CGD NOTES

Expanding Women's Role in Developing Technology: Increasing Productivity, Improving Lives

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Charles Kenny and Megan O'Donnell

Just as the evidence suggests that a more gender-inclusive political system may lead to better policies for women and girls (Chattopadhyay and Duflo, 2004), and integrating women into corporate boards may mean reaching new consumers (not to mention higher profits) (Joy et al., 2007), there is a case to be made for increasing women's presence in developing technology and innovation. Incorporating more women into technology sectors is likely to **1) increase productivity, 2) offers women a source of high-quality jobs, and 3) may have knock-on benefits for female consumers of technology**, whose needs are more likely to be taken into account. Here we discuss current gender gaps in technology patenting, potential reasons behind these gaps, and solutions to bridge them, including making research grants conditional on recipient organizations instituting policies that work to level the playing field for women (and especially women from low- and middle-income countries), or rewarding the institution of such policies.[1]

Innovation (as reflected in patents) is still male-dominated: The proportion of US patents including at least one woman inventor increased from 3.4 percent in 1977 to 18.8 percent in 2010, but under 8 percent of all patents have women as primary inventors (Milli et al., 2016). And looking across the subset of commercialized patents, Hunt et al. (2012) suggest that only 5.5 percent of holders are women. This is a global problem: across the world, women accounted for about 10 percent of patent authorships weighted by the number of names on each patent in 2013 (Sugimoto et al., 2014). Using the Sugimoto measure, this ratio was best in East Asian countries over the period 1976-2013—above a 30 percent share in Malaysia and Taiwan, and above 20 percent in China and Singapore—but even in these countries, a large gender gap remains.

Women inventors cluster around "traditional female roles": Above 50 percent of US patents in the field of "chemistry: natural resins or derivatives" include a woman inventor, but women are usually the primary inventor in patent technologies associated with traditional female roles: the two top-ranked patent classes with women as the primary inventor are "travel goods and personal belongings" and "jewelry, symbolic insignia and ornaments" (Milli et al., 2016).

Overall education rates are not the source of the problem, but specific concentrations are still part of it: Huyer (2015) finds that worldwide women represent 53 percent of bachelor's and master's graduates and 43 percent of PhD graduates. In the United States, where women are almost as likely as men to have a science or engineering degree, Hunt et al. (2012) suggest only 7 percent of the gap in commercialized patents is accounted for by the lower probability that a woman holds such a degree. The patenting gap largely exists because (in contrast to men) women with such degrees are scarcely more likely to hold a patent than women without such degrees. [2]

One factor behind this mismatch between the number of science and engineering degrees overall and patenting performance is the particular disciplines studied—engineering is a patent-rich discipline but one that attracts comparatively few women. In 2010, women accounted for 58 percent of biological science degrees and 39 percent of physical science degrees in the United States, but only around 20 percent of engineering and computer science degrees (Milli et al., 2016). The United States sees one of the lowest shares of women among engineering graduates in the world—significantly lower than many developing countries, and less than one half the proportion of Denmark, Poland, or Malaysia. But even these comparatively equal countries only see women making up a third or so of graduating classes in engineering (Huyer, 2015).

There is a drop-off between education and professional research careers and between research careers and patenting (particularly in the private sector). Huyer (2015) finds that worldwide women represent only 28 percent of researchers (compared to their 43 percent share of PhDs). In the United Kingdom, women account for 28 percent of researcher positions, 16 percent of publications and 6 percent of patent holders. The same numbers for Germany are 24, 14, and 4 percent, respectively (Schiebinger, 2010). There is a drop-off in women's representation at each level of the research hierarchy: in the United States, 19 percent of assistant professors are women compared to 4 percent of full professors (Schiebinger, 2010). The situation is worse in the private sector: in engineering, women account for 20 percent of paper authorship in universities and governmental institutes, but only 13 percent in industry (Ghiasi et al., 2015).[3]

Reasons may include industry structure and networks: Whittington and Smith-Doerr (2008) suggest that controlling for education and career history variables, women in many sectors are (still) less likely to patent than men, but biotechnology is an exception. The authors suggest that biotech tends to have more flexible, flatter and networked organizational structures where women do better that they do in hierarchical structures. Existing research also suggests that having industry contacts is a strong predictor of patenting involvement and women have fewer such contacts than men (Milli et al., 2016).

Women do not apply for public funding as often as men, and private funding for innovation also largely goes to men: In the United States, women at particular career stages are less likely to apply for competitive grants for which they are eligible (Ovseiko, 2016). Only three percent of venture capital funding in the United States went to businesses with a woman CEO between 2011 and 2013 (Milli et al., 2016).

Increasing women's participation in research will have significant positive effects: The current imbalance in research and innovation is driven by both implicit and explicit bias that leaves the field with a lower quality human capital stock than would exist absent such discrimination (Moss-Racusin et al., 2012). In addition, male and female engineers that collaborate with both genders are about twice as productive (producing more articles that are more cited) than those who only collaborate with one gender (Ghiasi et al., 2015).

It is not just research and innovation *by* women, but *for* women that is lacking. Ovseiko et al. (2016) note, for example, that while women represent nearly half of the people living with HIV (and girls and young women 15-24 are twice as likely to contract HIV as their male counterparts), they represent just 19 percent of antiretroviral drug subjects in clinical studies, and 11 percent of curative strategies. Similarly, heart research conducted with predominately male subjects has resulted in the misdiagnosis or under-treatment of women's heart disease symptoms, which manifest in different ways than men's (Seils et al., 2001; Kim et al., 2008). That treatment strategies are based on research conducted on men can make them less effective in treating female patients.

Institutions that fund scientific research and education possess the leverage needed to encourage a narrowing of these gaps, in particular through either making grants conditional on or rewarding policies that will help to ensure women can compete on equal footing as innovators and that topics of research are equally responsive to the needs of women and girls.

National and global scholarship programs can increase opportunities for women seeking to conduct research and contribute to developing technology. For example, the Organization for Women in Science for the Developing World, funded by the Swedish International Development Cooperation Agency (SIDA), funds PhD fellowships to women scientists from subSaharan Africa and least developed countries (LDCs) who travel outside of their home country to pursue their postgraduate studies in another developing country.[4]

About 4,000 foreign students receive Fulbright scholarships annually. The program has a diversity statement, which states that it "seeks and encourages the involvement of people from traditionally underrepresented audiences in all its grants, programs and other activities."[5] In furtherance of this goal, the Fulbright Program could, in considering applicants' eligibility, award points for female students and scholars proposing to conduct research, particularly in the areas of science, technology, engineering and math (STEM); currently, 39 percent of Fulbright scholarships in the fields of biological sciences, engineering, health sciences and physical sciences are awarded to women, as opposed to 61 percent to men.[6] As a first step, Fulbright (and other scholarship programs) should publish data on the gender breakdown of their scholarship recipients by area of study, in order to gauge the extent to which gender gaps in awards currently exist.

A number of national and global research efforts could increase the number of women researchers participating and a focus on research of particular importance to women and girls. The US National Science Foundation (NSF) ADVANCE program launched in 2001 with the aim of increasing the participation and advancement of women in academic science and engineering careers. The program has supported institutional reform in classrooms and laboratories to support greater women's participation, including supporting child and elder care, allowing for career breaks and offering parental leave (Schiebinger, 2010). As a next step, NSF research grants could be made conditional on such policies being in place in recipient institutions, and the NSF could award extra points in making selection decisions to teams that do approach gender balance, or additional research funding can be provided to such teams as a bonus payment.

Similarly, Horizon 2020 is the largest research and innovation program supported by the European Union, providing €80 billion from 2014-2020 and leveraging additional private investments, with the aim of developing new technologies. Through Horizon 2020, the EU awards an annual prize to outstanding women innovators, with the intent to "drive innovation through the recognition of achievements and the promotion of role models."[7] Award criteria include originality and marketability of the developed product or service, as well its demonstrated economic and social impact. Such criteria could be applied more broadly in Horizon 2020's grant funding, with a particular focus on demonstrated impact for advancing outcomes for women and girls.

CGIAR (previously the Consultative Group for International Agricultural Research) has a number of strategies that provide guidance on how to incorporate considerations of gender into their various areas of research, as well as works to improve the gender balance of its researcher cohorts, through providing (250 to date) AWARD fellowships. CGIAR's research centers, based primarily in low- and middle-income country contexts, could expand this fellowship proposal to make progress towards a gender balanced cohort of researchers. And other analogous institutions can follow in its footsteps in adopting similar fellowships.

Awards and additional financing can be given not only to individual female (or male) innovators, but also institutions that encourage women's research and innovation. A model to consider replicating is that of the UK Athena SWAN charter, founded in 2005 to encourage and recognize commitment to advancing careers of women in science, technology, engineering, math and medicine employment in higher education and research.[8] Awards are directed at academic institutions in the United Kingdom through the Equality Challenge Unit, a private charity with funding from the UK's higher education council.[9]

To directly encourage innovation by and for women, governments could create a women's venture top-up fund, which could provide additional finance up to a portion (perhaps 10 percent) of a given investment round for women-led firms attracting private venture capital, on the same terms as the private capital invested.

Conditions can also focus on policies to enhance impact for women and girls. Other criteria may include, where appropriate, the assurance of a gender balance in research subjects (as often men act as primary research subjects, with negative consequences for women's health). Researchers receiving grant funding should also be required to disaggregate results by sex, in order to provide a clearer picture of differential results. Finally, conditions can be placed on the substantive area of focus for research (e.g., projects that address questions of high priority to women's health or economic empowerment).

Research benefitting women and girls (and specifically improving their health outcomes) can also be incentivized through prizes and advance market commitments (AMCs). AMCs are financial commitments to purchase a specific new technology with set features and on set terms if it is developed. For example, Gavi (the vaccines alliance) has used an advance market commitment to incentivize the development of a vaccine variant for pneumococcal strains common in the developing world. Both prizes and AMCs could be focused on technologies of particular benefit to women and girls in areas such as obstetric and gynecological health and small-scale farming or towards ensuring technologies have equal utility for women and men in different socioeconomic settings.

Global networks convening women working in technology could also be organized and/or expanded. TechWomen, an initiative of the US State Department's Bureau of Educational and Cultural Affairs, seeks to connect and support women from Africa, Central and South Asia, and the Middle East through a 5-week program and continued mentorship. Since 2010, over 400 women have participated, but there is considerable potential to expand or replicate this program, which can work to overcome women's constraints in accessing networks.

Sector-specific networks (as well as scholarships, fellowships and policies that work to promote gender equality more broadly) should be prioritized in those STEM sectors with a particularly severe gender imbalance. The energy sector, for example, has a workforce that is just 12 percent female, suggesting the need for an expansion of efforts that build upon the Empowering Women in Clean Energy (EWCE) initiative—which came out of a partnership of the South African Department of Energy, Africa Energy Indaba, and Cennergi (South African renewable energy provider)—and works to support women's work, education, and training within the energy sector.[10]

Because technology is a global public good, there is space for global decision-making and commitments around gender in research and development. A cross-country partnership modeled on the Open Government Partnership might see countries commit to make policy progress towards greater gender equality in technology and submit to peer review of their progress. This could be part of an organization with a broader agenda around global gender equality or specifically concerned with technology.

The global gender imbalance in research and development is economically inefficient and socially harmful. Greater equality in both the supply of researchers and the beneficiaries of that research would increase the productivity of research and development expenditures by governments and the private sector. Existing progress and the leadership suggested by countries in East Asia and elsewhere suggests that it is possible to take strides towards that equality. This should be a policy priority for countries rich and poor alike.

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Footnotes

[1] Some of the recommendations proposed below do not pertain exclusively to women in LMICs. That said, even innovative and technological research conducted in rich country contexts, especially when focused on the health, well-being and empowerment of women and girls globally, should be considered a 'global public good' and therefore beneficial from a gender and development perspective.

[2] Only 29 percent of patents in the US are held by PhDs. At the PhD level women are 40-66 percent as likely to patent as men as compared to 8 percent for college graduates as a whole. A lower share of doctorates (only) accounts for about 10 percent of the patenting gap.

[3] According to a study conducted by African Women in Agricultural Research and Development, just 1 in 4 agricultural researchers is female, and just 1 in 7 hold leadership positions in African agricultural research institutions. This is in spite of the fact that women make up the majority of those who produce, process and market food in Africa (AWARD, 2008).

[4] "PhD Fellowship," Organization for Women in Science in the Developing World, accessed December 2, 2016, http://owsd.ictp.it/career-development/phd-fellowship. New York's STEM Incentive Program also provides full tuition to any state university in New York to the top 10 percent of students in every high school if they pursue a science, technology, engineering or math degree (and agree to live and work in-state for 5 years after graduation). A similar program could be targeted exclusively at high-achieving female graduates. "NYS Science, Technology, Engineering and Mathematics (STEM) Incentive Program," Higher Education Services Corporation, New York State, accessed December 2, 2016, https://www.hesc.ny.gov/pay-for-college/financial-aid/types-of-financial-aid/nys-grants-scholarships-awards/nys-science-technology-engineering-and-mathematics-stem-incentive-program.html.

[5] "Diversity," Fulbright Foreign Student Program, accessed December 1, 2016, http://foreign.fulbrightonline.org/about/diversity.

[6] O'Donnell, Megan. Interview with Iryna Dchuryak, Department Reports Manager at the Institute of International Education, December 6, 2016.

[7] "EU Prize for Women Innovators," Innovation Union: A Europe 2020 Initiative, accessed December 1, 2016, http://ec.europa.eu/research/innovation-union/index_en.cfm?section=women-innovators.

[8] "Athena SWAN Charter," Equality Challenge Unit, accessed December 1, 2016, http://www.ecu.ac.uk/equality-charters/athena-swan/.

[9] Additional examples include the Norwegian Ministry of Education and Research's Gender Equality Award, which was given from 2007-2014 to universities that make meaningful progress toward implementing 5 year gender equality action plans ("The Gender Equality Award," , and the Institute of Physics' Project Juno, which seeks to rewards academic departments that have taken action to address the underrepresentation of women in physics ("Project Juno," Institute of Physics, accessed December 2, 2016, http://www.iop.org/policy/diversity/initiatives/juno/index.html).

[10] Those seeking to improve the gender balance in their own niche of the energy sector can also look to the ECOWAS (Economic Community of West African States) Program on Gender Mainstreaming in Energy Access (ECOW-GEN), a flagship program that seeks to address barriers to the equal participation of women in expanding energy access in West Africa.