POLICY FORUM

INNOVATION POLICY

Improving equity in patent inventorship

Expanding who gets credit for invention may boost participation in innovation

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Inequality among patent inventors is a policy concern. For example, in the United States, if women, racial minorities, and people from low-income backgrounds invented at the same rate as that of high-income white men, the overall invention rate would quadruple (*1*). Disparities in patenting are far larger than disparities in other measures of innovation, such as scientific paper authorship or STEM (science, technology, engineering, and mathematics) workforce participation (*2*). One driver of this "innovator-inventor" gap may be the nature of attribution practices: Bias in who receives credit and differing standards for patent inventorship and scientific paper authorship suggest that marginalized scientists are more likely to be excluded as inventors, limiting their future inventive opportunities. Recent legislation requires the US Patent and Trademark Office (USPTO) to address this problem of patenting disparities, and many firms and nonprofits have committed to improving inventor equity. Here, we identify opportunities to better understand what policy interventions would be most effective at closing these attribution gaps.

THE VALUE OF ATTRIBUTION

Although the social value of strengthening or weakening patent rights remains contested, patents are widely used as a measure of innovation and bring substantial private value to the innovators named on patents (*3*). But these benefits are not equally distributed. Gaps in patenting by attributes such as gender would be substantially smaller if the pool of inventors more closely mirrored the STEM workforce or the authors of scientific papers. Women hold 29% of US science and engineering jobs but make up less than 13% of US-based patent inventors (*4*). In 2017, only 1% of female scientists and engineers received a patent; the share of male patentees among scientists and engineers was three times higher (*4*). One study of scientific research teams finds that compared with men, women are 13% less likely to be named as authors on articles and a staggering 58% less likely to be named on patents, even controlling for seniority and field (*5*). The implication is that if women were recognized on patents to the degree they are on papers, it would substantially narrow the gender patent gap.

These disparities likely have multiple causes, including inequalities in opportunity (*1*), but one factor may be attribution practices. It seems likely that scientists in less senior positions—disproportionately including women and racial minorities—are more likely to be excluded as patent inventors. One study of patent-paper pairs found junior and female scientists named as authors on a paper to be less likely than their counterparts to be named as inventors on the corresponding patent (*6*, *7*). Similarly, survey data from life scientists who contributed to a patent-paper pair suggest that hierarchical status in research groups strongly affects one's likelihood of being named a patent inventor (*8*).

Equitable inventor attribution matters not only for fairness but also because being named as a patent inventor leads to professional and economic benefits that accumulate over a career. Patents increase the earnings of inventors (*1*, *9*) and make them more invested in and less likely to leave their employers (*10*). Systemic inequity in attribution reinforces those disparities, decreasing lifetime earnings and making it harder to rise to more highly compensated positions. In the long term, this inequity affects not only who is recognized as an inventor but also what type of innovations are created. For example, all-female inventor teams are more likely to focus on women's health (*11*).

WORSE FOR PATENTS THAN PAPERS

A research team that has created a new invention may not simply list whomever they like as an inventor on their patent application. In the United States, the courts have held that each listed inventor must have contributed to the initial idea or "conception" of one of the claims in the patent, or else the patent can be invalidated. Thus, a researcher who did not contribute to the conception of an invention may not be listed on the resulting patent, even if the researcher performed the often challenging work of figuring out whether the idea actually works and how to implement it in practice—work that often qualifies for authorship of scholarly papers. In one prominent example, scientists with the US National Institutes of Health were held not to be inventors after they used their cell lines to determine that a new compound was effective against HIV/AIDS, despite being named lead authors on the corresponding scientific papers (*12*).

Despite the importance of this rule, it has no standard justification. The USPTO does not verify inventorship during the examination process, but third parties can ask the USPTO or the courts to correct inventorship or to invalidate patents with improper inventorship. Patent lawyers regularly warn clients against naming incorrect inventors because of these potential legal consequences. Jurisdictions outside the United States also generally have more restrictive criteria for inventorship than authorship.

One potential explanation for the innovator-inventor gap is bias in attribution. Because the conception standard created by US courts is not entirely clear, it is ripe for unconscious bias, and there is evidence that women scientists receive less credit than men do for similar contributions (*5*). These biases may be more pronounced for patents than for papers because attribution carries financial as well as reputational implications. Researchers who recognize that they were improperly omitted can sue to have inventorship corrected, but such lawsuits are rare, likely because of the financial and reputational costs of litigating against one's employer.

But a second potential explanation has received less attention: The legal standard for patent inventorship differs from typical norms for paper authorship in ways that are less friendly to scientists with lower status within research teams. For example, if women are less likely to play "conceptualizer" roles (such as setting a research team's direction) than implementation roles that are also crucial for bringing innovation to fruition, then they are also less likely to be permitted to add their names to resulting patents, even if they made substantial technical contributions sufficient to warrant authorship on a paper.

Empirically investigating this second explanation is challenging because the contributions of each member of a research team to

patented inventions are not routinely coded. But the specific contributions of researchers to scientific publications have been coded by using the recently introduced Contributor Roles Taxonomy (CRediT) taxonomy of 14 research roles, allowing us to quantify whether women are disproportionately less likely to play a conceptualizer role in this context.

We used data from an earlier study (*13*) of authors in PLOS journals that include details about the CRediT roles played by each author (see supplementary materials). We used the World Gender-Name Dictionary and the UCI Archive Gender-by-Name Dictionary to assign binary gender according to an author's first name to about 90% of authors in the CRediT dataset. Across all papers, women were only 38% of authors credited with "conceptualization," which is the closest role to the patent conception required of inventorship. By contrast, women were 45% of authors credited with "investigation," or actually performing the experiments and collecting data (see the figure). If a similar disparity holds for research teams working on patentable inventions, limiting inventorship to those who contributed to conception may be exacerbating the patent gender gap. In that case, expanding recognition beyond only those responsible for conception to also include those who perform experiments could boost female recognition by as much as 75% and could close the patent gender gap by 10% (see the supplementary materials).

POLICY PILOTS

To reduce disparities in patenting, stakeholders in the patent system can develop more rigorous evidence on which factors cause attribution gaps and which interventions are most effective at addressing these problems. For example, when a female paper author is left off the corresponding patent, is the problem that she should have been on the patent and was omitted because of bias, or that she could not legally have been on the patent because she did not contribute to conception?

If bias in attribution is a problem, then employers of innovators who seek numerous patents—including universities and large firms—could experiment with how they solicit information about who should be listed as an inventor. The USPTO could use policy pilots (*3*, *14*) to experiment with proactively requesting more information about who was involved in the inventive process, such as through a formal rubric. Policy-makers could also consider shoring up incentives to prevent the exclusion of inventors from the start.

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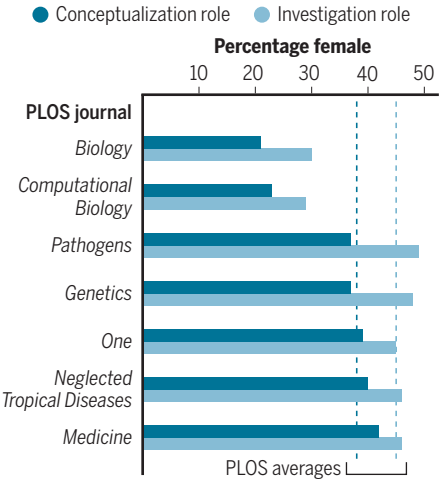
Female authorship contributions

Contributor Roles Taxonomy (CRediT) roles among PLOS publications from 2017–2018 were reported in (*13*). There were 80,643 observations of authors of identifiable binary gender with a "conceptualization" role and 86,156 with an "investigation" role (see supplementary materials).



To the extent that the problem instead stems from the constrained legal standard for inventorship, then US courts or Congress could consider whether this standard should be revised. But stakeholders could also take more modest steps to recognize contributors to patents—such as those who ran the experiments to determine whether and how an invention works—even if they are not recognized as legal inventors. For example, employers could formally credit employees as "contributors" to specific inventions. The USPTO could list this new category of invention contributors on the face of the patent alongside the names of inventors, boosting recognition of underrepresented innovators. This recognition might provide contributors with some of the same financial and other benefits that inventors enjoy while also opening up future inventive opportunities.

In this sense, the patent system could draw inspiration from the spread of approaches such as CRediT that allow for greater recognition of the contributions of individuals to scientific research. Formalizing inventorship roles could help remind senior inventors of team members who might otherwise have been omitted through unconscious bias and could provide a clearer framework for recognizing and valuing all substantial contributors to an invention. First-time and underrepresented innovators would likely obtain even more of a career boost from this kind of recognition, and this engagement with the patent system may inspire them to contribute more substantially to future inventions. Policy pilots could be used to evaluate whether these benefits would outweigh the administrative costs of implementation.

The time is ripe for intervention because there is interest across the political spectrum in developing more rigorous evidence on inventor diversity. The US Study of Underrepresented Classes Chasing Engineering and Science Success (SUCCESS) Act of 2018 and the Unleashing American Innovators Act of 2022 tasked the USPTO with studying and tackling the problem of increasing patenting by women, minorities, rural populations, and other innovators underrepresented in patent filings. The USPTO's current Learning Agenda, developed under the Evidence Act of 2018, commits the agency to assessing participation in the patent system by underserved populations. In support of these goals, the USPTO recently completed a randomized controlled trial showing that a new program to help patent applicants who began the patenting process without legal representation led to a substantial increase in inventors' willingness to continue engaging in the patent process to the point of receiving a patent (*15*). This completely closed the gender gap in application success rate in the areas in which women were doing the worst and among first-time US applicants. Hopefully this level of interest from the USPTO will inspire the use of many more rigorous experiments to test other diversity interventions, both within the agency and in the private sector. To that end, we have created the Diversity Pilots Initiative (https://diversitypilots.org) to help organizations rigorously test and evaluate diversity interventions. ■

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ACKNOWLEDGMENTS

The authors thank A. Kundadka and C. Garg for their assistance with the calculation of female authorship percentages.

SUPPLEMENTARY MATERIALS

science.org/doi/10.1126/science.adj2911

10.1126/science.adj2911

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Science **382** (6675), . DOI: 10.1126/science.adj2911