

The Gender Gap in Academic Patenting

W. Michael Schuster, Miriam Marcowitz-Bitton, and Deborah R. Gerhardt

Introduction

Gender disparities in academia have long vexed institutions whose core responsibilities include promoting equality, inclusion, and success for all members of university communities. Integrating women into senior faculty positions is essential to promoting women's advancement in society. The possibility of attaining these positions encourages the pursuit of higher education and recognition of scholarly achievement. The rising percentage of women professors is often touted as proof of academia's success in promoting gender equity.¹

With this in mind, we sought to learn more about women's academic success by examining the extent to which women transfer their knowledge from universities to industry. Identifying whether a gender gap exists in this domain is necessary to understand whether research universities are doing enough to promote equality in scientific inquiry and technology transfer. The U.S. academic sector provides an excellent case study because the United States is a world leader in scientific research and pioneered technology transfer beginning in the early 1960s.

Patent prosecution is often facilitated through university technology transfer offices that assist in securing patents to promote the commercialization of technology.² To measure the extent to which women's scientific discoveries are supported through this process, we examined how frequently women are named as inventors in university patent applications. We used the inventor names listed in patent applications filed by universities to identify the likely gender of each inventor. From this information, we counted the number of patent applications that named women inventors alone or as part of a group. We then determined the rates at which those applications succeeded and associated metrics.

We are not, however, the first to address women's ownership of intellectual property rights. Many studies show a sizable gender gap in both patent applications and issued patents.³ In the most comprehensive research to date, the World Intellectual Property Organization surveyed international patent applications in 182 countries and found that only 29 percent of them listed women as inventors.⁴ Although this percentage has increased over time, it is still low relative to the population and differs substantially across countries, technologies, and sectors.

Research addressing the United States presents similar findings. Between 1977 and 2010, only 7.7 percent of U.S. patents named a woman as the lead inventor.⁵ In 1977, only 3.4 percent

¹ See, for example, Bettina J. Casad, Jillian E. Franks, Christina E. Garasky, Melinda M. Kittleman, Alanna C. Roesler, Deidre Y. Hall & Zachary W. Petzel, *Gender Inequality in Academia: Problems and Solutions for Women Faculty in STEM*, 99 J. NEUROSCI. RSCH. 13, 16 (2020).

² David Orozco, *Assessing the Efficacy of the Bayh-Dole Act Through the Lens of University Technology Transfer Offices (TTOS)*, 21 N.C. J.L. & TECH. 115, 146 (2019).

³ Allie Porter, *Where Are the Women? The Gender Gap Within Intellectual Property*, 28 TEX. INTELL. PROP. L.J. 511, 512–16 (2020).

⁴ Gema Lax Martinez, Julio Raffo & Kaori Saito, *Identifying the Gender of PCT Inventors* 8 (World Intell. Prop. Org., Econ. Rsch. Working Paper No. 33, 2016).

⁵ JESSICA MILLI, EMMA WILLIAMS-BARON, MEIKA BERLAN, JENNY XIA & BARBARA GAULT, EQUITY IN INNOVATION:

of patents named at least one woman as an inventor,⁶ while the rate had grown to 21.9 percent in 2019.⁷ Notwithstanding this growth, women are still underrepresented as inventors named in patents.

Some of this disparity may be explained by underrepresentation in STEM fields (science, technology, engineering, and mathematics) generally and in patent-intensive fields specifically.⁸ However, this disparity does not appear to account for the entire gender gap in patenting.

Among college graduates, women are less likely to apply for a patent,⁹ and they hold a disproportionately low number of positions in patent-intensive areas, such as development and design.¹⁰ The Institute for Women's Policy Research found that, even if the current rate of progress holds, the United States will not reach gender parity in patenting until around 2092.¹¹

Beyond trends in aggregate application filing, women also succeed less often when prosecuting their applications before the United States Patent and Trademark Office (USPTO). Research from Kyle Jensen, Balázs Kovács, and Olav Sorenson found that, even after accounting for differences in technological fields, women inventors were 7–21 percent less likely to secure a patent than men.¹² When women did secure a patent, the USPTO allowed fewer of their claims and disproportionately narrowed their claims so that claims in patents prosecuted by women ended up narrower in scope and potentially less valuable. Once granted, patents secured by women are cited less frequently, and their assignees are less likely to pay maintenance fees to maximize the duration of their patents.¹³

In academia, prior research found that women professors are less likely to seek and obtain patents than men, even in fields approaching gender parity.¹⁴ A 2006 study by Waverly Ding,

WOMEN INVENTORS AND PATENTS 8 n.2 (2016), <https://iwpr.org/wp-content/uploads/2020/12/C448-Equity-in-Innovation.pdf>; Jessica Milli, Barbara Gault, Emma Williams-Baron, Jenny Xia & Meika Berlan, *The Gender Patenting Gap 2* (Inst. for Women's Pol'y Rsch., Briefing Paper No. C441, 2016), https://iwpr.org/wp-content/uploads/2020/12/C441_Gender-Patenting-Gap_BP-1.pdf.

⁶ MILLI ET AL., *supra* note 5, at 7.

⁷ U.S. Pat. & Trademark Off., Off. of the Chief Economist, *Progress and Potential: 2020 Update on U.S. Women Inventor-Patentees* (U.S. Patent & Trademark Off., Off. of the Chief Economist, IP Data Highlights No. 4, 2020).

⁸ David Beede, Tiffany Julian, David Langdon, George Mckittrick, Beethika Khan & Mark Doms, *Women in STEM: A Gender Gap to Innovation 2–3* (U.S. Dep't of Com., Econ. & Stat. Admin. Issue Brief No. 04-11, 2011); Lisa D. Cook & Chaleampong Kongcharoen, *The Idea Gap in Pink and Black 2* (Nat'l Bureau of Econ. Rsch., Working Paper No. 16331, 2010).

⁹ MILLI ET AL., *supra* note 5, at 5; *see also* Zhang Qiantao, Mary Frank Fox, Shiri M. Breznitz & Talia Capozzoli Kessler, *Analyzing the Impact of Gender on Entrepreneurship and Innovation: Evidence from University Graduates*, 51 J. TECH. TRANSFER (forthcoming 2024), <https://link.springer.com/article/10.1007/s10961-024-10128-z>.

¹⁰ Jennifer Hunt, Jean-Phillippe Garant, Hannah Herman & David J. Munroe, *Why Don't Women Patent? 2* (Nat'l Bureau of Econ. Rsch., Working Paper No. 17888, 2012).

¹¹ MILLI ET AL., *supra* note 5, at 5.

¹² Kyle Jensen, Balázs Kovács & Olav Sorenson, *Gender Differences in Obtaining and Maintaining Patent Rights*, 36 NATURE BIOTECH. 307, 307 (2018); *see also* W. Michael Schuster, R. Evan Davis, Kourtenay Schley & Julie Ravenscraft, *An Empirical Study of Patent Grant Rates as a Function of Race and Gender*, 57 AM. BUS. L.J. 281, 306 (2020).

¹³ Jensen et al., *supra* note 12, at 307.

¹⁴ Annette I. Kahler, *Examining Exclusion in Woman-Inventor Patenting: A Comparison of Educational Trends and Patent Data in the Era of Computer Engineer Barbie*, 19 AM. U. J. GENDER, SOC. POL'Y & L. 773, 787–91 (2011).

Fiona Murray, and Toby Stuart found that women faculty members in the American academy patent at about 40 percent of the rate of men.¹⁵ Similarly, Rainer Frietsch, Inna Haller, Melanie Funken-Vrohling, and Hariolf Grupp found that women scholars patent their research less frequently than they publish it.¹⁶

Data Reflecting Academic Patent Applications

In this section, we explain our methodology and our approach to quantifying women academics' interaction with the patent system. We began by identifying patent applications filed by university researchers,¹⁷ the gender of named inventors, and other relevant information. Next, we coded patent filings for gender, grant status, technology classification, forward citations, and filing years. We also describe the challenges we faced in identifying university applications, limitations of our approach, and why these limitations do not introduce bias into our data. After explaining our methodology in greater detail, we present our findings.

Analysis of Patent Applications

Patent applications reveal a trove of information about new inventions. To meet the specification requirements for issuance, a patent application must instruct a person having ordinary skill in the relevant field how to recreate and use the disclosed technology. This requirement fulfills one of the core missions of patent law—to promote the progress of science by contributing new inventions to human knowledge through public dissemination. Beyond disclosure of the new knowledge, an application includes the names of the inventors and may also identify who acquired their rights by assignment.

This information facilitates quantitative analysis of inventor collaboration, demographic information, and technology transfer.¹⁸ From large datasets containing this information, we devised means for locating patent applications filed by research universities and analyzed this data to identify trends in inventor team composition, fields of innovation, and inventor demographics. However, findings based on patent prosecution data have some limitations.

While patent applications identify inventors and describe inventions, they show us only a narrow snapshot of the broad innovation ecosystem. Some inventors and their assignees choose to maintain their discoveries as trade secrets or forgo filing a patent application for other reasons. A cost-benefit analysis may favor the choice to forego patent prosecution; in such cases, data about the innovation will not be reflected in patent datasets.¹⁹ Assigning all patents equal weight presents another limitation because not all patents reflect the same inventive contributions. A patent can protect multiple radical innovations or a single incremental improvement to prior technology. These concerns should not, however, prevent us from effectively studying patenting trends within

¹⁵ Waverly W. Ding, Fiona Murray & Toby E. Sturt, *Gender Differences in Patenting in the Academic Life Sciences*, 313 SCI. 665 (2006).

¹⁶ Rainer Frietsch, Inna Haller, Melanie Funken-Vrohling & Hariolf Grupp, *Gender-Specific Patterns in Patenting and Publishing*, 38 RSCH. POL'Y 590, 595 (2009).

¹⁷ University researchers include academic staff as well as student researchers.

¹⁸ See, for example, Richard Gruner, *The Golden West: Influential Innovation from the San Francisco Region Revealed in Patent Records*, 20 TUL. J. TECH. & INTELL. PROP. 43, 66 (2017).

¹⁹ ORG. FOR ECON. COOP. & DEV., OECD PATENT STATISTICS MANUAL 27–28 (2009).

the university system.

Data Collection

Our primary source of data was the USPTO’s Office of the Chief Economist (OCE) Patent Assignment Dataset.²⁰ The version we analyzed contained data on utility patents from 2001 to 2016 and was updated with grant data through 2019.²¹

To focus our analysis on academics within a digestible number of universities, we limited our dataset to the 250 top universities²² by research expenditures for the financial year 2019.²³ Consistent with past USPTO research on university patenting, we then matched university names (or their known patent-holding entity names) with assignee names in the database.

Identifying universities within the assignment data was a multi-step process. We initially ran a search identifying assignments with terms indicating academic involvement, such as “university,” “college,” or “academy.” Next, we culled the data to include only assignees that shared a relevant term with a university included in the study—for example, assignee names including the word “Oregon” were included because of “Oregon State University” and “University of Oregon.” We then manually reviewed the list and excluded any non-university assignees. This approach is consistent with the methodology used by other researchers.²⁴

One challenge we faced is that universities may report ownership of patents under various names.²⁵ While such variation poses some difficulty in identifying all university applications, it is not a critical drawback. We were interested in trends over time, not simply reporting the number of applications filed. Therefore, while our data may not include every relevant application, we can still achieve our goal of recognizing trends and patterns.²⁶

After identifying the scope of applications assigned to universities, we excluded applications that did not name university researchers as inventors. For example, patents that were

²⁰ *Patent Assignment Dataset*, U.S. PAT. & TRADEMARK OFF., <https://www.uspto.gov/ip-policy/economic-research/research-datasets/patent-assignment-dataset> (June 13, 2022).

²¹ The patent grant data was through August 2019 and came from the USPTO’s PatentsView dataset. We omitted plant patents, design patents, and reissued patents from the data. This dataset comprises self-reported patent ownership information, including assignment, security interests, name changes, and firm mergers. Each filing includes ownership information on one or more patents, including the name of the party obtaining the interest in the patent. We initially associated these filings with the patent application(s) relevant to that document. Likewise, filings were identified as being an assignment or a recording of some other property interest—for example, a security interest or patentee name change. Data unrelated to assignments was discarded because it is irrelevant to application ownership.

²² The 250-university threshold was adopted from prior USPTO research. *U.S. Colleges and Universities—Utility Patent Grants 1969–2012*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/web/offices/ac/ido/oeip/taf/univ/doc/doc_info_2012.htm [hereinafter *U.S. Colleges and Universities*].

²³ *Higher Education Research and Development: Fiscal Year 2019*, NAT’L SCI. FOUND. (Jan. 29, 2021), <https://nces.gov/pubns/nsf21314#data-tables>.

²⁴ *U.S. Colleges and Universities*, *supra* note 22.

²⁵ Examples include “JOHNS HOPKINS UNIVERSITY, THE, A NOT-FOR-PROFIT CORP. OF MD.,” and “JOHNS HOPKINS UNIVERSITY, A CORP. OF MD.”

²⁶ This approach proved robust. As described in our prior research, this approach provided data with a strong correlation to prior USPTO work. Deborah R. Gerhardt, Miriam Marcowitz-Bitton & W. Michael Schuster, *The Gender Gap in Academic Patenting*, 56 U.C. DAVIS L. REV. 759, 789 fig.1 (2022).

assigned to a university by some entity outside the institution are not representative of academic patenting and, thus, are excluded from our data. We used the OCE dataset’s “employer assignment” code to identify employee-to-employer assignments.²⁷ Using this coding, we excluded applications that were not assigned to a university via an employee-to-employer assignment.²⁸ We included an application in our data if at least one academic inventor signed an employee-to-employer assignment. This strategy made it possible to collect data on inventors who are professors (or other academic researchers, like graduate students) at colleges and universities.

Next, we created two distinct datasets. The first set identified all university applications and the inventors who signed “employer assignments.” This data identified university inventors, to the exclusion of non-university inventors (who may have signed later assignments to other entities). We call this the “University Researcher Only Dataset,” as it excluded non-university inventors. Using this dataset, we identified trends in the attributes of university inventors and their patenting activities.

Due to its exclusion of inventors from outside the academy, the University Researcher Only Dataset did not allow us to study inventor team attributes comprising both university and non-university inventors. Because we were interested in learning about the presence of women on inventor teams, we created a second dataset, the All Inventor Dataset, that includes *all* inventors named on applications assigned to a university.

After the two datasets were created, we began the work of estimating the gender of each inventor. The USPTO does not collect gender data from patent applicants, and due to the large size of the dataset, hand-coding was not feasible. Accordingly, we adopted a method common in the literature: identifying gender from each inventor’s name.²⁹

We used data from the Gender API website,³⁰ which contains gender data for over six million names from 189 countries. We uploaded the first name and country of residence for each inventor, and Gender API associated over 96 percent of inventors with the likelihood that someone with that name is a particular gender.

Next, we assigned each inventor name a binary gender code if the likelihood of that gender exceeded 50 percent.³¹ We then coded each application for which the gender of all inventors was available and sorted them into categories of only women inventors (Women Only), only male inventors (Men Only), or inventors who are men and women (Mixed Genders).³²

²⁷ Alan C. Marco, Amanda F. Myers, Stuart Graham, Paul D’Agostino & Kirsten Apple, *The USPTO Patent Assignment Dataset: Descriptions and Analysis* 11 (U.S. Pat. & Trademark Off., Econ. Working Paper No. 2015-2, 2015) (describing the available data).

²⁸ For further information on this choice, see Gerhardt et al., *supra* note 26, at 790–92.

²⁹ See, for example, Jensen et al., *supra* note 12, at 307; Schuster et al., *supra* note 12, at 295–98; William Michael Schuster, Miriam Marcowitz-Bitton & Deborah R. Gerhardt, *An Empirical Study of Gender and Race in Trademark Prosecution*, 94 S. CAL. L. REV. 1407, 1433–34 (2021).

³⁰ GENDER API, <https://gender-api.com/> (last visited Feb. 12, 2022).

³¹ There may be miscoding in some instances, but given the size of the dataset and the nonsystemic nature of any miscoding, it is safe to assume that the miscodings will largely cancel out.

³² As a robustness check for the use of Gender API, we took a sample of 100 patents assigned to research universities and randomly pulled one inventor’s name for each patent. We then conducted a Google search to identify the apparent

Descriptive Analysis

Our initial findings reflected a dramatic increase in patent applications filed by university researchers since 2000. Between 2001 and 2015, the number of employer-assigned university applications increased over 70 percent.³³ Figure 1 illustrates the distribution of patent applications filed by the top 250 U.S. research universities (by research-and-development (R&D) expenditures) from 2001 to 2015.³⁴ For robustness purposes, Figure 1 includes applications that were transferred to universities via employee-to-employer assignments and via any assignment (from an employee or otherwise). The correlation between the two groups is high (.991).

Fig. 1. University Patent Applications by Year

[INSERT FIGURE 1]

Figure 2 depicts the gender profiles of inventor teams by year. This analysis draws from the All Inventor Dataset, as we are interested in the breakdown of the entire inventor group, not just the inventors employed by the university. The graphs show the number of applications filed annually between 2001 and 2014.

Fig. 2. Gender Profiles of Inventor Teams, 2001–2014

[INSERT FIGURE 2]

As illustrated in Figure 2, teams of all men (light grey) constitute the greatest percentage of academic patent applications filed each year. However, teams including women gained ground over time. The number of applications filed by all-women teams (dark grey) and mixed-gender teams (medium grey) doubled over this fifteen-year period. The number of applications filed by men-only teams also increased, but not at the same rate.

Recognizing the significant disparities in the aggregate rate of application filings shown in Figure 2, we will next evaluate how often applications are granted. Table 1 sets forth the total grant rate for patent applications filed by university inventors between 2001 and 2015 and also the totals for teams that are mixed genders, women only, and men only.³⁵

gender of the inventor through an online photo or gendered pronoun. We also ran those 100 first names and the inventor's location through Gender API, which returned a gender for ninety-seven of the names. Of those ninety-seven, the perceived gender of ninety-four was identified via Google search. Of those ninety-four, Gender API coded ninety-one of them correctly (96.8 percent). This robustness check supports the validity of our approach.

³³ Applications filed on or after November 29, 2000, are, with certain limitations, available for inspection eighteen months after filing. 35 U.S.C. § 122(b)(1)(A). Accordingly, we start our analysis in 2001.

³⁴ The filing year was the actual filing year of each application (not the effective filing year).

³⁵ This is by actual year filed, not priority date.

Table 1. Comparison of Patent Applications to Granted Patents, 2001–2015 Application Year

Group	Patent Applications	Granted Patents	Grant Rate
Women Only	2,105	1,244	59.10%
Men Only	41,980	28,622	68.18%
Mixed Genders	22,394	14,340	64.04%
Total	66,519	44,238	66.50%

The results show that men working with other men (or alone) have the highest grant rate. While 68.18 percent of patent applications filed by teams of only men were granted, the mixed-gender teams had a 64.04 percent rate and teams of only women had a 59.10 percent grant rate. This disparity is an important topic for further research to determine whether this difference may be explained by subject matter, bias, or other variables.

Figure 3 describes university inventor applications by United States Patent Class (USPC) for the top fifteen most popular technological classes out of 370 represented in the data.³⁶ The substantial skew towards the bottom of the figure is notable, with the largest three classes (USPC classes 435, 514, and 424) accounting for 36 percent of all filings. The second and third classes (USPC Classes 514 and 424, both including “drug, bio-affecting and body treating compositions”) are largely interchangeable, with 514 being “considered to be an integral part of Class 424” by the USPTO.³⁷ The skew towards a few classes continues throughout the data with 74.1 percent of all applications falling in 10 percent of the classes represented and 86.7 percent being represented in 20 percent of the classes.

Fig. 3. Applications Filed by USPC Class, 2001–2014

[INSERT FIGURE 3]

The findings depicted in Figure 3 are notable in comparison to patents issued to the general public. The three dominant classes in university applications (435, 514, and 424) were the sixth, fourth, and ninth most common classes among all patents issued from 2001 to 2014.³⁸

Figure 4 displays the number of patent applications filed by teams of only men, only women, and mixed genders from 2001 to 2014 in the ten most common USPC classes.

Fig. 4. Gender Composition of Inventor Teams in Top Ten Patent Application Fields

[INSERT FIGURE 4]

This figure illustrates that chemistry (molecular biology and microbiology) and drug

³⁶ USPC data collected from the OCE’s application_data_2015 dataset.

³⁷ *Class 514 Drug, Bio-Affecting and Body Treating Compositions*, U.S. PAT. & TRADEMARK OFF., <https://www.uspto.gov/web/patents/classification/uspc514/sched514.htm> (last visited Feb. 13, 2022).

³⁸ *Patent Counts by Class by Year January 1977–December 2015*, U.S. PAT. & TRADEMARK OFF., <https://www.uspto.gov/web/offices/ac/ido/oeip/taf/cbcbby.htm> (last visited Feb. 13, 2022).

classes have been the dominant fields of innovation for teams of only men, only women, and mixed genders.

Teams of only women accounted for 4.10 percent of the applications across these top ten USPC classes, compared with 3.15 percent in the aggregate. Classes 800 (multicellular living organisms and unmodified parts thereof and related processes) and 530 (chemistry: natural resins or derivatives; peptides or proteins; lignins or reaction products thereof) had the highest rates of women inventor teams: 5.74 and 5.49 percent, respectively. Classes 600 (surgery), 257 (active solid-state devices—for example, transistors, solid-state diodes), and 382 (image analysis) reflected the lowest representation of women inventor teams. In these fields, teams of women filed less than 1.80 percent of patent applications.

Figure 5 shows the top ten USPC classes for applications from women inventor teams at universities from 2001 to 2014.

Fig. 5. Top Ten Fields Naming Only Women as Inventors in Patent Applications

[INSERT FIGURE 5]

Consistent with Figure 4 (detailing all university applications by USPC class), chemistry (molecular biology and microbiology, USPC class 435) and pharmaceuticals (bio-affecting and body treating compositions, USPC classes 514 and 424) dominate applications by women inventor teams.

Table 2 breaks down citation patterns for granted patents arising from applications filed from 2001 to 2015 (as of August 2019) for the different inventor gender categories. Forward citations serve as a measure of patent quality in the literature, and therefore, it is important to explore this measure in our dataset.³⁹

Table 2. Percentage of Patents by Forward Citations Count by Inventor Team Breakdown

Cites	Men	Women	Mixed
0–10	82.69%	89.32%	86.60%
11–20	7.85%	6.10%	6.62%
21–30	3.43%	2.09%	2.68%
31–40	1.92%	0.96%	1.35%
41–50	1.11%	0.64%	0.67%
51–60	0.66%	0.32%	0.52%
61–70	0.45%	0.08%	0.36%
71–80	0.37%	0.08%	0.22%
81–90	0.32%	0.24%	0.20%
91–100	0.17%	0.00%	0.13%
over 100	1.02%	0.16%	0.67%

³⁹ W. Michael Schuster & Kristen Green Valentine, *An Empirical Analysis of Patent Citation Relevance and Applicant Strategy*, 59 AM. BUS. L.J. 231 (2022).

Table 2 shows that 89.32 percent of patents filed by teams of women have been cited ten or fewer times, compared with 86.60 percent for mixed-gender teams and 82.69 percent for teams of men. We see a general trend of patents with male inventors being cited more often than those with female inventors. Within our data, teams of men were cited more often than those of women and mixed genders in every category (except for ten or fewer citations). Likewise, mixed-gender patents were cited more often than those prosecuted by women in all categories except 81–90 citations and ten or fewer citations.

One possible explanation for women’s lower citation rates may be that a larger percentage of patents with all-male inventors issued earlier (as male-only grants have been increasing at a slower rate than the others). Therefore, a greater number of male-only patents had a longer period to attract citations.

To check whether longevity may account for this difference, we ran the same data for patents granted in 2010 and 2015, so all relevant patents would have had the same amount of time to garner citations. Our findings were largely consistent. For the 2010 group, ignoring the ten or fewer citation group, the group of women inventors had the largest percentage of patents with 31–40 and 41–50 citations, and the mixed group had the largest percentage of patents with 71–80 and over 100 citations. For the 2015 group, ignoring the ten or fewer citation group, the all-male group was equal to or greater than the other groups in every category except 11–20 citations, where the mixed group was less than 0.02 percent ahead of the male-only group. Therefore, even accounting for the possibility that older patents will have more citations, inventor groups that included men had citation rates exceeding those of women inventor groups.

Additionally, we analyzed the breakdown of inventor groups by gender and team size. For this analysis, we evaluated all university applications in the All Inventor Dataset between 2001 and 2014 for which gender data was available for all inventors. Unsurprisingly, the percentage of patent applications with some missing gender information continues to climb as the number of inventors goes up. Thus, we acted in accordance with past research and only analyzed teams with four or fewer inventors, because using larger inventor groups would have required eliminating more than 10 percent of applications due to missing inventor gender data. Our data included 43,715 applications naming 2–4 inventors with the distributions shown in Table 3.

Table 3. Distribution of Applications with 2–4 Inventors by Group

Group	No. of Applications	Percentage
Men Only	27,472	62.84%
Women Only	705	1.61%
Mixed Genders	15,538	35.54%
Total	43,715	100.00%

Next, we analyzed inventor-team breakdown by size for groups of only men (left side of table) and only women (right side of table)—including single inventor teams, which were not included in Table 3. Table 4 shows the following distribution:

Table 4. Inventor Team Size (Men- and Women-Only)

Inventors on Team	Men-Only Teams		Women-Only Teams	
	Application Count	Percentage	Application Count	Percentage
4	4,352	11.92%	23	1.17%
3	8,561	23.45%	110	5.61%
2	14,559	39.87%	572	29.17%
1	9,041	24.76%	1,256	64.05%
4 or less	36,513	1	1,961	1

Surprisingly, this analysis revealed a significant deviation in the prevalence of solo invention by gender for men- and women-only inventor teams.⁴⁰ Over 60 percent of patent applications filed by women-only teams name solo inventors, compared with less than 25 percent of patent applications filed by men.

Looking to mixed-gender teams, we see that group size tends to be well distributed, with two-, three-, and four-member teams accounting for 34.18, 38.18, and 27.64 percent, respectively. Consistent with the general underrepresentation of women in our data, it was not surprising to see that male-majority teams are significantly more common than female-majority teams. Among mixed-gender teams with three inventors, groups of two men (and one woman) occur more than three times as often (3.77:1 ratio) as groups of two women (and one man). Looking at four-member teams, teams of three men (and one woman) are more than ten times (13.58:1 ratio) as common as teams of three women (and one man).

Our analysis so far has focused on the All Inventor Dataset, which gives us information about all inventors named on applications assigned to research universities. However, we now turn to the University Researcher Only Dataset, which only includes data on individuals that signed an employer assignment to a research university, indicating they are professors or researchers. Figure 6 depicts the percentage of named inventors⁴¹ who are women from 2001 to 2016 by application year.

Fig. 6. Percentage of Women Inventors Named in Patent Applications, 2001–2016

[INSERT FIGURE 6]

To check this data, we compared our findings with contemporaneous research conducted by Jordana Goodman.⁴² She reported the percentage of female inventors on patents granted to schools in four groups. The groups and percentage of women inventors from 2000 to 2015 were as follows: Ivy League colleges (14.4 percent), highly ranked schools outside of the Historically Black Colleges and Universities (HBCU) system with the most tenured Black faculty (17.5

⁴⁰ Similar findings have been made regarding non-professor patenting. Bridget Diakun, *Data Reveals Strong Growth in the Number of Female Inventors, but There Is Still a Long Way to Go*, IAM (Oct. 11, 2019), <https://www.iam-media.com/patents/data-reveals-strong-growth-number-female-inventors-there-still-long-way-go>.

⁴¹ Figure 6 depicts the percentage of named inventors whose gender could be identified by their name.

⁴² Jordana R. Goodman, *Sy-STEM-ic Bias: An Exploration of Gender and Race Representation on University Patents*, 87 BROOK. L. REV. 853, 882–84 (2022).

percent), HBCUs (20.1 percent), and research institutions (12.3 percent). Our annual data from 2001 to 2016 was largely consistent, finding that women represented 14–19 percent of named inventors from universities annually.

Analyzing the data further, Figure 6 notably shows an increase in the percentage of named inventors who are women over the period studied. However, data shows that the number of university researchers—for example, professors—who are women increased over the same period.⁴³ To compare the relative output of university researchers and professors by gender, data on women’s representation within the university as a whole must be ascertained. Ideally, annual data would be available on women’s representation in science and engineering faculty at research universities, mimicking our dataset. Unfortunately, this ideal data was not available.

However, one study provided a snapshot of the gender breakdown of science and engineering professors at top research universities for the year 2002.⁴⁴ It found that “14.8 percent of the faculty members in top science and engineering research departments are female.”⁴⁵ That data is similar to our finding that women represented 15.96 percent of named researchers from universities in 2002 (and 15.78 and 16.25 percent in 2003 and 2004, respectively).

This finding suggests an equal use of the patent system by university researchers regardless of gender. In contrast, recent research by Goodman analyzed a subset of 719 university patents, compared with the percentage of women on the respective schools’ faculty, and reported a disparity in patenting rates by gender between 2000 and 2015.⁴⁶ Specifically, she found a significant overrepresentation of male professors among named inventors. These disparate preliminary findings indicate that this topic warrants further research.

Primary Findings

Our primary findings are as follows.

First, academic patenting is on the rise. Patent applications originating from universities increased significantly between 2000 and 2015.

Second, inventor teams that included women had patents granted at a lower rate than teams of only men. Teams of all women had the lowest grant rate, mixed teams fared better, and teams of all men had the highest grant rate. The differences between male-only and women-only teams requires further research to understand the reason for their differences and their robustness.

⁴³ See, for example, BRIAN L. YODER, AM. SOC’Y FOR ENG’G EDUC., *Engineering by the Numbers* 32, <https://aseecmsduq.blob.core.windows.net/aseecmsdev/asee/media/content/papers%20and%20publications/pdfs/16p-rofile-front-section.pdf> (last visited Feb. 13, 2022) (showing an increase in the percentage of female engineering professors from 2007 to 2016). The National Science Foundation data is similar. *Survey of Doctorate Recipients Survey Year 2017*, NAT’L SCI. FOUND. (Feb. 2019), <https://ncesdata.nsf.gov/doctoratework/2017/> (percentage calculated from Table 17 data). This was a slight increase from the 2013 finding of 36.4 percent from the same survey. *Survey of Doctorate Recipients Survey Year 2013*, NAT’L SCI. FOUND. (Sept. 2014), <https://ncesdata.nsf.gov/doctoratework/2013/> (percentage calculated from Table 17 data).

⁴⁴ Ann M. Beutel & Donna J. Nelson, *The Gender and Race-Ethnicity of Faculty in Top Science and Engineering Research Departments*, 11 J. WOMEN & MINORITIES SCI. & ENG’G 389 (2005).

⁴⁵ *Id.* at 391.

⁴⁶ Goodman, *supra* note 42, at 886–87.

Third, we found that three USPC classes—consisting of drugs and chemistry (molecular biology)—dominate the technological classes of all types of inventor groups.

Fourth, patents from men-only inventors teams tend to be cited more often than those from women-only and mixed-gender teams.

Fifth, we found that there are many more men-only teams than women-only teams, with mixed-gender teams in the middle. This finding is consistent with work showing that researchers tend to work with people of the same gender,⁴⁷ as well as literature showing that most university STEM professors are men.⁴⁸ Men-only teams were most likely to work in pairs (about 40 percent), but groups of one and three inventors were also common (about 24 percent). In contrast, almost two thirds of women working in all-women teams filed as solo inventors. Mixed-gender teams tended to be two or three people, though groups of four were not uncommon.

Sixth, women academic inventorship has increased over time. However, due to a lack of historical and current data on the representation of female academic researchers in STEM in the U.S. academy, we are unable to determine whether their representation among patentees correlates with their representation in the academy. More research and data in this field is required.

Seventh, the percentage of women participating in academic patenting exceeds women's patenting participation percentage in the United States generally and worldwide. Indeed, our study reveals that women were named as an inventor in 36.5 percent of applications filed by U.S. universities from 2001 to 2014, which is greater than the 29 percent total representation worldwide reported in prior literature.⁴⁹ The percentage of American women's academic patenting is also higher than the overall representation of women in patenting worldwide (7.2 percent) and in the United States (8.7 percent).⁵⁰

Proposals

Based on our findings, we recommend the following proposals to better understand the gender gap in patenting and how it may be remediated. More research on global trends should be conducted. While much empirical research focuses on the U.S. market, fewer studies delve into international trends, making it difficult to discern which countries are closing the gender gap and why.

The following initiatives may also help close the gender gap in academic and general patenting:

Changes to patent law and policy. Potential changes include addressing subject matter eligibility criteria, the patent prosecution process (for example, blind review of patent applications with inventors' names redacted, reduced fees for small businesses, and government guidance

⁴⁷ Luke Holman & Claire Morandin, *Researchers Collaborate with Same-Gendered Colleagues More Often than Expected Across the Life Sciences*, 14 PLOS ONE 1, 9 (Apr. 26, 2019), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6485756/>.

⁴⁸ Negin Sattari & Rebecca L. Sandefur, *Gender in Academic STEM: A Focus on Men Faculty*, 26 GENDER, WORK & ORG. 158, 158 & n.1 (2019).

⁴⁹ However, the Martinez, Raffo, and Saito study examined only PCT applications. Martinez et al., *supra* note 4, at 9.

⁵⁰ UK INTELL. PROP. OFF., GENDER PROFILES IN WORLDWIDE PATENTING: AN ANALYSIS OF FEMALE INVENTORSHIP 30 (2016).

through the process) and introduction of an unregistered patent system to provide more egalitarian protection, which may reduce the patenting gender gap.⁵¹

Introducing data tools to track women's patenting activity. The lack of available data on the gender of inventors makes research on this subject far more challenging than it would be if the USPTO collected demographic information on inventors. Compounding the absence of inventor data, there is no systematic collection of data on women in STEM in the U.S. academy. To better understand women's patenting activity and make decisions about potential policy solutions, it is crucial to collect data systematically on women in STEM fields in the U.S. academy and to establish methods for studying demographics, such as voluntary surveys and other methods.

Developing networks of support services for inventors. While different resources are available to women in the United States, a comprehensive database of resources could help women and men inventors in all sectors secure assistance in the patenting process.

Fostering networks for women entrepreneurs and inventors. Women often lack mentors and networking opportunities, making it more difficult for them to advance professionally.⁵² A 2016 study found that having industry contacts is the most important factor for getting women more involved in patenting.⁵³ Mentorship and networking programs could be implemented to support research conducted by women. Networks are extremely helpful for inventors and provide industry contacts, access to funding sources, technical assistance with research and development, and opportunities to collaborate on projects. Promoting awareness and familiarity with different networks can promote women's engagement within these groups and lead to increased access to resources and opportunities for collaboration.

Supporting efforts to increase women's interest in STEM fields. Women are still underrepresented among STEM degree holders globally, and women are substantially underrepresented in particular fields in the United States, such as engineering. Therefore, another solution is to encourage girls in middle and high schools to be involved in STEM to prepare them for studying STEM subjects in college. When both boys and girls were asked to draw a scientist, girls were twice as likely to draw a man scientist than a woman.⁵⁴ Seventy percent of six-year-old girls drew women scientists, but only 25 percent of sixteen-year-old girls did so.⁵⁵ As girls get older, they often lose the courage to enter the STEM world, so it is vital to support girls who want to enter STEM at a young age and keep that support in place during middle and high school. Interpersonal interventions (such as mentorship, outreach, and campaigns against stereotypes) and systematic changes (such as enforcing policies against discrimination and harassment in hiring, promotion, and tenure decisions) should also be employed to address the gap.

⁵¹ Miriam Marcowitz-Bitton, Yotam Kaplan & Emily Michiko Morris, *Unregistered Patents & Gender Equality*, 43 HARV. J.L. & GENDER 47, 73 (2020); Miriam Marcowitz-Bitton & Emily Michiko Morris, *The Distributive Effects of IP Registration*, 23 STAN. TECH. L. REV. 306, 362–63 (2020).

⁵² Andie Kramer, *Women Need Mentors Now More than Ever*, FORBES (July 14, 2021), <https://www.forbes.com/sites/andiekramer/2021/07/14/women-need-mentors-now-more-than-ever/>.

⁵³ Yu Meng, *Collaboration Patterns and Patenting: Exploring Gender Distinctions*, 45 RSCH. POL'Y 56, 64 (2015).

⁵⁴ Carly Berwick, *Keeping Girls in STEM: 3 Barriers, 3 Solutions*, EDUTOPIA (Mar. 12, 2019), <https://www.edutopia.org/article/keeping-girls-stem-3-barriers-3-solutions>.

⁵⁵ Youki Terada, *50 Years of Children Drawing Scientists*, EDUTOPIA (May 22, 2019), <https://www.edutopia.org/article/50-years-children-drawing-scientists>.

Supporting family responsibilities. Research in the United States and elsewhere shows that one of the most significant challenges facing women academic scientists is balancing work and family obligations.⁵⁶ STEM faculties in universities often emphasize the importance of keeping up with academic standards and having total devotion to the field. This mentality makes it difficult for women to set aside time to raise children at early stages in their careers. Therefore, institutions need to find ways to support women who would like to work in STEM and have a family. Family-oriented policies, such as pausing the tenure clock for maternity leaves, are important changes that can help recruit and retain more women in science. Women outside of academia face similar issues. In recognizing the importance of family-oriented workplace policies in attracting and retaining talented women and men, employers should consider offering paid maternity and paternity leave.

Creating a variety of institutional incentives to apply for patents. Waverly Ding, Fiona Murray, and Toby Sturt show that gender differences in attitudes towards patenting exist.⁵⁷ Women academic scientists report that patenting activity requires the cost of less time with students, teaching, and university obligations. Men, by contrast, are more likely to state that commercial activity complements their teaching. Fiona Murray and Leigh Graham⁵⁸ found that many women scientists were ambivalent about commercial science and expressed reservations about the practice. Institutional policies supporting commercialization and metrics for how such activities factor into the promotion and tenure process could help assuage women's reservations and provide guidance on how the university views patenting activity. For example, in 2006, Texas A&M University approved a measure to include inventions in its promotion and tenure decisions. Since then, many universities have followed suit. The ever-increasing market value for patenting supports making it a measure of success in STEM fields. Additionally, behavioral changes, such as requiring inventors to report whether their inventions are patentable, could encourage more reflection on the possibility of patent prosecution.

Funding opportunities for women. Another explanation for the gender gap in patenting may be related to venture capital funding. Around 76 percent of venture capital investors consider patents when determining which companies to fund.⁵⁹ Although around 36.3 percent of all businesses in the United States are owned by women, only 3 percent of venture capital funding went to businesses with a woman CEO between 2011 and 2013.⁶⁰ Men who own businesses are significantly more likely than women to receive outsider equity to fund their businesses.⁶¹ Outside funding is extremely important for businesses going through the patenting process because it can be lengthy and expensive. A patent that lasts twelve or more years can have maintenance fees ranging from \$3,000 to over \$12,000, plus attorney's fees. The lack of funding makes it difficult for women-owned businesses to meet the high costs of patent prosecution.

Implementing initiatives to enhance gender equality generally. Women in STEM often

⁵⁶ Vicky J. Rosser, *Faculty Members' Intentions to Leave: A National Study on Their Worklife and Satisfaction*, 45 RSCH. HIGHER EDUC. 285, 289–90 (2004).

⁵⁷ Ding et al., *supra* note 15, at 665–66.

⁵⁸ Fiona Murray & Leigh Graham, *Buying Science and Selling Science: Gender Differences in the Market for Commercial Science*, 16 INDUS. & CORP. CHANGE 657, 682 (2007).

⁵⁹ Milli et al., *supra* note 5, at 7.

⁶⁰ *Id.*

⁶¹ ALICIA ROBB, SMALL BUS. ADMIN., ACCESS TO CAPITAL AMONG YOUNG FIRMS, MINORITY-OWNED FIRMS, WOMEN-OWNERS FIRMS, AND HIGH-TECH FIRMS 17 tbl.4 (2013), [https://www.sba.gov/sites/default/files/files/rs403tot\(2\).pdf](https://www.sba.gov/sites/default/files/files/rs403tot(2).pdf).

report feeling ignored, discriminated against, and sexually harassed in the workplace.⁶² Institutions with this dynamic should take concrete steps to change their behavior to create a welcoming and inclusive environment for women. Educational and social initiatives to support gender equality generally, and women inventors specifically, would also help narrow the patenting gender gap.

Finally, in October 2021, President Joe Biden nominated Kathi Vidal to be the next USPTO Director. On April 5, 2022, the Senate confirmed this nomination, making Vidal the second female director of the Office in U.S. history. In addition to serving as an inspirational role model, she initiated multiple programs to encourage more women to see themselves as potential leaders in intellectual property-intensive fields.

Conclusion

This study explores a dimension of the gender gap in academia that is often overlooked. Although past studies have examined the disparity in men's and women's representation among faculty in various contexts, our study empirically examines differences in men's and women's participation in technology transfer from academia to industry. Specifically, we examine the gender of inventors named in U.S. patent applications and find that a substantial gender gap exists both in the number of patent applications and how often women's inventions are cited by others.

These findings call for further research to examine the reasons these gaps exist and formulate solutions for optimizing academic women's inventive work. Faculty inventors often earn royalties from commercializing their patents. Accordingly, women's low rate of participation in patenting activity has tangible financial consequences: as a group, women faculty members benefit less than their male colleagues from these financial rewards. Therefore, women's lower representation in patenting may be contributing to the gender pay gap in the general workforce. Moreover, the low integration of women into knowledge transfer activities and patent commercialization may reduce their exposure to the private market, which can, in turn, diminish their professional opportunities.

Our findings can serve as a springboard for further in-depth research on the different aspects of women's integration in academia. The results of our study clarify that equality in academia is not merely a question of how many women are present. It is also a question of whether women faculty can and do fully participate in the innovation ecosystem as inventors. Because women are not equally represented in patent prosecution, additional research and policy initiatives should target this gender gap to close it.

⁶² Emmeline de Pillis & Lisette de Pillis, *Are Engineering Schools Masculine and Authoritarian? The Mission Statements Say Yes*, 1 J. DIVERSITY HIGHER EDUC. 33, 34 (2008).