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DISCUSSION PAPER

Women in Tech as a Driver for Growth in Emerging Economies

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Introduction

As the world transitions to an increasingly digital economy, many low- and middle-income countries face an obstacle: most emerging economies lack qualified people to fill critical information and communication technology (ICT) jobs, a shortage that is exacerbated by the low representation of women in these industries.[1] The gap between the demand for ICT workers and the supply of job seekers with the necessary technical skills threatens the ability of those countries to participate in a powerful driver of growth in the twenty-first century—the digital economy. Increasing the participation of women in the ICT labor force would help bridge this gap, but women are not yet able to take full advantage of this growing sector. While a degree in computer science or engineering is necessary for most professional-level careers in ICT, the share of women graduates in these fields is slipping in many parts of the world.

Although researchers and policymakers have focused on closing the gender divide in ICT jobs in the United States and Europe, far less attention has been focused on emerging economies, which increasingly rely on local labor forces to drive growth. Globally, ICT sector jobs are transitioning from Organization for Economic Cooperation and Development (OECD) countries to non-OECD countries because of the rapid growth of ICT markets in emerging economies.[2] According to a 2012 report by the International Telecommunications Union (ITU), "China is by far the largest producer and exporter of ICT goods today, while India is the largest exporter of computer and information services."[3] The demand for ICT skills has also grown outside of the ICT sector, as digital technologies are applied across other sectors to improve productivity.

Additionally, development policy faces an existential crisis. Dramatic advances in automation and artificial intelligence are rapidly replacing low-skilled and routine jobs and closing the traditional path of development through industrialization. Factories, agriculture, and call centers—traditional stepping stones to the middle class for low-wage workers—increasingly require fewer human hands. The global trend toward offshoring is even showing early signs of reversal because increased automation has made the cost of labor less significant. In this upheaval, the ITU notes, "more women than men have been displaced due to increased automation and computerization of workplaces."[4]

Expanding women's access to ICT jobs would not only advance economic opportunities for women, their families, and their communities, but it would also help address the shortage of skilled workers for these jobs and grow the digital economy. As women become increasingly active users of technology, their participation in designing and developing tech products and services will help to enhance technology's relevance for women as consumers, further boosting innovation and economic growth. Working together, the public and private sector should address the multiple barriers women and girls face, particularly in low- and middle-income countries whose economies stand to gain the most from greater participation of women in vital ICT jobs.

Why the Gender Gap Should Be Closed

Strengthening women's participation in the ICT sector is important for three reasons. First, increasing employment opportunities for women enhances gender equality, which is fundamental to human rights and dignity. Second, empowering women leads to benefits for their children and communities. Third, bridging the gender gap in ICT jobs can help address the mismatch between the supply and demand for jobs in emerging countries. Tapping into the ingenuity of the full population could fuel economic growth, not only by increasing productivity across sectors by effectively leveraging ICTs, but also by improving the design of ICT products and services to meet the needs of both women and men.

ICT jobs can advance the equality and status of women in several ways. These jobs often have the potential to offer flexible hours and locations, which can enable women to balance household and professional responsibilities. In particular, jobs that offer consulting services remotely through information technology (IT) often provide a better balance between work and family for women, who tend to be primary caretakers for children and the elderly.[5] Moreover, because ICT is a fast-growing sector, it offers many job and career growth opportunities, including a range of self-employment options.[6] ICT jobs are frequently higher paid and have opportunities for advancement. Lastly, employment in the ICT sector builds skills that are transferable not only within the ICT field, but also to other sectors.

When women have equal access to economic opportunity, social empowerment, and higher wages, their children also often benefit. Women are more likely than men to save and invest their increased wages in their communities and families, which leads to improved education and health outcomes for their children, including improved survival rates of girls and higher rates of child nutrition.[7] Studies demonstrate that women spend roughly 90 percent of their income on their families; by contrast, men contribute 30 to 40 percent.[8]

Enhancing the participation of women in the ICT sector—to help close the employment and wage gender gaps—would also promote economic growth. According to the recent McKinsey report "The Power of Parity," advancing women's equality could add as much as $12 trillion to annual gross national product globally by 2025.[9] Other research demonstrates that the restricted job opportunities for women in the Asia-Pacific region cost between $42 and $46 billion a year, and that similar limitations have also led to the loss of enormous economic potential throughout Arab states, which have the widest gender gap in economic opportunity.[10]

Public and private sector programs have been developed in various countries to increase women in the ICT labor force, with varying degrees of success. Because women are increasingly consumers of technology, it also makes economic sense for women to be involved in designing and developing these products and services so that they can be tailored to the needs and preferences of both women and men. As the 2012 ITU report states, "Engaging women and girls in ICT sector work is not only the right thing to do from the point of social justice. It is also smart economics."[11]

Challenges for Women in the Digital Economy

Women face significant barriers to entry and advancement in the ICT labor force. Understanding these challenges can help pave the way for effective policies to improve gender parity.

HIERARCHY AND BARRIERS FOLLOW TRADITIONAL PATTERNS

Participation of women in the ICT workforce varies from country to country, but across the board the ICT sector is typically perceived to be male-dominated, and upper management is predominately male.[12] Outside the United States, there is little data on the ICT labor force that is disaggregated by gender, but according to the International Labor Organization, traditional patterns of gender hierarchy are being replicated in the digital economy: men predominate in most high-skilled, higher wage jobs, and women hold low-skilled, lower wage jobs with few benefits or less security.[13] Women tend to hold jobs at the bottom of the supply chain in ICT, such as in administrative and clerical positions, phone operations, and data entry.[14] Describing the "feminization" of lower rung jobs in the ICT sector, another study of global trends in this field found that, on average, women accounted for 30 percent of operations technicians, but only for 15 percent of managers and 11 percent of strategy and planning professionals.[15] Even in developed economies, women's participation in the ICT labor force has declined as the sector has evolved from robotic and clerical work toward innovation and design.[16]

Women in emerging economies also face barriers to starting ICT-related businesses, in part because women often lack access to capital.[17] Microloan programs that support women entrepreneurs often focus on traditional women's work, such as handicrafts, rather than ICT-oriented industries. Moreover, women are underrepresented in ICT sector decision-making structures, including policy and regulatory institutions, ministries, and boards of ICT companies.[18]

SOCIAL ROLES

Among other challenges, in many countries girls may face cultural pressures and stereotypes that discourage them from developing the skills needed to join the ICT workforce. In many parts of the world, the tech field has developed a "geek" or "nerd" culture, which often attracts more boys than girls. In the United States, for example, there was a strong shift away from women entering computer science when personal computers came out, because they were marketed as toys for boys and not girls.[19] Even the origins of computer science are rooted in a masculine context—warfare—as the technology that paved the way for modern computing was developed during World War II by Alan Turing, the British scientist who developed a machine to break the Nazi enigma code.[20] Further, research suggests that boys have a tendency to tinker with computers as an innately interesting toy or puzzle, whereas girls tend to use technology as a tool for achieving another goal.[21] As a result, when girls take elective classes in computer science, they are often outnumbered and less experienced.

The jobs where women predominate are frequently lower paid and viewed as "soft," less prestigious, and less desirable for men. In fact, across the globe, women are overrepresented in education and health; on par with men in business, law, and social sciences; and underrepresented in engineering, science, manufacturing, and construction.[22] Although ICT jobs have the potential to offer flexible hours and the ability to work remotely, which can enable women to balance work and family responsibilities, few companies are structuring their work this way to make jobs more accessible to women. Additionally, the demand for increasingly advanced technical abilities requires workers to continually upgrade their skills, particularly as the ICT sector evolves. The 2012 ITU report points out that this puts women "at a disadvantage given their multiple roles in work, family, and community and the cultural bias that tends to value an investment in men's education before women's."[23]

Another challenge facing women in ICT is the lack of female role models and mentors in their academic and professional careers. For girls and women interested in pursuing a career in ICT—as in other male-dominated fields—role models have the potential to inspire them, provide support and networks for job access, and offer encouragement and advice through the course of their careers. Many of the case studies highlight the importance of role models for women in ICT and offer concrete examples of initiatives to provide mentors and role models.

EDUCATION AND DIGITAL LITERACY

Even when countries do have policies to promote women in nontraditional fields, efforts are often lumped together with a more general pursuit of science, technology, engineering, and math (STEM) fields.[24] In such situations, girls tend to gravitate toward the "soft" sciences that have neither the gender gap nor employment opportunities of ICT professions. Girls who do pursue computer science courses tend to lose interest after being subjected to curricula that are oriented around abstract algorithms, tedious syntaxes, or male-oriented problem sets about subjects such as sports and poker.

In many of the former British colonies in Africa, strict "cluster subject" prerequisites, including physics, are required to pursue a computer science degree. Girls are frequently discouraged from taking physics and such courses may not even be offered in some gender-segregated schools. Boys are therefore more likely to get on, and stay on, the tech track. Individual preference can certainly make women less likely to pursue ICT careers, but these preferences are shaped by powerful social attitudes about gender. Furthermore, because girls have less access to formal education in many countries, as women, they are less qualified for high-skilled digital work.

Another obstacle to gender parity in the ICT sector is that women have less access to technology as users, which decreases their digital literacy. In low- and middle-income countries, studies have shown that on average women have 14 percent less access to mobile phones and 23 percent less access to the internet.[25] With less access and less familiarity with ICTs, women are unsurprisingly less likely to pursue a career in this sector.

Case Studies

Examining case studies of specific countries sheds light on the strides women have made and the barriers they continue to face in the ICT labor market, as well as the variations across countries, regions, and cultures. There is limited comprehensive, updated data on women's participation in ICT jobs in low- and middle-income countries over comparable time periods, and the types of data collected and methodologies frequently vary from country to country. However, lessons can be drawn from the following case studies, which fall broadly into two categories:

- *underperforming countries,* where women's participation in the ICT sector is low as measured by university enrollment, graduation rates, and the labor force (Kenya and South Africa)
- *mixed-success countries,* where women are relatively well represented in either university studies or the labor force, but still face challenges (Brazil, United Arab Emirates, Myanmar, India, and Malaysia)

UNDERPERFORMERS

Kenya. Although Kenya's technology sector is still in its infancy, the country is considered the tech hub of sub-Saharan Africa.[26] Little data is available on the participation of women in ICT studies and professions, but as of 2007, only about 12 percent of computer science degrees are awarded to women, a statistic comparable to that of many other countries in the region.[27] Barriers for Kenyan women entering the ICT sector include gender role socialization, stereotypes, bias, and discrimination.[28] One study—based on interviews of women who were either managing or working in ICT firms in Kenya—reported that "fear of mathematics and sciences, which are important in the pursuit of technology, is . . . a result of negative attitudes instilled in girls during socialization at home and in school."[29] Moreover, ICT courses tend to be costly and "dominated by men."[30] The Kenyan women interviewed who indicated that they were ultimately successful, despite the barriers, credited parental support, motivation, and the influence of mentors—mostly men—who already worked in ICT fields.[31] Locally, organizations such as AkiraChix have sprung up to provide training, mentorship, and peer support for girls aspiring to pursue the ICT field.[32]

South Africa. Women have limited access to the ICT labor force in South Africa as well, particularly in rural areas. According to one study, as of 2009, South African women made up only 22 percent of those with undergraduate degrees in science, engineering, and technology, even though they represented 57 percent of all enrolled in university.[33] Women are well represented as doctoral graduates in health and social sciences, but there are few female graduates in engineering.[34] Data on race and gender participation in ICT jobs reflects that the numbers of black and white men in these jobs increased from 1996 to 2005, while the numbers declined for both black and white women. During this period, the average annual employment participation rate of black and white women in the ICT sector dropped by 2.2 percent and 1.1 percent, respectively. By contrast, over the same period, the participation rate for black men increased by 2.3 percent and for white men by 2.5

percent.[35] Women entering the ICT sector in South Africa face challenges such as work-family balance issues, the undervaluing of women's contributions at work, adverse stereotypes of women, the relative absence of women role models, difficult reentry because of the rapid pace of change in ICT, and a lack of guidance on career options.[36]

MIXED SUCCESSES

Brazil. The software industry is expanding in Brazil, and local companies, as well as companies outsourcing from more developed countries, have created market demand for computer science graduates.[37] However, the proportion of women studying computer science in college plunged from 26.9 percent in 2000 to 16.6 percent in 2009.[38] In fact, as a recent United Nations Educational, Scientific, and Cultural Organization (UNESCO) science report notes, in Latin America and the Caribbean "female participation is falling in [computer science], a field that is expanding globally as its importance for national economies grows, penetrating every aspect of daily life."[39] Despite the drop in the percentage of female computer science college students in Brazil, the representation of women in "technology and information" occupations overall only dropped from 33.3 percent of workers in 2003 to 28.3 percent 2010.[40] As in several other countries, women in science are concentrated in the "soft" sciences such as nutrition, psychology, and medicine, and men predominate in "hard" sciences, such as mechanical or electrical engineering, where 73 percent of students are male.[41]

Women trying to enter the ICT sector in Brazil are faced with a lack of role models, little effort to get girls interested in science, a rigid scientific community, stereotypes concerning what careers are considered "feminine" or otherwise attractive to women, discrimination, and cultural views about men's superiority.[42] Despite the clear demand for more skilled workers in ICT, the Brazilian government has been slow to develop initiatives focused on increasing women's participation in the sector.[43]

United Arab Emirates. Throughout the Arab states, the representation of women university graduates in science and engineering is relatively high, but there appears to be a significant drop between college graduation and employment in ICT-related fields.[44] The experience of the United Arab Emirates (UAE) offers a window into understanding this drop-off. In the UAE, the government has prioritized developing a knowledge economy, which it recognizes requires strengthening human capacity in science, technology, and engineering. According to a UNESCO science report, "With just 1 percent of the labor force being Emirati, [the UAE] is also concerned about the low percentage of Emirati citizens employed in key industries."[45]

To address this concern, the government has established policies to train Emirati citizens and encourage greater involvement of Emirati women in the workforce. In fact, UNESCO reports, "Emirati female engineering students have said that they are attracted to a career in engineering for reasons of financial independence, the high social status associated with this field, the opportunity to engage in creative and challenging projects, and the wide range of career opportunities."[46] However, once women graduate—even after studying science and engineering—they may encounter barriers to employment, such as family bias against women working in mixed-gender environments and a lack of female role models.[47]

Myanmar. As in the UAE, in Myanmar women study ICT during college—60 percent of students at Myanmar Computer University are women—but the number of women in the field drops off after graduation.[48] Cultural norms and a lack of support help explain why women are underrepresented in the profession, despite their strong participation in college. One observer in Myanmar's tech sector notes that in the country's largest city, Yangon, a public technical college's faculty and students were mostly women, but the school lacked new computers. At a private school, where all the students were men, the equipment was newer. The observer reports that a staff member at the private college informed him that companies were more likely to hire the private school students over the public school ones, despite their similar training.[49] Moreover, in terms of social norms, the tech industry sometimes operates nocturnally and requires programmers to remain awake at night coding. As an organizer with the Burmese group Geek Girls notes, "Strict parents might forbid women from staying late to work on projects with men, which can be a problem for Myanmar girls, [and] they get left behind."[50]

To remedy the gender gap in Myanmar, Geek Girls is creating an "ecosystem" by providing connections between women and entrepreneurs, offering job opportunities in the field, and providing technical and business training, boot camps, workshops, and opportunities to meet role models.[51] Groups in the tech community are taking other practical steps, such as providing hackers of both genders separate rooms to sleep during a forty-eight-hour hackathon event.[52]

India. In India, women represent 42 percent of undergraduate students in computer science and computer engineering as of 2011, more than double the proportion in the United States.[53] According to *Wired* magazine, 30 percent of programmers in India are women, in contrast to 21 percent in the United States.[54] Women have had a presence in the Indian software industry for more than a decade, and the ICT sector appears friendlier to women than other related engineering careers. When ICT work was outsourced from United Kingdom and the United States to India, the representation of women in the ICT sector increased.[55]

As members of a striving economy, parents in India often push their children to earn high wages by pursuing a career in lucrative fields such as medicine or ICT.[56] In fact, between 1970 and 1995, there was a significant rise in women engineering students in undergraduate programs, and, since 1991, fifteen women's engineering colleges have been established, perhaps indicating a shift away from engineering's masculine image.[57] Studies indicate that "women feel at home in engineering" and that "female students described the culture of computing as one that prizes meticulousness, intelligence, sociability, and mutual assistance."[58]

However, the ICT workforce is highly stratified, with the largest numbers of female workers concentrated in entry-level positions and lower-tier industries such as business process and information technology outsourcing services.[59] Furthermore, the elite Indian Institutes of Technology, a group of premier public engineering institutes, lag far behind other engineering colleges in gender equality; women made up only 11 percent of the student body in 2011.[60] Although women enter IT professions in relatively large numbers, they also drop out at an alarming rate. In 2011, only 3 percent of female employees in IT occupied senior roles, 16 percent were middle management, and 81 percent were junior, according to a report by the global recruitment firm Kelly Services.[61] The study also found that many barriers cause women to ultimately drop out of the IT industry: 22 percent dropped out due to family reasons, 27 percent to take care of their children, and 32 percent were unable to return to the IT sector due to lack of suitable employment opportunities.[62]

Malaysia. In Malaysia, the participation of women in the information technology workforce is equal to that of men due to two historical factors: the participation of women in the Malaysian electronics industry, a precursor to the IT industry, and the national commitment to securing a "pan-Malaysian" society across people of Indian, Chinese, and Malay descent.[63] In addition to women being well represented in the IT workforce, they also enroll in science and IT college programs in large numbers. In fact, they represent over half of the students in some reported IT-related college programs.[64] More broadly, the Malaysian constitution provides special rights and privileges to Malays, who are in the majority, over Chinese and Indians.[65] According to UNESCO, because few Malay men pursue careers in ICT, women have more access to these jobs, and Malay parents tend to support their daughters' entry into these prestigious, highly paid jobs, which often lead to upward mobility.[66] Former Prime Minister Mahathir Mohamad recently reflected a common Malaysian concern, claiming that Malay boys were not as ambitious as Malay girls, noting that proportionately more girls pursue "serious" subjects, such as science, engineering, and management, and boys are more likely to study "simple subjects which they think they can pass," such as Islamic studies and social sciences.[67] According to another study, some Malaysian men view IT careers, which often involve working indoors, as less masculine than engineering jobs, which can involve working outdoors at construction sites.[68]

Although women have successfully moved into ICT jobs in Malaysia, their success is qualified in light of several considerations. Malay women have benefited from these measures and perceptions, but Indian and Chinese women have not.[69] Additionally, there is a class divide. On the one hand, there are middle-class women who are professional IT workers and academics.[70] On the other hand, there are many women in low-skilled jobs such as the electronic components industry. Malay women poured into these jobs in the 1970s when Malaysia opened up its economy and promoted export-oriented sectors. Women worked these jobs in part because of a perception that female workers are "nimble-fingered" and "docile."[71] In fact, these assembly-line jobs are not the types of true ICT jobs that are the future of the digital economy, but they nonetheless helped pave the way for the electronics sector to be more generally associated with femininity.

Policy Recommendations

The gap between the number of ICT jobs and workers with skills to fill these jobs has sparked interest in recruiting more women into the ICT labor force, particularly in emerging economies, which can reap the largest benefits from boosting the involvement of women and girls. Many small-scale initiatives have been piloted, but successful programs should be scaled up, funded on a more sustainable basis, and integrated into policy. The following steps are recommended to increase the participation of women in the ICT workforce on a larger scale in low- and middle-income countries. In most cases, the recommendations do not propose new programs nor call for new funding, but rather advocate for a shift in policy, priorities, and existing funding to ensure that economic development and education investments can better integrate women and girls into the ICT labor force.

INTEGRATE ICT IN SCHOOL CURRICULA

Governments should modernize primary and secondary school curricula. ICT skills are increasingly important in almost all sectors and careers, and schools should integrate analytical thinking, digital technologies, and coding into their curricula, starting in primary school. This will better prepare all students for the workplace. Early exposure has shown to be of particular benefit to building confidence and overcoming cultural stereotypes for girls.[72] Integrating ICT studies as part of the core curriculum will also have the benefit of ensuring a critical mass of girls in classes, rather than relying on students to self-select. In 2014, the United Kingdom began requiring computer science for all students in both primary and secondary school, in recognition of the shortage of ICT skills among job seekers.

Primary, secondary, and tertiary schools should orient computer science curricula around relatable problems rather than abstract concepts. Many women and girls see ICTs as tools for solving problems, rather than as an end in itself. Thus, introductory courses, which are focused on abstract concepts such as algorithms and programming syntax, can feel dry and irrelevant. In the United States, Harvey Mudd College found that when it redesigned its mandatory introduction to computer science class to use tools that enabled students to write interesting and useful programs quickly and provided hands-on research experiences, the college more than doubled the percentage of women choosing to major in computer science. Schools should orient their curricula to follow this model.

HELP WOMEN ENTER THE ICT SECTOR

Governments, donors, and nongovernmental organizations (NGOs) should prioritize initiatives that help bridge the gender gap in access to mobile phones and the internet. Access is the first step toward digital literacy and a path to ICT-enabled career options. It also is a driver for broader economic growth, increased productivity, and empowerment. Ensuring women have equitable access requires tackling the root causes of the current disparity including unaffordable prices, gaps in digital literacy, the lack

of relevant content and services, and cultural barriers in economic development programs.[73] Programs such as GSMA's Connected Women (formerly mWomen), Intel's Women and the Web Alliance, and the Alliance for Affordable Internet have started to make inroads on these issues and can serve as a model for further investment.

Governments, donors, and NGOs should design more employment and job skills training programs to steer women toward jobs that build ICT skills. One example is digital microwork, which creates sustainable livelihoods through tasks such as transcription, cataloging, and digitization. Workers in these fields benefit from dramatically higher wages and more stable livelihoods, and these jobs can propel women to pursue further education, develop marketable skills, and sustainably support their families. ICT-oriented jobs can offer women superior growth opportunities, compared to traditional female jobs, such as smallholder agriculture and handicrafts, which women are often steered toward.

ENCOURAGE AND SUPPORT WOMEN IN TECH CAREERS

Governments, donors, and NGOs should integrate ICT mentorship and support networks for women in education and employment programs. The lack of role models and the isolation inherent in pursuing male-dominated professions contribute significantly to the high attrition rate for women. Mentor and peer networks can provide support and combat isolation. Some successful programs have demonstrated proof of concept, but are not set to scale. Elements of successful programs need to be integrated into large donor education programs or core government services to reach a larger demographic and become sustainable.

For example, the U.S. Department of State's TechWomen program empowers, connects, and supports the next generation of women leaders in science, technology, engineering, and mathematics from Africa, Central Asia, and the Middle East through a U.S. exchange program and mentorship network. TechWomen is a successful model, but only serves about one hundred women a year. The companion TechGirls program, also administered by the State Department, is an international summer exchange program designed to empower and inspire young girls from the Middle East and North Africa to pursue careers in science and technology. Separately, Women Enhancing Technology (WeTech) has provided training, built professional networks, and offered professional opportunities for women and girls to enter and succeed in technology careers. WeTech was created through a number of corporate commitments announced at the Clinton Global Initiative, but does not have long-term sustainable funding. These programs have demonstrated the potential of role models, mentorship, networks, and training to support women and girls in the ICT sector and can serve as a valuable starting point for broader interventions.

Companies should promote flexible work policies. Many ICT jobs have the potential to support flexible hours and locations, which can better align with the competing responsibilities women face at work and at home. Flexible work structures will help draw more talent to a sector that needs it.

IMPROVE DATA COLLECTION

Data on the participation of women in ICT is extremely limited for emerging economies. Without such data, it is difficult to appropriately target interventions by governments, NGOs, and companies. Governments and international agencies should collect comprehensive, reliable, and disaggregated data on the representation of women in ICT education and professions to more effectively characterize the divergent trends that exist across countries, fields, and career stages. This data should be normalized for comparison and gathered every few years to identify gaps and trends.

UN Foundation's Data2X and other gender data initiatives should prioritize the collection of data on women in ICT. The GSMA's Connected Women program, Intel's Women and the Web Report, and the International Telecommunications Union have collected data, but they primarily report on the use of ICTs by women. Data on the participation of women in ICT studies and jobs is limited, particularly for low- and middle-income countries. The UN Foundation's Data2X initiative was established to build partnerships to improve data collection and demonstrate how better data on the status of women and girls can guide policy, leverage investments, and inform global development agendas. More recently, in May 2016, the Bill and Melinda Gates Foundation announced a new $80 million initiative to close gender data gaps and accelerate progress for women and girls. These initiatives and others should prioritize the collection of gender-disaggregated data regarding the global representation of women in ICT at all stages, from the classroom to the boardroom.

Multilateral institutions should publish comprehensive data on women studying ICT in universities. UNESCO or a similar multilateral institution should undertake a comprehensive study, similar to *UNESCO Science Report: Towards 2030*, to gather and analyze gender-disaggregated data on technology education and career paths. The World Bank and other donors should encourage, and in some cases provide monetary support for, governments to publish gender-disaggregated data on university graduation rates for both undergraduate and graduate degrees, broken down by science, technology, and engineering fields.

Technology companies should release gender diversity numbers. Governments, advocacy organizations, and industry associations should encourage companies in emerging economies to follow the lead of technology companies in the United States, many of which have published their gender diversity numbers in recent years both for technology and leadership positions.

Conclusion

The fact that there are too few workers for the ICT workforce in low- and middle-income countries gravely undercuts one of the strongest drivers of innovation and growth in the global economy. Women could help fill the gap, but they are currently underrepresented in the ICT workforce, particularly in higher-skilled, senior, and management positions. Increasing women's access to jobs in this field would advance economic opportunities for women, their families, and their communities, and would help grow the digital economy. As women continue to become more active users of technology, their involvement in designing and developing tech products and services will help to ensure technology's relevance for women as consumers. International institutions, governments, and NGOs, as well as companies and foundations, should work together to address the multiple barriers women and girls face, particularly in low- and middle-income countries whose economies can benefit the most from greater inclusion of women in the ICT labor force.

Endnotes

1. *The 2015 (ISC) 2 Global Information Security Workforce Study* (San Antonio, TX: Frost & Sullivan, 2015). Because the World Bank is no longer using the term "developing countries" as a catch all for low- and middle-income countries (nor the distinction between developing and developed countries), instead, to describe this category, this paper uses the term "emerging economies." See Tim Fernholz, "The World Bank Is Eliminating Use of the Term 'Developing Countries' From Its Data Vocabulary," *Quartz*, May 17, 2016, http://qz.com/685626/the-world-bank-is-eliminating-the-term-developing-country-from-its-data-vocabulary/.
2. Nidhi Tandon, *A Bright Future in ICT Opportunities for a New Generation of Women* (International Telecommunications Union, 2012), p. 13. Note that the OECD currently includes: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.
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