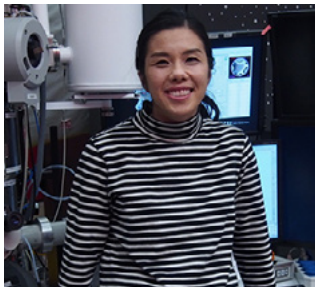
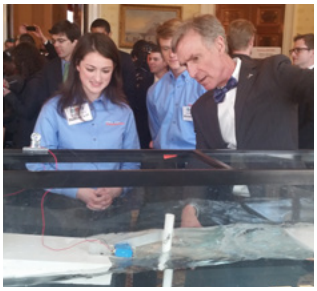
Policy Initiatives Needed to Foster Female Inventors' Contributions to U.S. Economic Growth









Executive Summary

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Challenge

The United States is working to (re)create jobs and stimulate the economy in the midst of the COVID-19 pandemic; to ensure success, we suggest policy makers look to the rich resources inherent in our female population. New initiatives and investments must be deliberately designed to include the largely untapped yet abundant ingenuity of women. Two key factors shed light on why this is essential in developing new policies for economic recovery.

FIRST, far fewer women than men are represented in U.S. patents. The U.S. Patent and Trademark Office (USPTO) reported in 2019 that just 4% of patents issued in the previous decade were filed solely by women, either as a lone inventor or as an all-female team; and, for the year 2016, only 12% of patents were awarded to women as first inventor—whether as the lone inventor, as an all-female team member, or as part of a mixed-gender team (2019a). Women who participated on mixed-gender teams were much more likely, however, to be named as a patent co-inventor. According to the USPTO, 21% of all patent holders (listed in any order) in 2016 were women from mixed-gender teams (2019a, 2019b). A clarion call is sounding: Milli et al. (2016) predicted that, absent policy intervention of some type, it will be 2092 (72 years) before half of all patents list at least one woman as a co-inventor.

SECOND, funding to support commercialization of new discoveries is less likely to be awarded to women than men; consequently, those women who hold patents may never be able to bring their inventions to market. Considering the vital role entrepreneurship plays in the U.S. economy, this is an enormous missed opportunity.

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Proposed Solutions

Our research has led to seven ideas—initiatives to help women engage in developing new and novel solutions to problems and to support the commercialization of their intellectual property through the creation of start-up companies. Our proposed solutions are as follows:

1. **Incentives for patent-intensive industries in the private sector** to hire more women in research and development focused on team-based projects with patent and commercialization potential.

2. **Incentives for faculty inventors and private-sector partners to recruit**, mentor, and continuously supportfemale college students enrolled in patent prone fields in which women are underrepresented.

3. **Support that empowers female faculty** to further develop as inventors and to commercialize their inventions.

4. **Resources and policy changes at the K12 level** to allow for deliberate efforts as part of public schooling to support the development of young inventors and to increase interest in STEM college and career pathways among young women. Also, engagement of parents and others in the community in support of this effort.

5. **Dual-enrollment options for high school students** in which courses jointly offered by high schools and community colleges will focus on engaging students in problem-oriented project-based learning. Projects involve developing a working prototype of an invention that solves a problem student teams identify, and the course will carry dual credit to have the same bearing as an Advanced Placement course in calculating the grade point average used for college admissions.

6. **Provision of legal services and waivers of filing fees for women** seeking to protect their intellectual property.

7. **Longitudinal studies of the efforts** described above to determine what works, under what conditions, and for whom.

Benefits of Policies to Support Invention and Entrepreneurship Among Women

Multiple studies' findings suggest that increasing women's involvement in inventing and bringing new products and services to market would yield benefits in four areas:

1. growth in the national economy from gender diversity,
2. leadership within the global economy,
3. growth in local economies and jobs, and
4. new possibilities for remedying gender-based wealth inequities.

The wide-ranging potential of these benefits signifies that women's ingenuity cannot be overlooked or underestimated, especially in light of the current search for ways to boost the economy. Fechner and Shapanka (2018) and Farre-Mensa et al. (2015) noted that the estimated economic activity from patents is over $8 trillion, or more than one-third of the U.S. gross domestic product (GDP). We could raise the GDP by 2.7–3.3% simply by achieving greater diversity in patenting, including greater participation of women and underrepresented groups (Fechner & Shapanka, 2018; Hunt et al., 2012). A further argument for the inclusion of women is research on venture capitalist investments, conducted by Cook (2019) and by Rock and Grant (2016), which confirmed that diverse teams produce significantly better outcomes.

Designing initiatives that encourage women to patent in greater numbers and that promote funding to commercialize women's innovations will not only vastly reduce the present gender disparity in these fields, it will also bring a bold new dimension to America's economic recovery and ongoing success.

"Don't be afraid of hard work. Nothing worthwhile comes easily. Don't let others discourage you or tell you that you can't do it. In my day, I was told women didn't go into chemistry. I saw no reason why we couldn't."

Gertrude B. Elion, 1997 Lemelson-MIT Lifetime Achievement Award Winner

"It's sometimes harder for us to push ourselves and to have those opportunities that others can have. We work hard at it, but to see our invention happen, that's pushed me to want to go even further."

Melody Sanchez, 2018 InvenTeam member, Garey High School, Pomona, CA

"I tell girls to go out there and uncover things. Learn how a soccer ball works so you can make a better soccer ball…Invention doesn't happen in a vacuum, it happens in teams. So, if you build up your knowledge together, together you can solve most problems."

Kayla Nguyen, 2018 "Use it!" Lemelson-MIT Student Prize Graduate Winner, Cornell University

"Northeast high School is producing students who are going to go out and be ready for their career before they enter college and that was sparked by the InvenTeam project and the Lemelson-MIT Program."

Clara Mabour, 2012 InvenTeam member turned 2018 InvenTeam educator, both at Northeast High School, Oakland Park, FL

References

American College Testing. (2019). The condition of college and career readiness 2019. http://www.act.org/content/act/en/research/reports/act-publications/condition-of-college-and-career-readiness-2019.html

Akcigit, U., Grigsby, J., & Nicholas, T. (2017). *The rise of American ingenuity: Innovation and inventors of the golden age*. National Bureau of Economic Research Working Paper No. 23047.

Atkinson, R. D., & Mayo, M. (2010). *Refueling the U.S. Innovation Economy: Fresh Approaches to Science, Technology, Engineering and Mathematics (STEM) Education*. Information Technology and Innovation Foundation. https://itif.org/files/2010-refueling-innovation-economy.pdf

Bell, A., Chetty, R., Jaravel, X., Petkova, N., & Van Reenen, J. (2018). *Who becomes an inventor in America? The importance of exposure to innovation*. https://opportunityinsights.org/wp-content/uploads/2019/01/patents_paper.pdf

Committee for the Study of Invention. (2004). *Invention: Enhancing inventiveness for quality of life, competitiveness, and sustainability*. Report sponsored by the Lemelson-MIT Program and the National Science Foundation.

Committee on STEM Education. (2018). *Charting a course for success: America's strategy for STEM education*. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

Cook, L. D. (2019). The innovation gap in pink and black. In M. Wisnioski, E. S. Hintz, & M. S. Kleine (Eds.), *Does America need more innovators?* (pp. 221–247).

Couch, S., Estabrooks, L. B., & Skukauskaite, A. (2018). Addressing the gender gap among patent holders through invention education policies. *Technology & Innovation*. 19(4), 735–749. https://doi.org/10.21300/19.4.2018.735

Couch, S., Skukauskaite, A., & Estabrooks, L. B. (2020). Telling cases that inform an understanding of factors impacting the development of inventors from diverse backgrounds. *Technology & Innovation*. 21(2), 133–142. https://doi.org/10.21300/21.2.2020.133

Csikszentmihalyi, M. (1999). 16 implications of a systems perspective for the study of creativity. In R. J. Sternberg (Ed.), *Handbook of Creativity* (pp. 313–336). Cambridge University Press. https://doi.org/10.1017/CBO9780511807916.018

Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences*, 1(1), 21–29. https://doi.org/10.1177%2F2372732214549471

Ding, W., Murray, F., & Stuart, T. (2006). Gender differences in patenting in the academic life sciences. *Science*, 313(5787): 665–667. https://dx.doi.org/10.2139/ssrn.1260388

Eccles, J. S., Jacobs, J. E., & Harold, R. D. (1990). Gender role stereotypes, expectancy effects, and parents' socialization of gender differences. *Journal of Social Issues*, 46(2), 183–201. https://doi.org/10.1111/j.1540-4560.1990.tb01929.x

Farre-Mensa, J., Hegde, D., & Ljungqvist, A. (2015). *Bright side of patents*. United States Patent and Trademark Office, Office of the Chief Economist. Economic Working Paper No. 2015-5.

Fechner, H., & Shapanka, M. S. (2018). Closing diversity gaps in innovation: Gender, race, and income disparities in patenting and commercialization of inventions. *Technology & Innovation*, 19(4), 727–734.

Hunt, J., Garant, J. P., Herman, H., & Munroe, D. J. (2012). *Why don't women patent*. National Bureau of Economic Research Working Paper No. 17888. https://www.nber.org/papers/w17888

Invention Education Research Group. (2019). *Researching invention education: a white paper*. TLF K12 Convening: 2019 Nov. 19-21; Washington, DC. https://lemelson.mit.edu/sites/default/files/content/documents/LMIT-ResearchingInventEdu-WhitePaper-2.21.2020%20copy.pdf

Kim, K. H. (2016). *The creativity challenge: How we can recapture American innovation*. Prometheus Books.

Marco, A. C., Carley, M., Jackson, S., & Myers, A. (2015). *The USPTO historical patent data files: Two centuries of innovation*. USPTO Economic Working Paper 2015-1. http://ssrn.com/abstract=2616724

Milli, J., Williams-Baron, E., Berlan, M., Xia, J., & Gault, B. (2016). *Equity in innovation: women inventors and patents*. Institute for Women's Policy Research. https://iwpr.org/publications/equity-in-innovation-women-inventors-and-patents/

Murray, F., & Graham, L. (2007). Buying science and selling science: Gender differences in the market for commercial science. *Industrial and Corporate Change*, 16(4): 657–689. https://doi.org/10.1093/icc/dtm021

Nager, A., Hart, D., Ezell, S., Atkinson, R.D. (2016). The demographics of innovation in the United States. ITIF. http://www2.itif.org/2016-demographics-of-innovation.pdf

National Science Board, National Science Foundation. (2018). *Science and Engineering Indicators* 2018. NSB-2018-1. https://www.nsf.gov/statistics/indicators/

National Science Board, National Science Foundation. (2019a). Elementary and secondary mathematics and science education. *Science & Engineering Indicators 2020*. NSB-2019-6. https://ncses.nsf.gov/pubs/nsb20196

National Science Board, National Science Foundation. (2019b). Higher education in science and engineering: Supplemental tables. *Science & Engineering Indicators 2020*. NSB-2019-7. https://ncses.nsf.gov/pubs/nsb20197

National Science Board, National Science Foundation. (2019c). Doctorate recipients from U.S. universities: 2017. *Science & Engineering Indicators 2020*. https://ncses.nsf.gov/pubs/nsf19301/

National Science Board, National Science Foundation. (2020). Invention, knowledge transfer, and innovation. *Science & Engineering Indicators 2020*. NSB-2020-4. https://ncses.nsf.gov/pubs/nsb20204

Rock, D., & Grant, H. (2016). Why diverse teams are smarter. *Harvard Business Review*, 95(11), 2–5. https://hbr.org/2016/11/why-diverse-teams-are-smarter

Sanders, L. M., & Ashcraft, C. (2019). Confronting the absence of women in technology innovation. In M. Wisnioski, E. S. Hintz, & M. S. Kleine (Eds.), *Does America need more innovators?* (pp. 323–343).

Sexton, K. B., & Ligler, F. S. (2018). Strategies to close the gender gap in invention and technology commercialization. *Technology & Innovation*, 19(4), 701–706.

Sohar, K., Mercier, N., Goble, L., Ghahramani, F., & Loftin, B. (2018). Gender data gap: Baseline of U.S. academic institutions. *Technology & Innovation*, 19(4), 671–683.

Sugimoto, C. R., Ni, C., West, J. V., & Lariviere, V. (2015). The academic advantage: Gender disparities in patenting. *PLoS ONE*, 10(5): e0128000. https://doi.org/10.1371/journal.pone.0128000

UK Intellectual Property Office Informatics Team. (2016). Gender profiles in worldwide patenting: An analysis of female inventorship.

United States Patent and Trademark Office. (2019a). *Progress and potential: A profile of women inventors on U.S. patents*. https://www.uspto.gov/sites/default/files/documents/Progress-and-Potential.pdf

United States Patent and Trademark Office. (2019b). *Report to Congress pursuant to P.L. 115-273, the Success Act*. https://www.uspto.gov/sites/default/files/documents/USPTOSuccessAct.pdf

Wisnioski, M. (2019). The innovator imperative. In M. Wisnioski, E. S. Hintz, & M. S. Kleine (Eds.), *Does America need more innovators?* (pp. 1–14).

"My InvenTeam experience was absolutely incredible. It was the first real experience I had with engineering in all aspects of a project, and it taught me to deal with problems better than any other project could have because, with this project, there is a real-life application. We had to encounter problems in real time and solve them in real time."

Katelyn Sweeney, 2012 InvenTeam member, Natick High School, Natick, MA and MIT alumna '18