patents (i.e., temporary increase of annual earnings) as men do, but not the same long-term returns (i.e., longer-lasting premiums in earnings after three years).[34] Hoisl and Mariani found that women and men are equally likely to receive awards for their inventive achievements.[35] However, female inventors receive a 49.6 per cent lower reward in nominal monetary terms (about 1,255 Euros less compared to an overall average of 3,252 Euros). This leads to a cumulative wage gap. In 2009, female full-time workers in the US earned 77 per cent as much as male full-time workers, and in the European Union, gender-based wage

30 *Bell/Chetty/Jaravel/Petkova/Van Reenen*, 2019.
31 *Podolny*, 1993.
32 *Ridgeway*, 1991.
33 *Jensen/Kovács/Sorenson*, 2018.
34 *Toivanen/Väänänen*, 2012.
35 *Hoisl/Mariani*, 2019.

gaps amounted to 16.2 per cent in 2011 and 14.2 per cent in 2014.[36] Authors often argue that such differentials reflect differences in endowments or productivity. Others show that the wage gap persists, even though the productivity gap has closed over time.

The presumably unfair treatment of women inventors results in higher drop-out rates of women from this male-dominated profession. Hunt, for instance, used the 1993 and 2003 US National Surveys of College Graduates and found that only 9.8 per cent of male engineers were leaving R&D, while the exit rate of female engineers amounted to 12.9 per cent.[37]

Hoisl and Mariani provided an analysis that aims to better understand the differences in income and job performance between women and men in the inventive professions.[38] The analysis is based on data collected through a large-scale survey of 9,799 inventors from 21 European countries, Israel, the US and Japan (the InnoS&T Survey[39]), conducted between 2009 and 2011. The data contain information on the inventors' individual characteristics and women's participation in science and engineering, the characteristics of the employer organizations, the role of the inventors within organizations, their willingness to take risks, and their technological field of activity.

The results showed that a gender-wage gap exists in favor of male inventors, though the gap does not correspond to better inventive outcomes in terms of the technological importance of the inventions they produce. Additionally, even in high-skill jobs, not only is the wage gap not fully explained by differences in the inventors' observable characteristics, such as the number of working hours, past productivity levels, education, or the type of the employer organization, but it particularly concerns female inventors who have children.

Overall, if talent is equally distributed between male and female inventors, the fact that only 4 per cent of inventors are female in the sample examined, and that having children may be responsible for some of the

36 *Boll*/*Lagemann*, 2018.

37 *Hunt*, 2016.

38 *Hoisl*/*Mariani*, 2017.

39 InnoS&T ("Innovative S&T Indicators Combining Patent Data and Surveys: Empirical Models and Policy Analyses") is a project commissioned with FP7 funding conducted in co-operation with researchers from Bocconi University (Milan, IT), Bologna University (Bologna, IT), K.U. Leuven (Leuven, BE), and IESE Business School (Barcelona, ES). InnoS&T developed and collected novel and systematic science and technology indicators covering Europe, Israel, the US and Japan through extensive surveys of patent inventors and the creation of indicators based on citations to science in patents.

dropouts from this market, is worrisome. This would imply that while we are exploiting the entire distribution of talents for men (and, therefore, we are drawing also on less talented individuals), we are exploiting only a small part of the talent distribution of women. This may have a negative impact on the quality and quantity of the inventions that can be produced.[40]

WOMEN IN ENTREPRENEURSHIP

Despite increasing efforts to incentivize venture creation (European Commission, 2014), women remain underrepresented within the entrepreneurial community.[41] Women-owned businesses tend to lag behind men-owned ventures with regard to the number of employees, turnover, profitability and growth performance.[42] Policymakers and researchers agree that this gender gap represents an untapped economic.[43]

To date, entrepreneurship literature has considered various explanations for women's lower entrepreneurial propensity. Early work investigated whether female entrepreneurs are discriminated due to systematic barriers in the business environment (*demand-side effects*). Similar to the challenges that inventors face, female entrepreneurs are disadvantaged with respect to resources. They are less likely to receive external capital and lack access to relevant networks.[44] While studies from the late 1990s and early 2000s do find evidence for gender-based discrimination, the conditions of female entrepreneurs seem to have significantly improved over the past decades.[45] Nevertheless, a female entrepreneur remains an exception.

More recent literature has focused on the characteristics of female versus male entrepreneurs (*supply-side effects*). Results show that women's preferences and personality traits differ from characteristics typically associated with entrepreneurs. Especially perceptual variables, such as a low perception of one's own skills and a high fear of failure, considerably affect women's propensity to found businesses.[46]

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40 *Koning/Samila/Ferguson*, 2020.
41 *European Commission*, 2014.
42 *Klapper/Parker*, 2011.
43 *Zwan/Verheul/Thurik*, 2012.
44 *Klapper/Parker*, 2011; *Marlow/Patton*, 2005.
45 *Muravyev/Talavera/Schäfer*, 2009.
46 *Langowitz/Minniti*, 2007.

Another strand in female entrepreneurship literature attributes the gender gap to "nature", assuming that different biological dispositions lead to different gender-specific personality traits or behavioral patterns. Bönte et al.[47] and Guiso and Rustichini,[48] for instance, link entrepreneurial propensity to "typically male" biological predispositions, such as high prenatal testosterone levels. However, these differences have only found partial support in the existing literature. Hence, claiming a dissonance between female genetic dispositions and the necessary traits for becoming an entrepreneur as the sole culprit for the gender gap in entrepreneurship appears to be too simplistic.

Given the compelling evidence for socialization effects as drivers for gendered behavior, another argument is that societal influences, such as cultural norms or prevailing stereotypes, evoke gender differences in preferences, occupational aspirations, or achievement motives. In a world where children start to develop gender stereotypes about cognitive abilities at the age of six or seven,[49] it is likely that women's aspirations and self-perceptions are consciously or subconsciously shaped by a constant confrontation with gender roles in their social reality.

Bechthold and Rosendahl Huber conducted a field experiment to understand how exposure to female entrepreneurial role models at the pre-nascent stage influences the development of entrepreneurial self-efficacy (i.e., an individual's belief in his or her capacity to become an entrepreneur), attitudes and intentions among female students. [50] We consider the pre-nascent stage to be a crucial point in time for fostering female entrepreneurship as gender differences in traits tend to diminish among nascent entrepreneurs.[51]

The combination of a mandatory entrepreneurship course, random assignment of students to teams and entrepreneurs, as well as a pre-post design, allowed us to draw causal inferences about the impact of female entrepreneurial role models. One of the major results is that exposure to female entrepreneurs boosts the development of entrepreneurial self-efficacy and attitudes towards entrepreneurship of female students.

In the second part of our study, we explored whether having entrepreneurial peers, same-gender peers, or being in a highly emotionally intelligent team influences students' development of entrepreneurial in-

47 *Bönte/Procher/Urbig*, 2016.
48 *Guiso/Rustichini*, 2018.
49 *Bian/Leslie/Cimpian*, 2017.
50 *Bechthold/Rosendahl Huber*, 2018.
51 *Brixy/Sternberg/Stüber*, 2012.

tentions. Contrary to previous evidence,[52] we did not find that highly entrepreneurial peers serve as direct transmitters of entrepreneurial propensity. We found some indications that same-gender peers boost the development of positive attitudes towards entrepreneurship as well as entrepreneurial self-efficacy. This effect is larger for female students than for male students. Finally, our results indicate that having highly emotionally intelligent peers positively influences entrepreneurial learning.

WOMEN IN ACADEMIA

In academia, the under-representation of women does not only manifest itself in the share of professorships held by women, but in all parts of academic everyday life. Female researchers receive less grants and less grant money,[53] publish less,[54] are less prominent in textbooks,[55] and receive tenure less often.[56]

The gender imbalance in top academic positions is particularly striking, since gender is more balanced among students and at early stages of an academic career. In the literature, this phenomenon is referred to as the "leaky pipeline", according to which females drop out of academia at different stages of the academic career at higher rates than males do. Understanding the leaky pipeline is crucial for remedying gender disparities in academia.

Again, we have to distinguish between a demand-side effect (i.e., the actions of the research community and peers) and a supply-side effect (i.e., the choices and behavior of female researchers).[57] The latter can include inefficient networking, lack of geographical mobility and self-promotion. The former can include a hostile work environment, gendered institutional policies and apparent implicit bias in promotion and tenure processes.[58]

Ductor et al. showed that female researchers are more likely than male researchers to work with the same authors, resulting in more intensive collaborations of females compared to males. [59] As a consequence, networks of women are denser than those of men. Dense networks are beneficial in

52 *Weber*, 2012.
53 *Oliveira/Ma/Woodruff/Uzzi*, 2019.
54 *Larivière/Ni/Gingras/Cronin/Sugimoto*, 2013.
55 *Stevenson/Zlotnik*, 2018.
56 *Conti/Visentin*, 2016.
57 *Fernandez-Mateo/Kaplan*, 2018.
58 *Lundberg/Stearns*, 2019.
59 *Ducto/Goyal/Prummer*, 2020.

environments with low uncertainty.[60] Sparse networks, on the contrary, deliver new information faster than dense networks, which is particularly valuable in environments characterized by high uncertainty, such as academic science. Another reason for differences in the network structure of female versus male scientists might be that female scientists, especially if they have school-age children, are more unwilling to move jobs than males.[61] Job mobility, however, increases the size of the professional network.[62]

In academia, researchers are judged by the impact of their research, typically by the number of citations they receive for their publications. The publications of female scientists get fewer citations. One of the reasons for this is that women self-promote themselves less than men. A study based on 1.5 million research papers showed that, during the last two decades, male researchers self-cited their own work 70 per cent more often than female researchers.[63]

While a hostile environment is difficult to operationalize, there is empirical evidence of prejudice towards female scientists shared by colleagues and students. Wu (2018) analyzed the comments posted on an anonymous (and non-representative) forum for economists and documented strong sexist sentiment.[64] Contributors used words that concern the physical appearance (e.g., "hot" or "attractive") when referring to female economists. In contrast, when writing about male economists, contributors used words that refer to academic roles or achievements, such as "advisor", "Nobel" (laureate) or "supervisor". Students mirror the attitudes of the professional community. Boring analyzed teaching evaluations filled out by students from a French university and showed that male students express a positive bias in favor of male professors.[65] Students commented on different dimensions of teaching that match gender stereotypes. Men are perceived by both male and female students as being more knowledgeable and having stronger class leadership skills (which are stereotypically associated with males). However, there is no effect on knowledge transfer; that is, students seem to learn as much from female professors as from male ones.

Female scientists appear to be disadvantaged during the publishing process and receive less credit for their work. Hengel analyzed a body of scien-

60 *Lindenlaub/Prummer*, 2021.
61 *Azoulay/Ganguli/Zivin Graff*, 2017.
62 *Mahroum*, 2000.
63 *King/Bergstrom/Correll/Jacquet/West*, 2017.
64 *Wu*, 2018.
65 *Boring*, 2017.

tific articles and established that, conditional on the quality of the paper, female-authored papers are held to a higher standard.[66] Focusing on readability, she found that manuscripts written by female authors are more readable at the time of submission, but nevertheless spend about three to six months longer in the review process than manuscripts written by males. Findings of Sarsons reinforce these results.[67] She found that women receive less credit for co-authored papers than their male colleagues as measured by subsequent tenure decisions. Finally, Rose and Georg showed that women in economics are acknowledged less often on other person's research papers for informal collaboration.[68] It could be that men do not approach women for feedback while conducting research, but the mechanism is far from clear.

Moreover, female researchers appear to carry a higher load of non-research-related tasks; for example, chairing a committee.[69] This is not due to higher personal altruism or a specific taste for these tasks, but rather due to gender stereotypical expectations: Women are more likely to be asked to volunteer and accept such requests. In addition, gender quotas, that in some cases have to be fulfilled, play an important role in increasing the administrative burden of female scientists.

Just like the inventor and entrepreneurship literature summarized above, studies analyzing the success of female scientists highlight the importance of role models. The availability (or lack) of role models and mentors has been shown to be particularly relevant in explaining the leaky pipeline. Gaulé and Piacentini, for instance, report that chemistry Ph.D. students with advisors of the same gender tend to be more productive during and after graduate school and are less likely to leave academia. [70] Studying the likelihood of enrolling for STEM degrees, Canaan and Mouganie showed that the benefits from same-gender mentor-mentee relationships are even more pronounced for high-performing females. [71]

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In developed countries, there have been no institutionalized restrictions for female labor market participation for decades. Nevertheless, the gender gap is still a concern. We started this chapter with the notion that a gender

66 *Hengel*, 2017.
67 *Sarsons*, 2017.
68 *Rose/Georg*, 2018.
69 *Babcock/Recalde/Vesterlund/Weingart*, 2017.
70 *Gaulé/Piacentini*, 2018.
71 *Canaan/Mouganie*, 2021.

gap is not only an issue of social fairness but has direct negative implications for individual productivity and, consequently, for economic growth. The literature summarized above, as well as our own findings, stress that it is not only possible to fight the gender gap, but that doing so is worthwhile.

If we want to have more female inventors, entrepreneurs and scientists, we should support girls from an early age. Since children are in the process of learning about how society works, they tend to be less sensitive to social roles and stereotypes. For instance, boys and girls tend to be equally competitive.[72] Additionally, role models in schools or at home seem to be beneficial. Having an inventor in the family increases the likelihood of becoming an inventor later on.[73] Teachers at school, who are not stereotypically biased, can empower female students to choose mathematics-intense tracks.[74] At later stages, policymakers should introduce carefully designed policies that support gender equality on the labor market and ensure that there are no hidden barriers, such as a lack of accessible childcare.

The role of the individual in fighting the gender gap is often underestimated. At the individual level, it is particularly important to be aware of the problem and one's own biases. Even if, nowadays, only a few people sincerely believe in a superiority of one sex over the other, each of us can unconsciously contribute to the problem. A good start to learning more about how biased we are is to take an Implicit Association Test (available free online). A better knowledge of one's own biases can help to assess the performance of others objectively and independently of gender. Taken together, our biases form prejudices and stereotypes that sometimes are entrenched in social norms. Social norms are slow and difficult to change. Yet, the current situation is not the only possible order of things. We can observe the opposite in matrilineal societies. There, gender stereotypical behavior diminishes or even reverses completely.[75]

72 *Dreber/Von Essen/Ranehill*, 2011.
73 *Bell/Chetty/Jaravel/Petkova/Van Reenen*, 2019.
74 *Lavy/Sand*, 2018.
75 *Andersen/Bulte/Gneezy/List*, 2008; *Gneezy/Leonard/List*, 2009; *Gong/Yang*, 2012.

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Selected Publications:

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Selected Publications:

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Selected Publications:

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Selected Publications:

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ABOUT THE INSTITUTE

The Max Planck Institute for Innovation and Competition
The Max Planck Institute for Innovation and Competition is committed to fundamental legal and economic research on processes of innovation and competition and their regulation. The research focuses on the incentives, determinants and implications of innovation. The Institute informs and guides legal and economic discourse on an impartial basis. As an independent research institution, it provides evidence-based research results to academia, policymakers, the private sector, and the general public.

Innovation and entrepreneurship are important sources for the growth of modern economic systems and the enhancement of the prosperity and quality of life of their citizens. However, they can entail high economic and social costs and may cause major disruptions at the individual and societal level. A profound scientific understanding of the causal relationships between the determinants and outcomes of innovation and entrepreneurship processes is necessary to successfully carry out such tasks. The Department of Innovation and Entrepreneurship Research engages in research to explore and analyze these relationships from an economics perspective and contributes to the innovation discourse with other disciplines in close cooperation with the legal department of the institute.

Disparities and inequalities crucially affect who gets the opportunity to be innovative. Research on how society and the economy can promote and support talent regardless of gender, and which consequences arise when not doing so, add important insights to the department's scientific agenda.