



Empowering women in the digital age

WHERE DO WE **STAND?**

HIGH-LEVEL EVENT

at the margin of the 62nd session
of the UN Commission
on the Status of Women

14 MARCH 2018
NEW YORK CITY
UNITED STATES

This brochure summarises the initial findings of the forthcoming OECD report *Bridging the Digital Gender Divide*. Prepared at the request of the Australian Government, the report will inform the debate of G20 ministers in charge of the Digital Economy under the 2018 Argentinian G20 Presidency, around policy measures to foster the equitable participation of women in the digital economy.

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Executive summary

New digital tools are empowering, and can serve to support a new source of inclusive global economic growth. To seize this opportunity it is essential that no one, and especially no woman, is held back in trying to achieve their aspirations. Now is the time to step up the efforts and take advantage of the digital transformation to ensure that it represents a leapfrog opportunity for women and a chance to build a more inclusive digital world. The G20 efforts are an important and timely step forward towards better policies to close the digital gender gap. Establishing the evidence base that reveals how women are faring in the digital transformation is essential for developing and monitoring these policies. This brochure represents a preliminary effort by the OECD, working with the G20, to broaden the evidence base to better understand the position of women in the economy and society that is being transformed by digital technologies.

The key findings include:

1. Today, around the world, some 250 million fewer women than men are online. In developing countries, limited access often concerns women living in Sub-Saharan Africa and in rural parts of Asia. In developed countries women face a facet of the digital gender divide: the **systematic under-representation in information and communication technology (ICT) jobs, top management and academic careers**. For instance, women worldwide are 20% less likely to hold a senior leadership position in the mobile communication industry, they make only 8% of the investing partners at the top 100 venture capital (VC) firms and only 17% of the scientists earning more than USD 105 000 (in 2015).
2. **Gender gap in science, technology, engineering and mathematics (STEM) fields grows with age**. 15 year-old girls are two times less likely to aspire to a career as an engineer, a scientist or an architect and three times more likely than boys to expect to become health professionals. Consequently, there is no surprise if women account today for only 20% of tertiary graduates in ICT fields. And even when they do study STEM they face a “glass ceiling” preventing them from holding senior positions: women make up for only 20% of scientists who are identified as “corresponding authors” (a proxy for leadership in the world of research) and have little likelihood to be peer reviewers or editorial board members of scientific journals.
3. **Software development still seems to be (mostly) a male-dominated club**. Over the past five years, almost 90% of downloads packages of one of the most used, “big data”, open-source software packages were authored by men. This is particularly worrying, given the growing importance of “big data” analytics to the digital economy, and the possible consequences of unintended bias creeping in due to this marginal role of women.
4. **However, women’s inventiveness is finally starting to emerge**, holding promise to narrow an historical gap. While almost 80% of all patents filed at key intellectual property offices worldwide still come from teams of only men, over the last two decades the number of patents featuring *at least one woman* in the team of inventors has increased more rapidly than the average of all patents. This is especially the case for patents related to ICT, suggesting women are increasingly getting credit for their inventiveness and creativity.
5. **Start-ups and venture capital investment point to socio-cultural gender bias in equity financing**: today, 90% of innovative start-ups seeking venture capital investments have been founded by men. Women-owned start-ups receive 23% less funding and are 30% less likely to have a positive exit – i.e. be acquired or to issue an initial public offering – compared to men-owned businesses. **Nevertheless, progress is possible**: VC firms with *at least one female partner* are more than twice as likely to invest in a company with a woman in the management team, and three times as likely to invest in female chief executive officers (CEOs).
6. **Women at work today: digital skills command higher labour market returns**. While women appear less endowed with some of the skills needed to thrive in the digital era – such as numeracy and STEM quantitative skills – a window of opportunity is emerging: those women who perform more ICT-intensive tasks in their job receive a 12% higher pay increase than men. Perhaps a window of opportunity to narrow the wage gap?

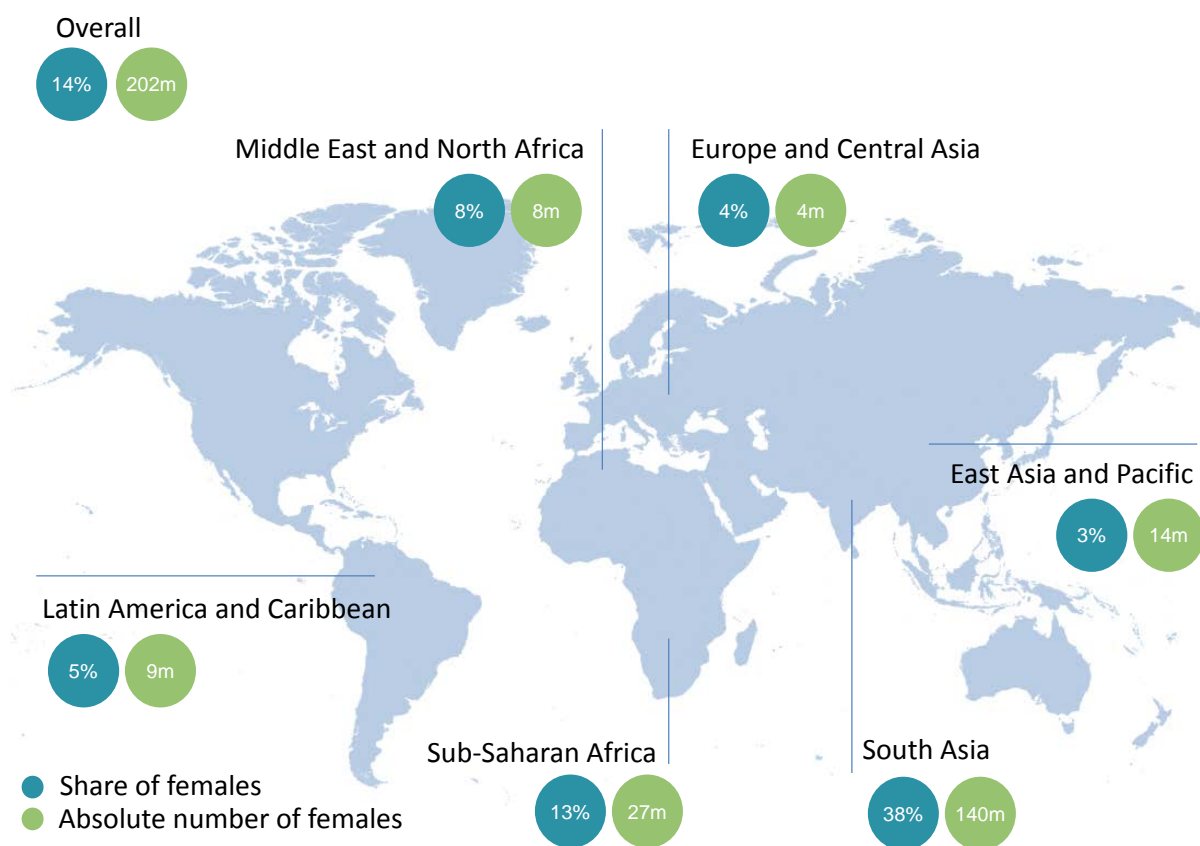
- 7. Digital tools can be part of the solution and may offer “leapfrog” opportunities for women’s economic empowerment.** The use of digital platforms is providing women with greater access to markets, knowledge and more flexible working arrangements. These can result in higher female employment rates on platforms than in traditional industries: in the United States, the proportion of female drivers is higher for Uber (14%) than for traditional taxis (8%). Furthermore, mobile money – a way to make financial transactions from SIM card to SIM card using mobile phones and without needing a formal bank account – is proving a powerful source of inclusion for the 2 billion individuals without a formal financial account.
- 8. Closing the digital gender gap is not out of reach but we need to accelerate progress.** The commitment of the G20 ministers in charge of the Digital Economy last year in Düsseldorf to foster digital gender inclusion and the range of measures devised to address the root causes of this divide are important steps into the right direction. **What the future will hold for women depends on what policy does today.** The OECD is proud to be working closely with the G20 towards better policies for bridging the digital gender divide.

1. The digital gender divide at a glance

Digital technologies have a vast potential to improve many aspects of people's work and life. Today, nearly half of the world's population is connected to networks, up from 4% in 1995. ICT enable new businesses and business model to arise, and help improve firm performance, by ensuring better communication and information flows (OECD, 2017i). However, this unprecedented growth in connectivity¹ has not been enjoyed by everyone equally. Differences in resources and in the ability to access and effectively utilise ICT within and between countries, regions, sectors and socio-economic groups have led to a **digital gender divide**, which sees women worldwide particularly at disadvantage (UN Women, 2015).

Today, globally, **there are some 250 million fewer women online than men** (ITU, 2016). This is especially worrying as the gender gap in terms of Internet penetration has been increasing since 2013. Furthermore, today **200 million fewer women than men own a mobile phone** (GSMA, 2015) (Figure 1) and even those who own one tend to use it for less complicated tasks than men (Demirguc-Kunt et al., 2015). While the majority of women who lack access to digital technologies are in developing countries – i.e. the gender gap in mobile broadband access is 45% in Sub-Saharan Africa and up to 50% in some parts of rural Asia – gaps in usage, for example, are also observed in OECD countries: Internet usage among women is below that of men in countries such as Turkey (-16%), Italy (-6%), and Germany (-3%). Gender differences in Internet uptake being more marked for older generations, a further narrowing of the gender gap can be expected in the future, as the technology continues to reduce the cost of online access and today's “digital natives” become adults (OECD, 2017h).

Figure 1. Gender gap in mobile phone ownership, by region



Note: m = million.

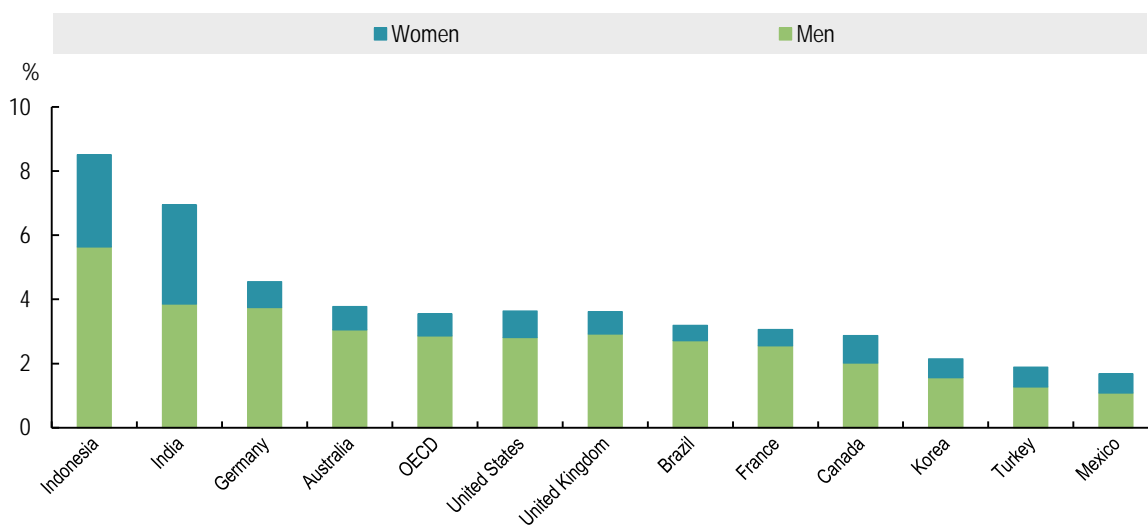
Source: OECD, adapted from GSMA (2015), *Connected Women, Bridging the Gender Gap: Mobile Access and Usage in Low- and Middle-income Countries*, <https://www.gsma.com/mobilefordevelopment/programmes/connected-women/bridging-gender-gap>.

Together with affordability of the technology, lack of relevant knowledge and skills in using digital tools are among the main reasons for the digital gender divide worldwide (see Sections 6 and 7). **In addition, socio-cultural perceptions are often reported among the top barriers for women in owning and using a mobile phone, especially in rural zones of developing countries.** In India, for instance, around 12% of women would not use the Internet because of negative social perception, and 8% of women don't use it due to the lack of acceptance by family members (Intel and Dalberg, 2012). Social-cultural perceptions and stereotypes may be also playing a role in determining a different facet of the gender divide; i.e. the under-representation of women in senior roles within digital companies and in ICT fields, both in emerging and advanced economies alike (see Sections 2 and 5): in the mobile communications industry, for instance, women worldwide are 20% less likely to hold a senior leadership position (GSMA and ATKearny, 2015), while only 8% of the investing partners at the top 100 VC firms are women.² Furthermore, in the ICT industry, the quit rate seems to be more than twice as high for women (41%) than it is for men (17%) (National Center for Women & Information Technology, 2016).

2. Women in science

Women are significantly less likely to choose natural sciences, engineering, and ICT studies. In 2015, they only accounted for 30% of all students graduating in these fields at tertiary level, within OECD countries (OECD, 2017a). Furthermore, women represent only 20% of tertiary graduates in ICT-related studies – fields which are particularly relevant for the digital era. **However, emerging economies show encouraging counter-trends:** with more than 260 000 female tertiary ICT graduates in 2015, India is the country closest to gender parity in this field, followed by Indonesia (Figure 2).

Figure 2. Tertiary graduates in ICTs, by gender, 2015



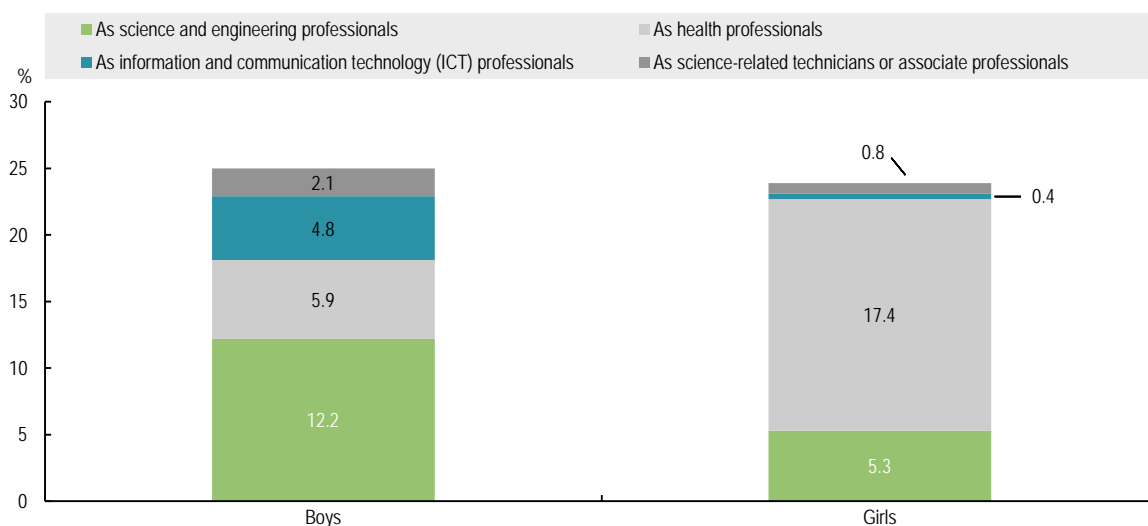
Source: Based on OECD (2017a), *OECD Science, Technology and Industry Scoreboard 2017*, <http://dx.doi.org/10.1787/888933618479>.

While there are some encouraging signs of change, the road ahead is still long. The dearth of women in fields of study such as computing and engineering is rooted in boys' and girls' gender-related career expectations (OECD, 2016c). Although, on average across the OECD, the share of boys and girls who expect a science-related career is balanced at aggregate level (at nearly 25%), there is a wide different in the choice of fields: twice as many boys expect to work as engineers, scientists or architects, while almost three times as many girls expect to become health professionals. When it comes to a career in ICT the gap widens to 4.8% of boys and only 0.4% of girls (Figure 3). Particularly large differences between boys' and girls' career expectations are observed in some countries, even in those countries with high rates of female participation and pro-female gender norms. In Finland, for example, boys (at 6.2%) are more than four times as likely as girls (at 1.4%) to expect a career as an engineer, scientist or architect (OECD, 2015b). These findings indicate that **the career paths of boys and girls are already starting to diverge before the age of 15, and well before important career choices are actually made**. One contributing factor is entrenched stereotypes about passed on to children by their families, teachers, and society at large. Indeed, OECD PISA (Programme for International Student Assessment) reveals, that parents are more likely to expect their teenage sons than their daughters to work in STEM occupations – even when their daughters perform just as well as in STEM fields (OECD, 2015a).

Fortunately, OECD PISA data also show that, in many countries, girls excel and do have the confidence that is necessary to have successful careers in science and technology. Nonetheless, although data suggest that boys and girls are generally on a par when it comes to performance in science, gender differences do emerge in boys' favour among the highest achieving students in test questions which require students to explain phenomena scientifically, or refer to physical systems that require, for example, knowledge of the structure and properties of matter. On the other hand, girls are generally less likely to appear among the lowest-achieving students,

and appear to be more proficient in evaluating and designing scientific enquiry, and to have more interest in knowing how scientists enquire and develop scientific theories. These differences come on top of gender differences in mathematics performance among the highest achieving students, reinforced by the fact that many girls hold negative attitudes about their mathematics abilities and express high levels of mathematics anxiety (OECD, 2015). Policy makers across the OECD are aware of gender stereotyping at school and the effect that it may have on future education and career choices and many countries have initiated efforts to address these stereotypes and further bridge the divide (see Section 9).

Figure 3. Proportion of 15-year-olds who expect to work in a science-related occupation by the age of 30, by type of science professional, OECD average, 2015



Notes: ICT = information and communication technology. OECD PISA 2015 asked students what occupation they expected to be working in by the time they reached the age of 30. Students could enter any job title or description in an open-entry field; their answers were later classified according to the International Standard Classification of Occupations, 2008 edition (ISCO-08). These coded answers were used to create an indicator of science-related career expectations, defined as those whose realisation requires the study of science beyond compulsory education, typically in formal tertiary education. Within this large group of science-related occupations, the following major groups were distinguished: science and engineering professionals; health professionals; science technicians and associate professionals; and ICT professionals.

Source: OECD (2016b), *Education at a Glance 2016*, <http://dx.doi.org/10.1787/eag-2016-en>.

Even those girls that do persevere and study STEM and go into scientific careers continue to face barriers to attaining senior decision-making positions within scientific occupations. A new indicator, based on an experimental global survey of scientific publication authors, shows that only 21% of scientists who are identified as “corresponding authors” – a proxy term for leadership in the world of research – are women (Figure 4) (OECD, 2017a). And while women account for around 20% of peer reviewers and editorial board members, this share drops to less than 15% when these activities are remunerated. While women see the relevance of their scientific outputs being recognised by citations in medicine protocols or legal proceedings, their impact is systematically less acknowledged in patents, media and government reports. Furthermore, in 2015, only 17% of those scientists earning more than USD 105 000 were women. Finally, the representation of women among corresponding authors is highest in the social sciences, especially in the arts and humanities (slightly above 30% of corresponding authors), and lowest in physics, followed by materials science and chemical engineering at 15% or less). These figures, which partially reflect the gender composition of the R&D personnel and doctorate holders, point to a male-centric academic world and suggest that gender equality in scientific publishing and team leadership is not a reality, at least not yet.

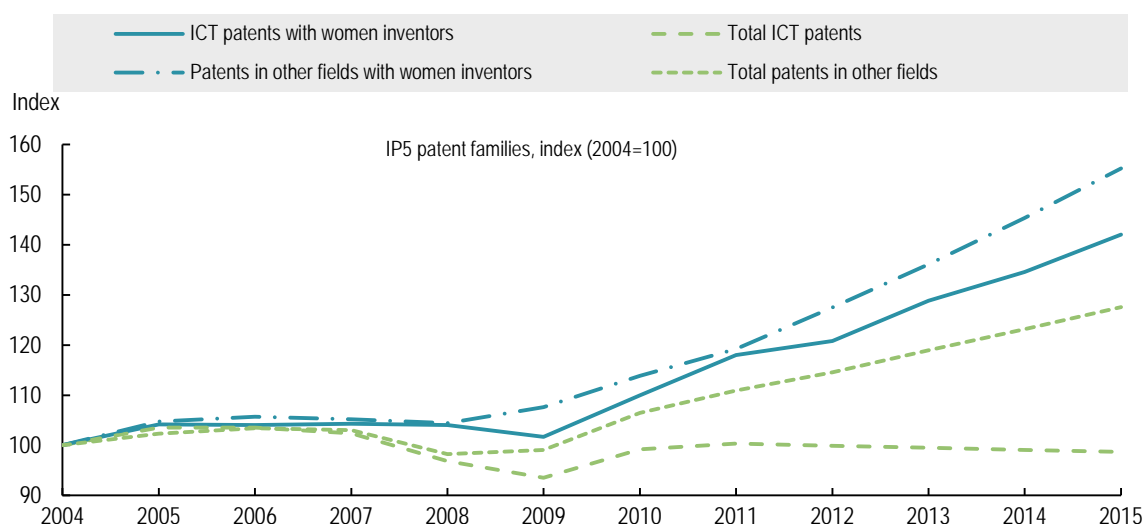
Figure 4. Share of women within the relevant group of corresponding scientific authors

Source: OECD (2017a), *OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation*, <http://dx.doi.org/10.1787/9789264268821-en>.

3. Women inventors: a narrowing gap in patenting activity?

Narrowing the gender gap requires not only empowering women in science and R&D, but also allowing them to experiment, invent and claim credit for their innovation. One way to assess whether and to what extent women are able to do so is to look at the proportion of patents featuring women inventors. OECD analysis³ focusing on G20 countries shows that **over the last two decades the number of patents featuring at least one woman in the team of inventors has increased more rapidly than the average of all patents**. As a consequence, in the G20 area, the share of patents invented by women reached 8.4% in 2014, compared to a level of 5.6% in 1994. Furthermore, women participation in inventive activities grew in all technology domains, and especially so in patents related to ICT, therefore suggesting an increasing contribution of women to the digital transformation (Figure 5).

Figure 5. Patents featuring woman inventors in G20 countries

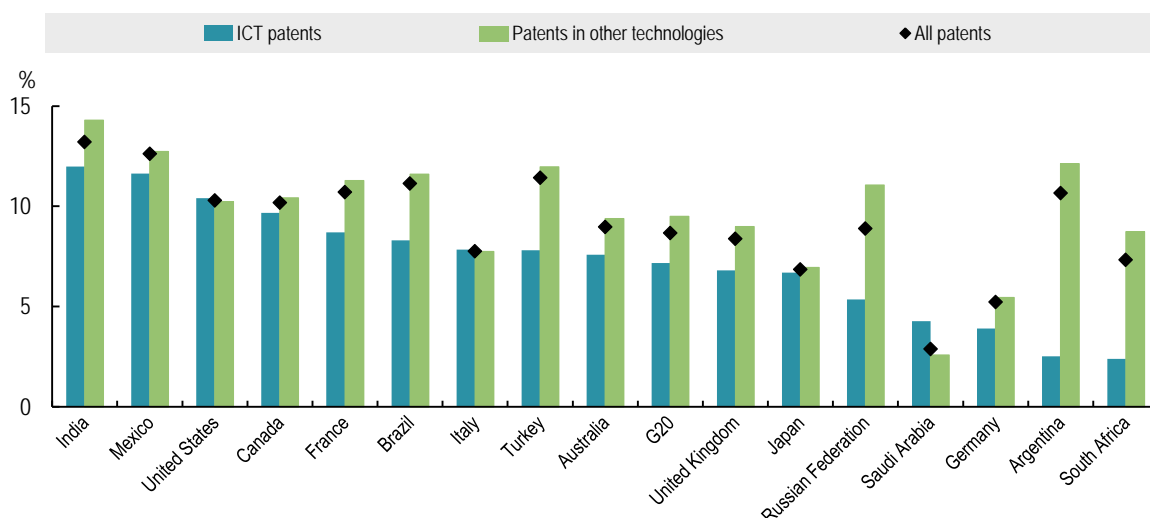


Notes: ICT = information and communication technology. Data refer to patents with at least one woman inventor located in G20 countries in the team of inventors listed in the patent documents. Data are based on whole counts. IP5 patent family figures from 2014 are estimates based on existing data.

Source: OECD (2018), *STI Micro-data Lab: Intellectual Property*, <http://oe.cd/ipstats> (accessed January 2018).

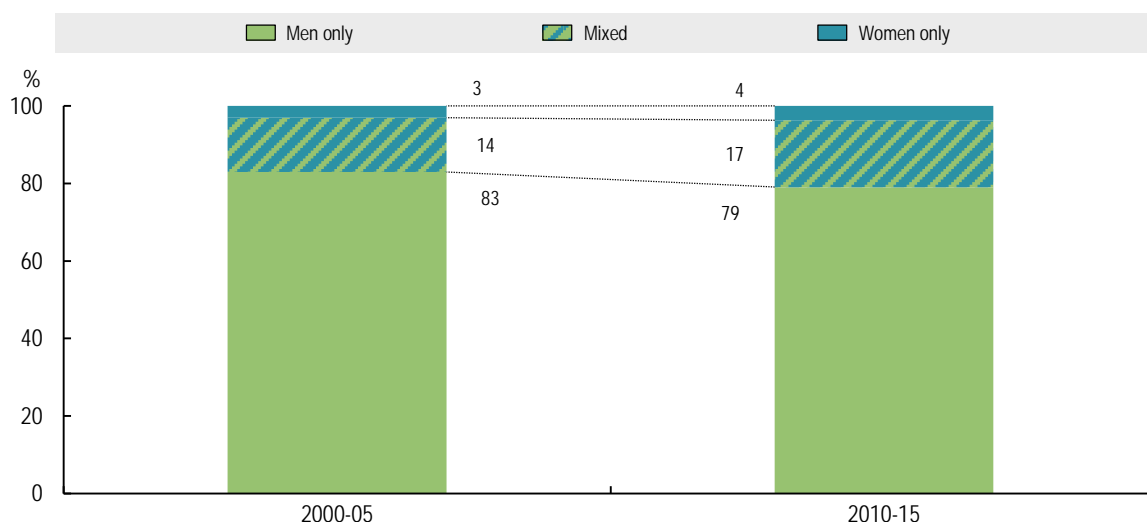
The recent growth in the number of ICT-related patents featuring at least one woman in the team of inventors is a much welcome sign of the possible narrowing of a historical gender gap. With the exception of the United States and Saudi Arabia, women inventors in G20 countries have traditionally been less active in ICT-related patents than in other technology domains (especially chemistry, pharmaceuticals, biotechnologies). Overall, among G20 countries, India, Mexico, Turkey and Argentina reported the highest shares of innovations invented by women that received a patent between 2010 and 2015 (Figure 6).

While some encouraging signs of change have begun to emerge, the broader evidence about female participation in inventive activities point to the existence of a wide and persistent gender gap. Still in 2015, almost 80% of all patents filed at key intellectual property offices worldwide came from teams of only men, basically unchanged over the decade (Figure 7). Also, between 2010 and 2015, the number of inventions made by female-only teams represented nearly 4% of patents, compared to 3% observed in the 2000-05 period. Mixed teams of men and women accounted for 17% of all patent families from 2010 to 2015, 3 percentage points more than between 2000 and 2005. While these figures suggest some gains, the sheer size and the slow pace at which the gap is narrowing underscore that gender equality among inventors remains an uphill battle.

Figure 6. Share of patents invented by women, G20 countries, 2010-15

Notes: ICT = information and communication technology. The share of patents invented by women refers to the number of patents with women inventors located in a given country divided by the number of patents invented in the country, by technology. Due to incompatibility of data, Korea and the People's Republic of China are not included in the G20 average. Figures from 2014 onwards are based on incomplete data and only countries with more than 50 IP5 patent families in 2010-15 are included.

Source: OECD (2018), *STI Micro-data Lab: Intellectual Property*, <http://oe.cd/ipstats> (accessed January 2018).

Figure 7. Composition of inventors' team by gender, G20 area

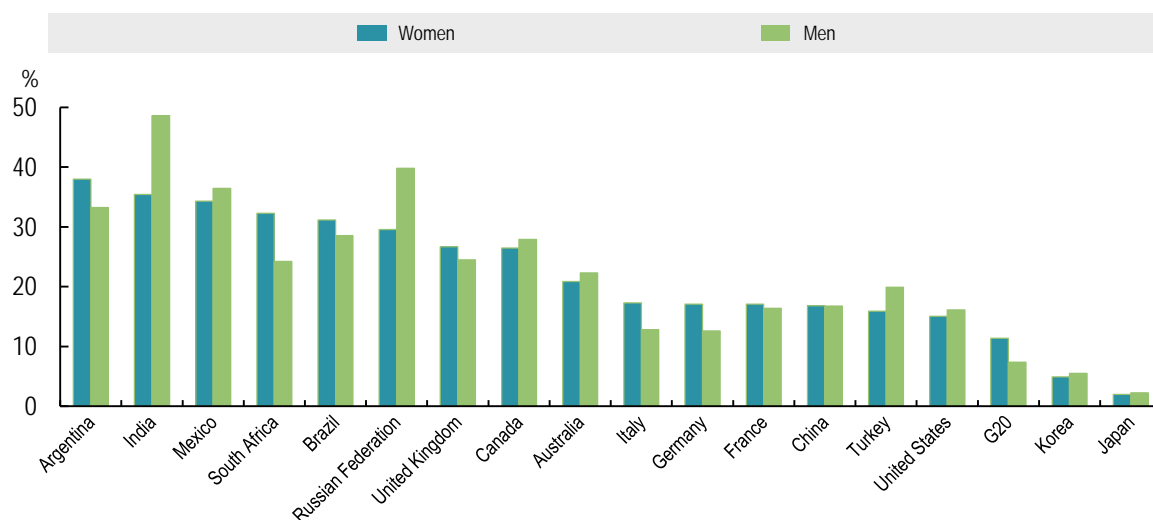
Note: The indicator is based on whole counts of IP5 patent families by inventors' country.

Source: OECD (2018), *STI Micro-data Lab: Intellectual Property*, <http://oe.cd/ipstats> (accessed January 2018).

Diversity and international collaborations have been found to increase the value of the inventive output. But, what is the role of women inventors in international collaboration? **Between 2010 and 2015, an average 11% of patent families invented in G20 countries were the result of international collaborations, meaning that they included at least one foreign co-inventor besides one or more domestic inventors. While the level of international cooperation varies among countries, data suggest that in G20 countries women generally tend to be more involved in international co-inventions (Figure 8) than men.**

Figure 8. International collaboration of inventors, 2010-15

International co-inventions as a percentage of IP5 patent families

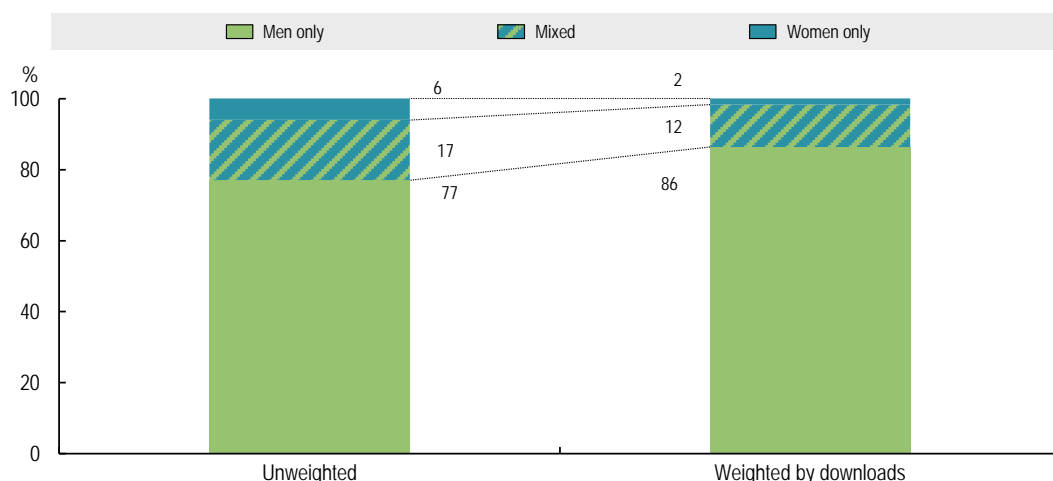


Source: OECD (2018), *STI Micro-data Lab: Intellectual Property*, <http://oe.cd/ipstats> (accessed January 2018).

4. Software: still mainly about (male) geeks?

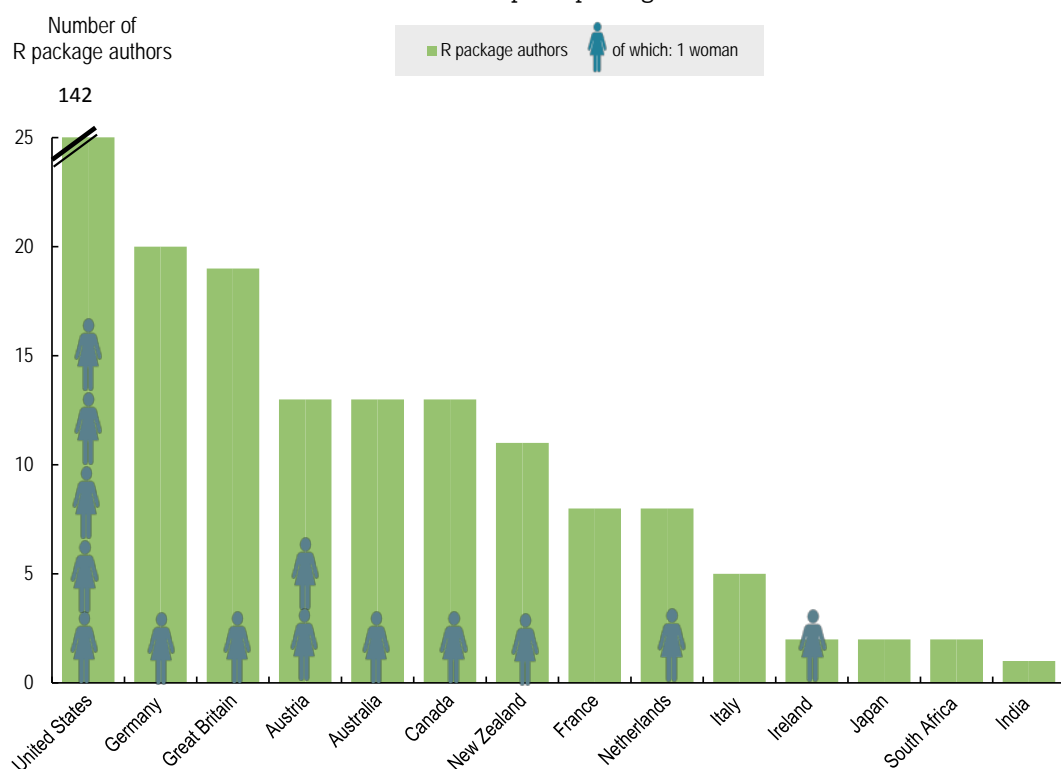
As innovation goes increasingly digital, software use and creation becomes a key asset for the digital transformation. Experimental indicators using information about a popular open-source programming language for data analysis, R, shows that about three quarters (i.e. 77%) of the 12 000 R-based software packages created during the period 2012-17 were produced by teams of only men. Women-only teams accounted for a mere 6% of such packages, whereas the remaining 17% came out of mixed teams of software developers (Figure 9).

Figure 9. Gender composition of teams producing R-based software packages
Number of packages and downloads, October 2012 – December 2017



Source: OECD (2018), *STI Micro-data Lab: Intellectual Property*, <http://oe.cd/ipstats> (accessed February 2018).

Figure 10. R package authors, by country
Data related to top 300 package authors



Source: OECD (2018), *STI Micro-data Lab: Intellectual Property*, <http://oe.cd/ipstats> (accessed February 2018).

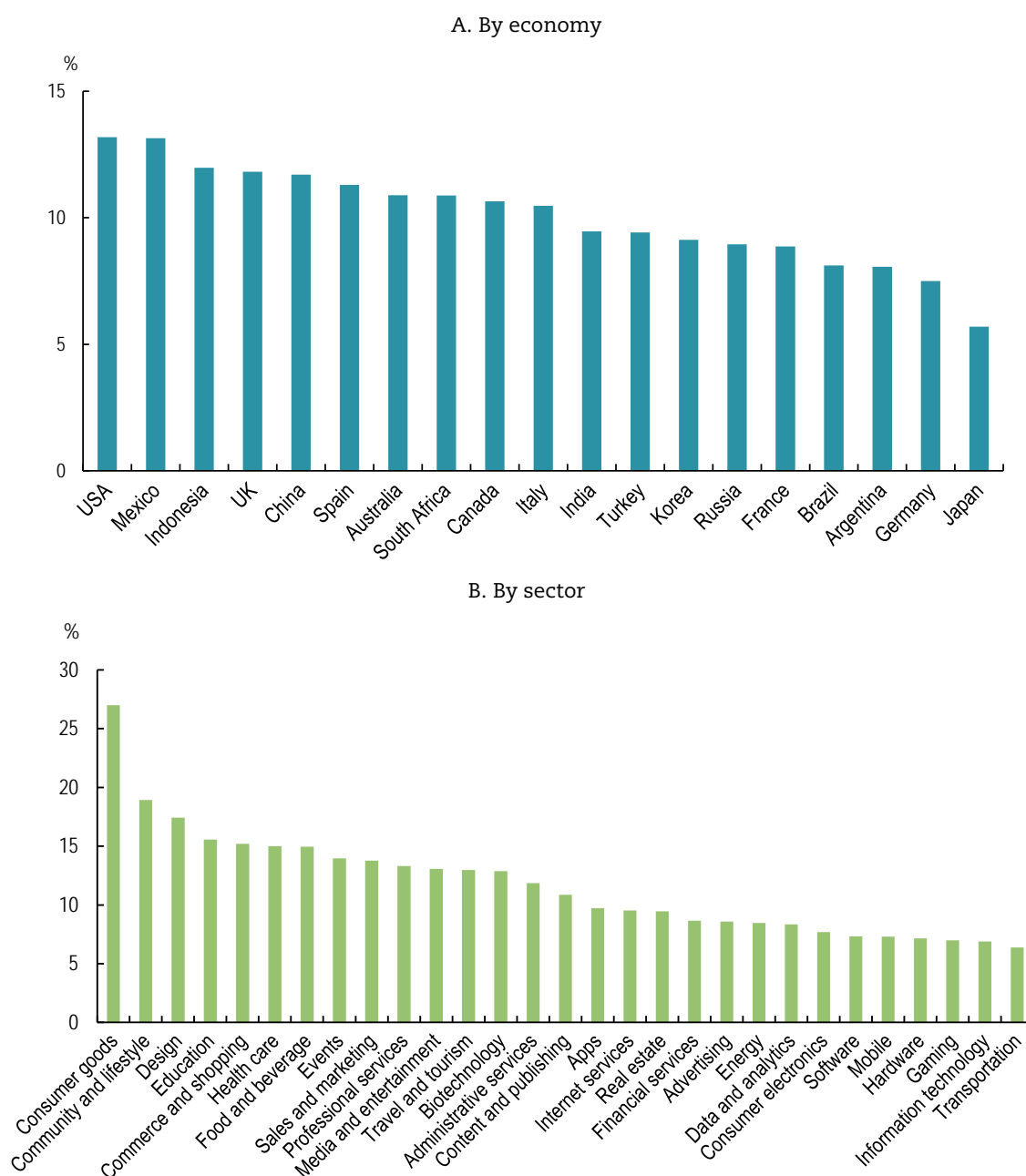
A look at the downloads of these R-based software packages, which can be taken as a sign of the usefulness of such software, unveils the **marginal role of women in the software world**: the vast majority of (86%) of download-weighted packages were authored by men-only teams against a tiny 2% of packages authored by teams solely made of women.

Looking at the location of top R-based software package authors shows that in many countries software is a male-only affair (Figure 10). Given the growing importance of “big data” analytics to the digital economy, this gap is of concern both in terms of engagement of women as well as potential unintended biases that may be embedded due to a lack of diversity.

5. The gender gap in start-up activity and venture capital investments

Innovative entrepreneurship is essential for economies. Yet despite the proven role of entrepreneurship as an engine of social inclusion (OECD and European Commission, 2014), the gender gap in entrepreneurship is striking and persistent, with men being nearly twice as likely as women to be self-employed (OECD and European Union, 2017), and three times more likely than women to own a business with employees across OECD countries (Piacentini, 2013).

Figure 11. Share of females among start-up founders



Note: Percentage of females in the sample of founders of companies less than ten years old and for whom gender is known.

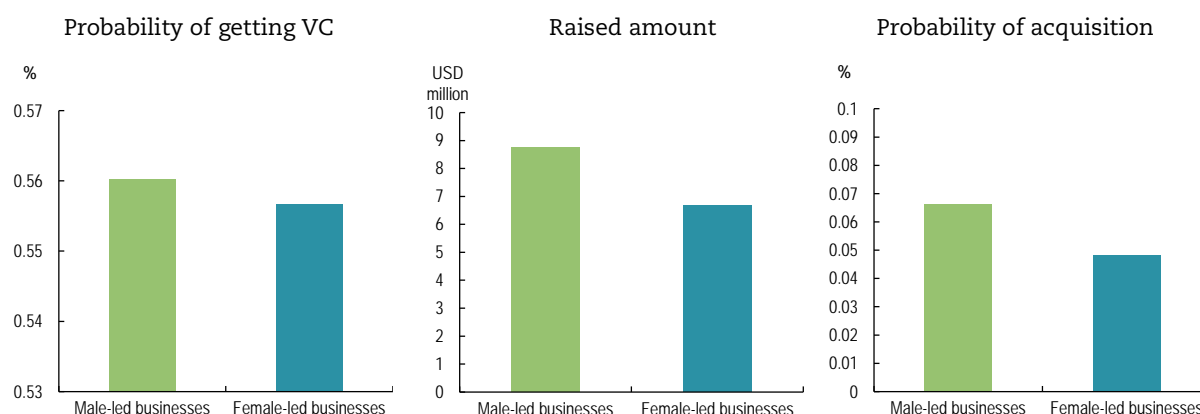
Source: OECD, based on Breschi, Lassébie and Menon (2018), www.crunchbase.com.

Women entrepreneurs also appear to be missing out on the opportunities created by globalisation and digitalisation – women-operated businesses are less likely to export, and less likely to engage in international business-to-business transactions (OECD, 2017b). Perceptions, once again, may be playing an important role: only 37% of women in OECD countries *believe* that they have the skills to start a business, compared to 51% of men. Moreover, new female entrepreneurs are only half as likely as men *to expect* to create at least 19 jobs over the next five years (OECD and European Union, 2017).

Among innovative start-ups looking for VC investments, the gender gap is even more striking: only 11% of such start-up founders are female. This share varies substantially across countries and sectors; however, even at best, female entrepreneurs represent less than a third of all start-up founders (Figure 11). **Unleashing the full potential of female entrepreneurial talents is needed to make women thrive.**

Not all start-up founders look for investors in the VC market to help get their businesses off the ground, but those who do, know how difficult the pitching process can be. Recent OECD analysis based on Crunchbase data⁴ finds that raising capital is even more difficult for female-owned firms (Breschi, Lassébie and Menon, 2018): in a sample of 25 000 start-ups operating across a wide set of countries and sectors, female-led business ventures, i.e. start-ups with at least one female founder, are significantly less likely to be funded. Even if they are funded, they **receive on average 23% less funding** than male-led start-ups, even after controlling for the location and the nature of the start-up, as well as for the education level and professional background of start-up founders (Figure 12). Female-led start-ups are also 30% less likely to have a positive exit, i.e. be acquired or to issue an initial public offering. This is consistent with well-known anecdotes reporting “a particularly toxic atmosphere for women in Silicon Valley” (Burleigh, 2015) (and in other start-up hot-spots).

Figure 12. The gender gap in start-up funding and acquisition



Note: The graphs show results from Ordinary Least Squares (OLS) regressions of the three outcomes variables on a set of founders and firms characteristics, and country and sector fixed effects. Bars show the average predicted probability of receiving VC, the amount of funding conditional on getting VC and the probability of acquisition for male- and female-led businesses. The advantage of this way of representing the data is that it gets rid of potential confounding effects such as education or prior experience of start-up founders.

Source: OECD, based on Breschi, Lassébie and Menon (2018), www.crunchbase.com.

Several **factors may** contribute to explain the gender gap in entrepreneurship and determine the gap in start-ups activity and VC investment (Johnstone et al., forthcoming). Among them:

- It may be yet another reflection of the widespread gender gap in **STEM studies**, which are particularly relevant for acquiring the skills needed to thrive in the innovative entrepreneurship world (see Section 2).⁵
- Differences in **attitudes towards risk** may also play a role, as women are generally more risk averse than men with regard to financial decisions (Croson and Gneezy, 2009) and less likely to try to start a new venture after a failure.

- Gender differences in network formation and in **social network ties to secure VC funding** (Stephan and El-Ganainy, 2007) **can be playing a significant role.** In a similar vein, “**homophily**” may be influencing equity financing, with investors – who are disproportionately male – more likely to finance other men.

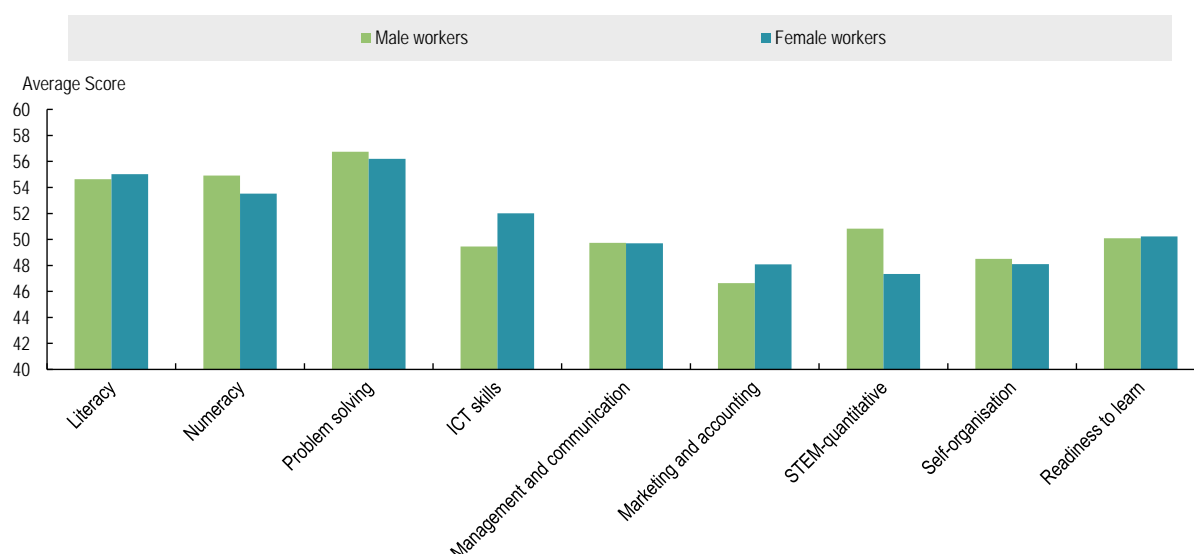
The glass looks half empty if one considers that the share of women acquiring the position of “partner” in VC firms has been increasing in recent years at an extremely slow pace (Crunchbase News, 2017), with the number of female partners at the top one hundred venture firms going up only by 1% in 18 months (i.e. 64 women out of 752 partners at the top 100 VC firms). The same glass may look half full, though, if one considers that even a small increase in female representation in venture firm partnership could translate to a more favourable VC market for female-led start-ups. Evidence show that VC firms with a female partner are more than twice as likely to invest in a company with a woman on the management team (34% vs 13%); and they are three times as likely to invest in female CEOs (58% vs 15%) (Diana Project, 2014).

Boosting the presence of women on the supply side of financial markets is surely a step in the right direction. While many G20 countries are increasing support to female entrepreneurs (see Section 11), more needs to be done. Women entrepreneurs have enormous potential for making greater contributions to economic growth, job creation, innovation and social inclusion: some recent estimates suggest that if the entrepreneurship gender gap were eliminated, global GDP could rise by as much as 2% annually (Blomquist et al., 2014).

6. Women at work in the digital era: less training but higher labour market returns?

As the digital revolution unfolds and the content and nature of jobs change, so do the skills required to perform them. Solid cognitive skills, coupled with the ability to solve problems and to learn and think creatively, are key to adapting to the scale, speed and scope of digital transformations. Recent OECD analysis (OECD, 2017c), based on the frequency of tasks performed at work, shows that, on average, workers in digital intensive industries exhibit a greater endowment of all types of skills. This is true for cognitive as well as non-cognitive and social skills, and notably for ICT⁶ skills, STEM-quantitative and self-organisation skills. In short, all these skills are particularly important to successfully navigating the digital transformation. Looking at the skill levels of male and female workers across 31 developed and developing countries (Figure 13) female workers generally appear to be equipped with relatively better literacy, ICT, marketing and accounting skills, while male workers display greater endowments of numeracy and STEM-quantitative skills, and slightly better problem solving and self-organisation skills. This might to some extent be explained by women's relatively lower propensity to pursue STEM-related studies (see Section 2). Given that these skills are significantly and positively related to labour market returns (OECD, 2017c, based on Grundke et al., forthcoming), especially for workers employed in digitally intensive sectors, part of the persistent gender wage gap observed across countries can be explained by men's current greater endowment of numeracy and STEM-quantitative skills.

Figure 13. Average skill levels for male and female workers, 31 OECD countries and partner economies, 2012 or 2015



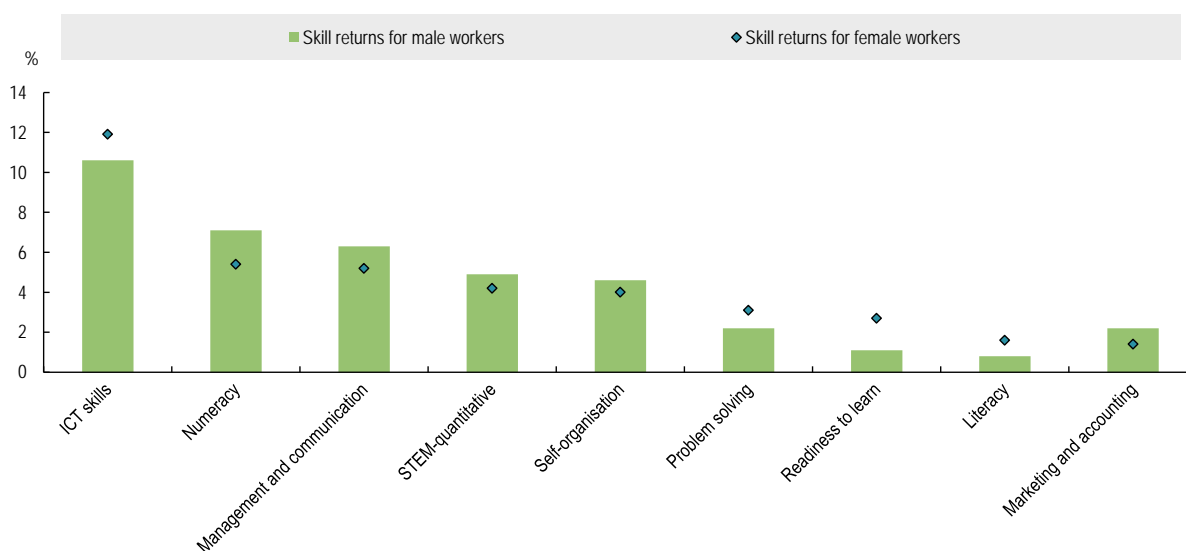
Notes: ICT = information and communication technology; STEM = Science, technology, engineering and mathematics. All skill indicators are rescaled to the interval 0-100. Averages across 31 OECD countries and partner economies are computed giving the same weight to each country. All differences in skill means between male and female workers are significant at the 5% level, except for Management and communication and Readiness to learn.

Source: OECD (2017c), *Towards the implementation of the G20 Roadmap for digitalisation: Skills, business dynamics and competition*, www.oecd.org/g20/OECDreport_Implementation_G20_Roadmap.pdf.

The relative importance of certain skills in the digital transformation can also be seen by looking at whether labour markets reward various skills differently, and how this may differ between the sexes. **OECD analysis shows that while men have higher returns to management and communication skills, the returns related to ICT skills and readiness to learn are higher for women** (Figure 14). These results hold also when differences among individuals in age, education, country, industry or occupation of employment are taken into account. The increase in earnings of female workers due to an increase in their ICT skills ranges from approximately 4% (Denmark) to 19% (Korea) and is on average 12 percentage points (holding other observable characteristics of the individual constant).

This suggests that women may find themselves better off in a digital world, which increasingly demands ICT skills, and which is willing to reward them proportionally more. **The provision of greater ICT skills for women could be a policy lever to narrow the gender wage gap at least in the short term, before the labour market adjusts to the increased supply of ICT skills.** Narrowing the gender wage gap may require policies aimed to equip female workers with better numeracy, STEM-quantitative skills and ICT skills, starting with encouraging them to pursue STEM-related studies and supporting the ever-increasing need for systematic updating and enhancement of workers' skill sets.

Figure 14. Labour market returns to skills by gender across 31 OECD countries and partner economies, 2012 or 2015



Notes: ICT = information and communication technology; STEM = Science, technology, engineering and mathematics.

Labour market returns to skills are based on Ordinary Least Square (OLS) wage regressions (Mincer equations) using data from the OECD Survey of Adult Skills (PIAAC) (OECD, 2017j) for 31 OECD countries and partner economies. The estimates by gender are obtained through including an interaction term of the skill variable and the gender variable. The figure shows the percentage changes in wages determined by an increase in skills by one standard deviation, holding other correlates of individual wages constant. Shaded diamonds indicate that the difference between man and women is not significant at the 5% level.

Source: OECD (2017c), *Towards the implementation of the G20 Roadmap for digitalisation: Skills, business dynamics and competition*, www.oecd.org/g20/OECDreport_Implementation_G20_Roadmap.pdf.

Adult learning may allow for smoother transitions of individuals between occupations and sectors, thus helping people reap the benefits of the digital transformation, while minimising its social costs. For this to happen, however, **equity in learning opportunities needs to be enhanced.** Recent OECD analysis shows that, on average, across countries, only approximately 25% of workers receiving training in 2012 or 2015 are classified as having low skills. In fact, those who are most likely to get trained are those with already a high proficiency in numeracy and literacy, when observable characteristics are held fixed. Furthermore, workers performing jobs that are largely routine in nature (which are also the ones at higher risk of losing their jobs, since routine tasks are easier to automate) have a lower probability to be trained. **Finally, men receive systematically more hours of training than women performing similar jobs. Re-thinking and better targeting the beneficiaries of current training programmes may help the most vulnerable and give them opportunities to effectively adapt their skills during their working life to fully benefit from the digital era.**

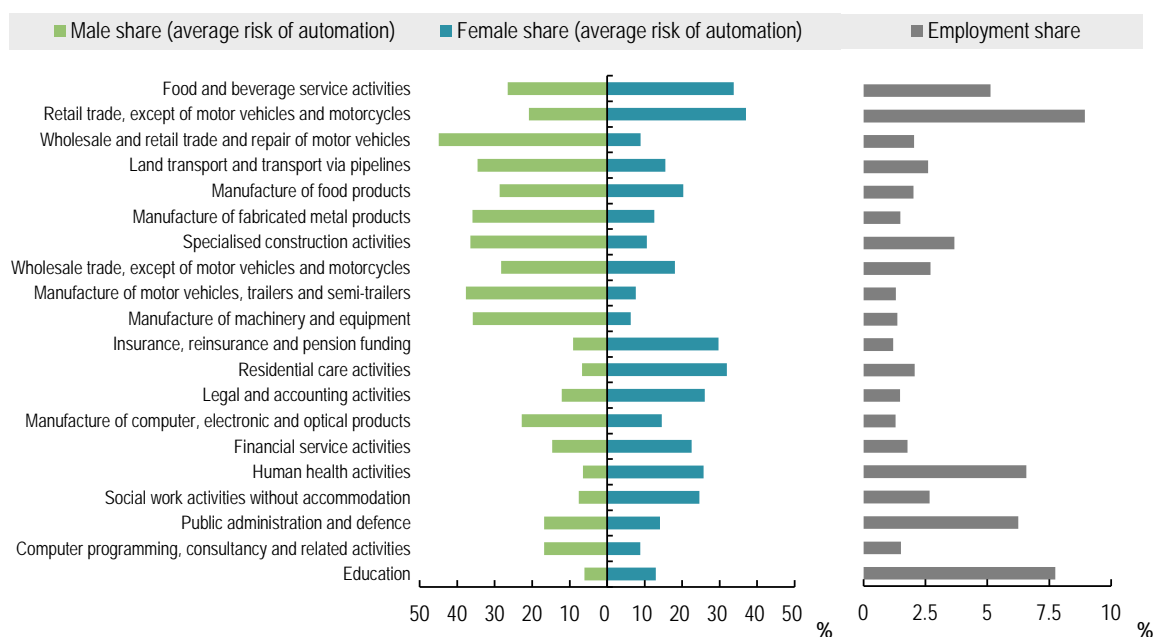
This entails removing barriers to human capital development and to adult education, for both men and women. This could be done through tax systems designed to support learning and through targeted supports aimed at alleviating the costs of learning for those in need of help. It could also mean providing more flexible opportunities for adults to upgrade their skills, including easing access to formal education, improving the recognition of skills acquired after initial education, providing family support and enhancing career guidance. This would help women especially, as the OECD Survey of Adult Skills (PIAAC) (OECD, 2017j) shows that family responsibilities are a major barrier to participation in education and training for women.

7. The future of work for women: more at risk of automation?

Technological innovations can contribute to greener production, safer jobs (with some hazardous work performed by robots), new and more customised goods and services, and faster productivity growth. While new technologies will create jobs through a number of channels, and productivity-raising technologies will benefit the economy overall, the associated adjustments will have consequences on many domains, including employment and well-being (OECD, 2017d). An issue that sparks much debate is automation: some fear that it may result in significant loss of jobs, particularly in the case of industrial robots which are designed to carry out tasks otherwise performed by humans (OECD, 2017a). Recent studies however find that robots do improve productivity, but that their impact on employment and wages is ambiguous (Graetz and Michaels, 2015; Acemoglu and Restrepo, 2016; Acemoglu and Restrepo, 2017). In parallel to increasing automation, over the past two decades, most OECD countries have experienced a process of labour market polarisation whereby the share of employment in high-skilled (and to some extent in low-skilled jobs) has increased, while the share of employment in middle-skilled jobs has decreased (Autor, Katz and Kearney, 2006; Marcolin, Miroudot and Squicciarini, 2016; OECD, 2017f). Estimating to which extent technological advances in artificial intelligence, ICT and robotics will lead to further automation is complex, and estimates vary considerably. Recent calculations place the percentage of jobs at a high risk of being displaced by automation (i.e. over 70% of tasks in those jobs could be automated) in the next 15 to 20 years in the range 9% (OECD, 2016a) to 14%, for OECD countries (Quintini, 2018). Another 30% or so of jobs are at risk of significant change as a result of automation.

Figure 15. The average risk of automation, by industry and by gender

20 industries with the greatest number of jobs at risk



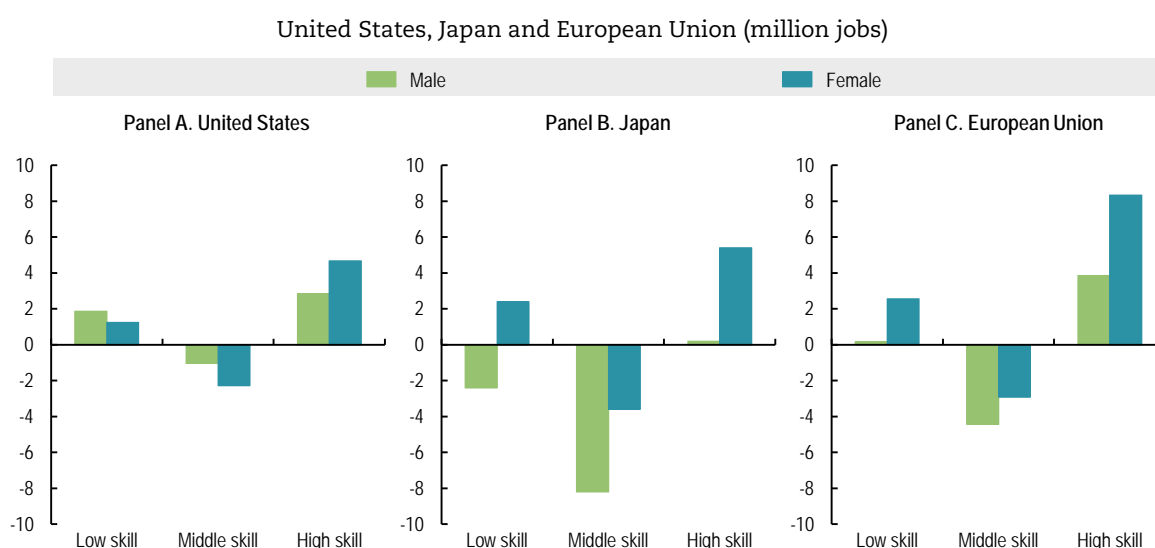
Notes: The chart shows the 20 industries with the greatest number of jobs at risk (measured as the average risk of automation weighted by the employment share of the industry), in descending order of overall risk of automation (left panel). The width of each bar in the left panel represents the average share of jobs at risk in each industry. The placement of each bar relative to the centre line depicts how that risk is shared between men (light blue) and women (grey). Values in the right panel represent the share of total employment held by each industry. Risk of automation values are based on likelihoods calculated in Arntz, Gregory and Zierahn (2016). Countries covered in this analysis include the 29 OECD countries that participated in the first and second rounds of the OECD Survey of Adult Skills (PIAAC) (OECD, 2017j).

Source: OECD (2017e), "Going Digital: The future of work for women", www.oecd.org/employment/Going-Digital-the-Future-of-Work-for-Women.pdf.

Whether automation will affect men and women to different extents is not clear. While the risk of automation has traditionally been highest in manufacturing, where men dominate, OECD analysis shows a mixed and more nuanced picture. Some large industries with high shares of women such as food and beverage service activities, and retail trade (OECD, 2017e) (Figure 15) appear at a high average risk of automation. Men, in turn, feature prominently in industries like manufacturing, construction and transportation where the average risk of automation is also high. Other sectors, such as education, social work and health care seeing an important presence of women have a lower risk of job automation; but since many women work in these large sectors, the absolute number of female workers at risk of being displaced is still high. **On average, across all industries, men and women are seemingly exposed to similar risks of automation.**

However, there are several reasons why the risk of automation may not necessarily translate into actual job losses. Technology development and adoption depend on a host of economic, legal, ethical and social factors, as well as on the availability of the skills needed to make technology work. In addition, not all technological change is labour-replacing: **some digital technologies make workers more productive.** At the same time, it is important to bear in mind that **technological progress is creating many new jobs** – either directly (for example big data architects, cloud service specialists or digital marketing specialists⁷) or indirectly through its effect on demand (e.g. by lowering prices of goods and services, and increasing their quality).

Figure 16. Change in employment levels, by gender and skill level, 2003-15



Notes: High-skill occupations include jobs classified under the ISCO-88 major groups 1, 2 and 3, namely: legislators, senior officials, and managers (group 1); professionals (group 2); and technicians and associate professionals (group 3). Middle skill occupations include jobs classified under the ISCO-88 major groups 4, 7, and 8: i.e. clerks (group 4); craft and related trades workers (group 7); and plant and machine operators and assemblers (group 8). Low skill occupations include jobs classified under the ISCO-88 major groups 5 and 9, namely: service workers and shop and market sales workers (group 5), and elementary occupations (group 9). European EULFS employment data beyond 2010 are mapped from ISCO-08 to ISCO-88 using a many-to-many mapping technique. Data for Japan is for the period 2003 to 2010 due to a structural break in the data. Data for the European Union includes: Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, the Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, and the United Kingdom. Data for Germany is from 2003 to 2013.

Note by Turkey:

The information in this document with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the “Cyprus issue”.

Note by all the European Union Member States of the OECD and the European Union:

The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Source: OECD (2017e), “Going Digital: The future of work for women”, www.oecd.org/employment/Going-Digital-the-Future-of-Work-for-Women.pdf.

Skills provide an important safeguard against the risk of automation (OECD, 2017g). Fewer than 5% of workers with a tertiary degree are at a high risk of losing their job due to automation, on average, compared to 40% of workers with a lower secondary degree (Arntz, Gregory and Zierahn, 2016; OECD, 2016a). This is good news for women: across OECD countries, more women than men are now tertiary graduates (OECD, 2016b). **Indeed, looking at the type of jobs gained and lost over the last 15 years, shows that most job growth has been on the high-skill end, and that women have benefited from this more than men** (see Figure 16). This is true in the United States, Japan, as well as in Europe as a whole. Similarly, jobs in the middle of the skills distribution have declined in absolute terms in all countries, but the gender distribution of losses varies by country. Everywhere, more women now also work in low-skilled jobs. In the United States, a larger share of the growth in low-skilled jobs has gone to men, while the opposite is true in Europe. In Japan, the number of men in low-skilled jobs has declined.

8. Leapfrogging opportunities to bridge the digital gender divide

While the gender gap in the access and usage of digital technologies remains a challenge for policy, society as a whole as well as individuals, digital technologies can provide “leapfrog” opportunities for women’s economic empowerment and contribute to bridging the digital gender divide.

Platforms: The use of digital platforms may offer women many additional opportunities, including the possibility to overcome challenges related to physical immobility, access to new markets, to knowledge as well as flexibility in working time and supplementing household income: Etsy found that 17% of its sellers, for instance, have annual household income under USD 25 000 and nearly half had never sold their goods before joining Etsy (Etsy, 2015). The use of digital platforms may therefore result in relatively higher female employment rates on platforms than in traditional industries or businesses: in the United States, for example, the proportion of female drivers is higher for Uber (14%) than for traditional taxis (8%) (Hall and Krueger, 2015). Furthermore, online platforms may allow women to more easily access new product markets, which, in turn, can trigger innovation in e-commerce. Evidence from the United States shows that gender pay gaps also tend to be lower in industries where working arrangements are more flexible (Goldin, 2014) and that women perceive their work through digital platforms as a possibility for equal pay to their male counterparts (Hyperwallet, 2017). In the online Chinese e-commerce group Alibaba women account for 9 of the 30 partners, while on average only 6% of corporate board positions are occupied by women in Asia (Financial Times, 2014). Finally, analysis from Europe shows that greater work flexibility goes hand-in-hand with higher employment rates among mothers (OECD, 2017k and calculations based on Eurofound, 2015).

Mobile phones: Mobile phones have proved to have both direct and indirect effects on the economic situation and social well-being of women, their families and the wider economy. On an individual level, mobile phones have contributed to economically empower women, through enhanced access to information, markets, and improved saving behaviour. They have also provided women with improved access to knowledge about governmental support, pension rights, medical treatments and maternal health care. Closing the digital gender gap is also a business opportunity: it is estimated that connecting women would provide the mobile industry with a new market worth USD 170 billion over the period 2015-20 (GSMA, 2015).

Figure 17. Countries with installed mobile money services for those without a bank account



Source: OECD, based on GSMA (2018), “Mobile Money Deployment Tracker”, <https://www.gsma.com/mobilefordevelopment/m4d-tracker/mobile-money-deployment-tracker>.

Mobile money: Today, 45% of adults worldwide – or 2 billion individuals – do not have a formal financial account (e.g. bank account). For them, mobile money can be a resource – this is a way to make financial transactions from SIM card to SIM card using mobile phones and without requiring subscription to a formal bank account. However, despite mobile money having grown to a significant size and having reached the mark of over half a million registered accounts in less than a decade (Figure 17), women as a whole are less likely to own and use a mobile money account. Closing the gender gap in access to mobile money can help reduce remittance costs, facilitate digital finance and thus increase the volume of transactions and loans to individuals and businesses, as well as allow governments to save by reducing leakage in spending and tax revenue. This would ensure broader financial inclusion, and ultimately help reaching sustainable development goals.

9. Bridging the digital gender divide: from national practices to a global effort

Policy can play an important role in creating a more inclusive digital world by improving access to digital technologies, by endowing people with the skills needed to cope with and thrive in the digital transformation, and by fostering employment, entrepreneurship, financing and leadership in the digital era. Recognising both the opportunities that digitalisation is providing for the economic empowerment of women, and the challenges of ensuring that the benefits of the digital transformation are being equitably shared by all, G20 ministers in charge of the Digital Economy in Düsseldorf in April 2017 agreed to support the equitable participation of women in the digital economy. As a first step in the G20s actions to help increase the economic empowerment of women in the digital economy, G20 members agreed to “*share national practices on efforts to bridge the digital gender divide*” (Action 11 in G20 [2017]). Initial results of this sharing exercise show that many G20 countries have a national strategy, policy or plan that includes efforts to reduce the digital gender divide (Box 1). Many countries have laws or regulations which include gender-related provisions when developing digital economy policies and few countries have set time-bound targets for women’s participation in STEM, in entrepreneurship activities or in decision-making boards.

BOX 1. EXAMPLES OF COUNTRIES’ EFFORTS TO REDUCE THE DIGITAL GENDER DIVIDE

A number of countries have measures to engage women and girls in STEM across education systems, for example:

- The Australian Government is investing AUD 13 million over five years from 2016/17 to initiatives focused on women’s participation in STEM. The National Innovation and Science Agenda is contributing to ongoing efforts across the Australian Government to encourage more girls and women to study STEM and pursue STEM-based and entrepreneurial careers.
- *Meninas Digitais* in Brazil aims to promote technology and STEM subjects by motivating female high school students and by developing their skills with short computing courses.
- Korea is supporting a research fund for female student research teams in architecture, material and machinery, as well as computers. They are also promoting female talent in science and engineering fields by providing field experience programs.
- The Japanese Government is carrying out the Riko Challenge to inspire women to choose careers in STEM and increase the number of female science and engineering professionals.
- The OECD Mexico initiative, *NiñaSTEM PUEDEN*, launched in early 2017, invites Mexican women who have prominent careers in science and mathematics to act as mentors encourage girls to choose STEM subjects. *Codigo X* in Mexico is a programme to orientate women to disciplines related to STEM and to promote the inclusion of girls and women in ICT sectors.
- Germany launched in 2008 the National Pact for Women in MINT (STEM) Careers to increase women’s interest in scientific and technical studies. The initiative brings together politics, business, science and the media to improve the image of STEM-related professions in society.
- In the United States, the Department of Education’s programme, *Race to the Top*, launched in 2009, prioritises improving STEM in the grants it awards to states. The Investing in Innovation programme seeks to increase the number of STEM teachers from groups traditionally under-represented in STEM; and the National Science Foundation awards grants to support the ADVANCE programme, which aims at increasing the participation and advancement of women in academic science and engineering careers.

Alongside the G20 German Presidency’s *eskills4Girls* initiative,¹ endorsed by G20 Leaders in 2017, there are a range of national programmes that aim to support girls and women in improving their digital literacy and boosting female employment rate in the digital economy:

- South Africa’s initiative, including South Africa’s Women’s Net, provides tailor-made training on basic digital skills, advocacy and lobbying online.

- Argentina's *Ellas Hacen* (They Do) programme, in conjunction with the National Plan for Digital Inclusion and the Digital Educators Network of Argentina, aims to increase digital literacy among unemployed women and provide the most vulnerable sectors of the population with the necessary skills, motivation and confidence to use new technologies for their own benefit, through courses for the creation of basic Internet use capabilities.
- Russia's Love2Code course teaches the creation of mobile applications.

Furthermore, G20 countries have programmes in place supporting efforts in other countries, particularly developing ones, for example:

- Canada has four different initiatives, including increasing access to education and training in selected Commonwealth countries with a high prevalence of child marriage, and improving the skills and employability of girls and women in Haiti and African countries.
- Germany has initiatives and public-private partnerships to address the need for improving gender equality in the workplace by raising the digital skill levels of women in South East Asia.

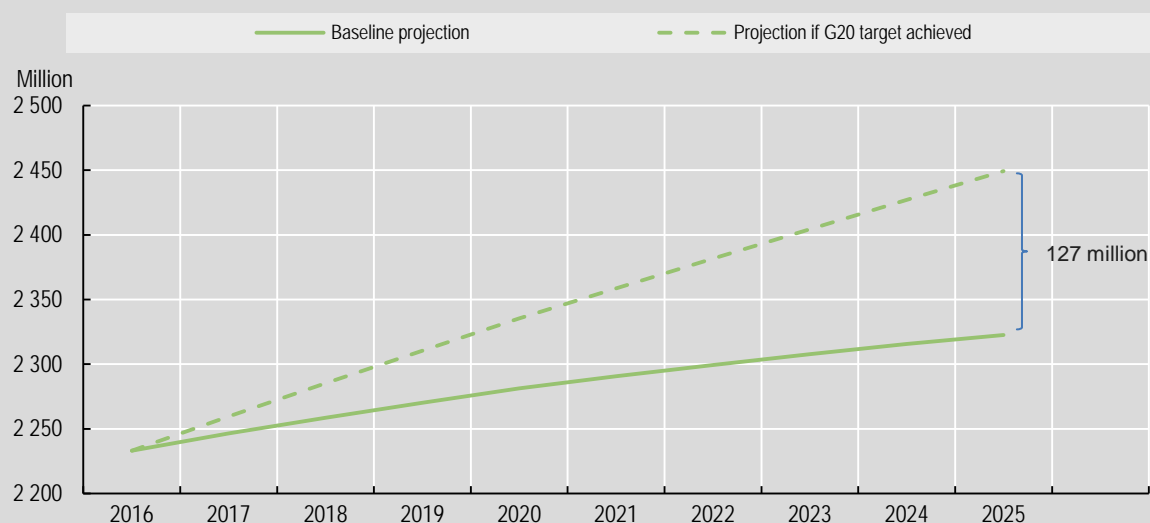
1. <https://www.eskills4girls.org/>.

These important initiatives across the G20 address some of the root causes of the digital gender divide and will therefore **contribute to the broad G20 gender equality agenda and in particular will be instrumental to help to achieve the "25x25 target"** (Box 2). **More needs to be done.** From reinforcing basic framework conditions to boost access in developing countries (notably through enhancing competition, that contributes to lower cost that disproportionately benefits women); to providing life-long learning opportunities for women to deal with changing skill and job profiles in the digital economy; to a supportive environment for workplace flexibility in emerging and developed countries alike (i.e. adjusting social systems for the digital reality and ensuring their appropriateness for women). Implementation and the scaling up of current efforts will also be essential to achieve a concrete narrowing of the digital gender gap. Furthermore, efforts at G20 level can play a key role to foster digital gender inclusion, for instance by helping countries identify interventions to prioritise and by promoting a better evidence base through gender disaggregated ICT statistics, in order to facilitate the design of targeted policy interventions. Here again, digital tools could be part of the solution as they can be instrumental to enhance policy design, implementation, monitoring, evaluation and enforcement.

BOX 2. PROGRESS IN ACHIEVING THE G20 TARGET TO REDUCE THE GENDER GAP IN LABOUR FORCE PARTICIPATION

At their 2014 Summit in Brisbane, G20 leaders committed to reduce the gender gap in labour force participation observed in 2012 by 25% by 2025 (the so-called "25x25 target"). In 2016, this gap in participation rates between men and women aged 15-64 was estimated to be around 26 percentage points for the G20 economies (57% for women versus 83% for men), ranging from a low of 7 percentage points in Canada to a high of 58 percentage points in Saudi Arabia. The G20 target was adopted in recognition that narrowing this gap could help foster greater gender equality in the labour market and boost economic growth. Since 2012, most G20 economies have made good progress in narrowing the gender gap in participation, with particular large decreases recorded in Brazil, Indonesia and Japan.

Achieving the G20 gender target would result in a considerable boost to the G20 labour force by around 130 million in 2025¹ (Figure 18). This amounts to a 5.7% increase in the total G20 labour force relative to the projected level under the baseline scenario. The increase in the labour force is more substantial in those countries with the largest gender gap currently. For instance, the increase in India would be almost 13% as a result of 65 million more women joining the labour force if the G20 target is reached.

Figure 18. Projected increase in the G20 labour force if G20 gender target achieved

Note: The baseline scenario assumes that labour force entry and exit rates by five-year age groups and gender are fixed at their average level observed during 2006-16. The target scenario assumes that the G20 target of reducing the gender gap in participation is achieved progressively over the period 2016-25 and adjusts participation rates of women accordingly given the projected baseline rates for men.

Source: OECD (2017), "Labour force forecast", <https://data.oecd.org/emp/labour-force-forecast.htm>.

New digital tools are empowering and catalyse responses to complex global challenges, and can serve to support a new source of inclusive global economic growth. To seize this opportunity it is essential that no one, and especially no woman, is held back in trying to achieve their aspirations. **What the future will hold for women depends on what policy does today:** Now is the time to step up the efforts and take advantage of the digital transformation to ensure that it represents a leapfrogging opportunity for women and a chance to build a more inclusive digital world. The G20 efforts are an important and timely step forward towards better policies to close the digital gender gap, so that everyone can benefit from the digital transformation.

Notes

1. Here used as a synonymous of broadband penetration: the number of subscriptions to fixed and mobile broadband services, i.e. with advertised data speeds of 256 kbps or more, divided by the number of residents in the country.
2. <https://techcrunch.com/2017/10/04/announcing-the-2017-update-to-the-crunchbase-women-in-venture-report/>.
3. The analysis is based on the STI Micro-data Lab3, a data infrastructure project of the OECD Directorate for Science, Technology and Innovation (STI) gathers and links large-scale administrative and commercial micro-level datasets. These mainly relate to administrative data such as intellectual property (IP) assets, including patents, trademarks and registered designs; scientific publications; and information on companies from private providers. IP data are collected in the framework of the OECD-led IP Statistics Task Force, which gathers representatives from IP offices worldwide.
4. OECD analysis based on data from www.crunchbase.com.
5. For instance, in the United States women account for nearly half of employed college graduates age 25 and over, but for only about 25% of employed STEM degree holders and an even smaller share – just about 20% – of STEM degree holders working in STEM jobs (Beede et al., 2011). The situation in other OECD countries is very similar (OECD, 2015a). See www.scwist.ca/programs-and-events/make-possible/.
6. ICT skills relate to the use of programming languages, emails, word processing software or spreadsheets, or to the processing of transactions through the internet.
7. <https://www.linkedin.com/pulse/future-employment-jobs-didnt-exist-10-years-ago-amirsan-roberto>.

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