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The Future of Female Inventors in the United States: A Comparative Analysis to the Republic of Korea

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I. BASICS OF FEMALE INVENTORS

A. History of Female Inventors

In May 1809, a young woman from Connecticut became the first woman in the United States to own a United States patent.[1] Mary Kies developed a method of weaving silk or thread into the straw of a straw hat, which quickly became a fashion staple as the straw hat industry grew.[2] She decided to patent her creation under the 1790 Patent Act, which allowed *any* person to be granted a patent.[3] Despite the success of her invention, though, Mary Kies' story was an anomaly in early America. Interestingly, another New England woman invented the method to braid straw hats at home before Mary Kies developed her invention, but this woman never patented her method.[4] Also, despite the success of her invention, Mary Kies ended up dying impoverished.[5] Her story reflects the struggles early female inventors faced in the United States, and perhaps hints at the remaining barriers female inventors face in the modern United States patent system.

Early in American history, women were discouraged from seeking a patent for their inventions, or at least naming themselves as the inventor.[6] Only 4-5% of inventor-patentees in the United States in 1870 were women, and this figure hardly doubled within a span of seventy years.[7] This was mainly due to "restrictions on women's property rights, lack of educational opportunities, limited economic resources, unflattering stereotypes of women inventors, and gender bias."[8] If a woman was lucky enough to obtain a patent with her named as the inventor, if she was married, her capabilities of utilizing her patent were limited[9] until some states began passing laws to allow married women to own patents.[10] Similarly, society discouraged women from pursuing social or legal recognition of inventions that were created outside of a professional setting.[11] Out of fear of social ridicule, many women were turned off by science, technology, engineering, and math (STEM) opportunities or pursuing commercialization and patenting of their inventions.[12]

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[1] Erin Blakemore, *Meet Mary Kies, Americ a's First Woman to Become a Patent Holder: Brain plus bonnets equal a historic first*, SMITHSONIAN MAG (May 5, 2016), https://www.smithsonianmag.com/smart-news/meet-mary-kies-americas-first-woman-become-patent-holder-180959008/.
[2] *Id.*
[3] *Id.*
[4] *Id.*
[5] *Id.*
[6] Dan Burk, *Do Patents Have Gender?*, 19 AM. U.J. GENDER SOC. POL'Y & L. 881, 886 (2011).
[7] ANDREI IANCU & LAURA A. PETER, U.S. PATENT & TRADEMARK OFFICE, STUDY OF UNDERREPRESENTED CLASSES CHASING ENGINEERING AND SCIENCE SUCCESS: SUCCESS ACT OF 2018, at 8 (2019).
[8] Annette 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, 778–779 (2011).
[9] *Id.* at 779 ("With respect to intellectual property, a married woman could not sell her patent rights, mortgage real property to finance a business operation using a patent, or sue for patent infringement . . . and the woman would have no remedy at law.").
[10] Iancu & Peter, *supra* note 7, at 18.
[11] Dan Burk, *Bridging the gender gap in intellectual property*, WIPO MAG., Apr. 2018.
[12] Kahler, *supra* note 8, at 780.

B. Proposed Explanations of Gender Disparity in Patenting

The rate of female inventors who patent and commercialize inventions is significantly lower than the rate of equivalent male inventors.[13] Several studies and academics have theorized why so few women seek patent protection for their inventions compared to men in the same areas, despite the growth in women pursuing STEM fields.[14]

Explicit barriers towards women in STEM and female inventor patent protection have virtually been eliminated through legal and societal changes, but many academics insist that subtle biases still persist in these areas.[15] For one, female inventors have been reported to be less likely to commercialize or market their inventions when compared to comparable male inventors.[16] This could be due to women being socialized to lack risk-taking capabilities and assertiveness.[17] Further, women in STEM fields typically focus their research for the purposes of having a social impact rather than developing a patentable invention for commercialization purposes.[18] Barriers to networks that would help commercialize their inventions also affect female inventors more than male inventors.[19] Should a female inventor be able to utilize one of such networks, funding sources "may take female [inventors] less seriously, and view their inventions less favorably than they would the inventions produced by similarly situated men."[20] Female inventors are usually hindered by societal influences, different motivations than their male counterparts, and a depleted social network in their field of expertise.

Lack of mentorship also affects women pursuing certain STEM fields.[21] Studies have shown that introducing females to female inventors and innovators early in life increases the chances of later innovation.[22] However, early exposure to male inventors does not make it more likely for females to invent later in life.[23] As such, female inventor participation is mostly growing "in the technologies and organizations where women have historically been more likely to innovate," indicating that less women are entering male-dominated fields or sectors.[24] This is most prevalent in the disproportionate number of women leaving engineering fields.[25] Therefore, female inventors are more likely to thrive in areas where they have early exposure to other female inventors and a strong network of female mentors.

The work environment for female inventors may also affect their likelihood of patenting their inventions. Women in public and nonprofit organizations are offered more opportunities than women in private firms, and therefore women in public organizations are more likely to be female inventors.[26] In the academic sector, women patent much less than male faculty partly due to women spending more time teaching, and possibly due to the misconception that commercializing an invention would hurt their academic careers.[27] Women who work in industry rarely patent if their firm has a hierarchical environment.[28] A smaller gender gap between male and female inventors exists in more flexible

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[13] Dan Burk, *Diversity Levers*, 23 DUKE J. GENDER L. & POL'Y 25, 26 (2015).
[14] Burk, *supra* note 11. *See also* Burk, *supra* note 13, at 32.
[15] Kahler, *supra* note 8, at 777. *See also* Burk, *supra* note 6, at 887.
[16] Burk, *supra* note 11.
[17] Burk, *supra* note 13, at 33.
[18] UNESCO, UNESCO Science Report: Towards 2030, at 99 (2015).
[19] Burk, *supra* note 11.
[20] Burk, *supra* note 13, at 33.
[21] Iancu & Peter, *supra* note 7, at 19.
[22] Burk, *supra* note 11. *See also* Iancu & Peter, *supra* note 7, at 18-19 ("[C]hildren who gained greater exposure to patenting by moving from a low-patent producing neighborhood . . . to a highly innovative neighborhood . . . would increase the chance of patenting by 37%.").
[23] Iancu & Peter, *supra* note 7, at 10.
[24] *Id.* at 11.
[25] *Id.* at 19.
[26] *Id.* at 10.
[27] *Id.* at 11; *see also* UNESCO, *supra* note 18, at 99.
[28] *Id.* at 19.

organizations in both industry and academia.[29] To address the lack of social networks available to women in science, collaborative and teamwork environments help women stay in STEM fields longer.[30]

Because of these implicit biases, many governments push for increasing and advocating for women in STEM fields.[31] Despite the bias on the STEM side though, some academics suggest that the patent laws and system also contain biases that negatively affect female inventors who are pursuing patents.[32] This is implicated by the fact that research grant awards and other metrics do not reveal as significant of a gender gap as in the ratio of females to males pursuing patent protection.[33] For example, Dan Burk argues that the lack of female inventor involvement in the early days of patent law led to the development of patent doctrines that intrinsically favor male inventors, such as the supposedly objective person of ordinary skill in the art standard.[34] This objective standard disfavors female inventors in part because of the nature by which female inventors approach problem solving.[35] Because of these intrinsic biases in the development of patent doctrines, the patent system therefore inadvertently discourages female inventors from pursuing patent protection.[36] A possible solution to the inadvertent discrimination could be to reformulate the patent laws in order to acknowledge these existing biases.

C. Current Status of Female Inventors

Each year, the World Intellectual Property Organization (WIPO) publishes "World Intellectual Property Indicators," which includes data on female inventors named on Patent Cooperation Treaty (PCT) applications. WIPO has consistently reported a steady increase in the number of female inventors named in PCT applications. In 2018, 17.1% of all inventors named in PCT applications were women.[37] However, at least one male inventor was named on 94% of PCT applications in 2018.[38] This suggests that women are still vastly underrepresented in patent applications worldwide. The United Kingdom Intellectual Property Office (UK IPO) reported in 2016 that for United Kingdom patents, it was more common to find individual female inventors or female inventors on a mixed gender team, as opposed to an all-female team.[39] The dynamics of female inventors was further investigated in the UK IPO 2019 report, which expanded its scope to worldwide patenting. The 2019 report concluded that the majority of patents with a named female inventor are either a single female inventor, or the only female inventor as a part of an otherwise all-male

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[29] Kjersten Bunker Whittington & Laurel Smith-Doerr, *Women Inventors in Context: Disparities in Patenting across Academia and Industry*, 22 GENDER & SOC'Y 194, 196 (2008).

[30] *Id.* at 197.

[31] Burk, *supra* note 11.

[32] Burk, *supra* note 6, at 888; *see also* Burk, *supra* note 13, at 29 ("The goals and structure of intellectual property law are not generally thought of as being associated with . . . gender . . . . And yet on closer examination, what seems ostensibly neutral may hold hidden biases.").

[33] Burk, *supra* note 11; *see also* UNESCO, *supra* note 18, at 98 ("Gaps and barriers persist throughout the scientific research system. This has been systematically documented in Europe and the USA, where a decade or so of injecting policy, programming, and funding into the system have not produced as much progress as expected.").

[34] Burk, *supra* note 6, at 903–04 ("Older cases discussing the obviousness standard refer to the 'skilled man,' and indeed this terminology is still current in the patent systems of other industrialized English-speaking countries. This suggests that we might ask regarding the [person of ordinary skill in the art] . . . whether the original, gendered designation of the legal standard may be revealing with regard to an underlying practical bias.").

[35] Burk, *supra* note 13, at 31.

[36] Burk, *supra* note 6, at 905–06.

[37] WIPO, WORLD INTELLECTUAL PROPERTY INDICATORS 2019, at 21 (2019).

[38] WIPO also reports that 32.6% of PCT applications in 2018 named at least one female inventor. Despite the near-majority percentage of PCT applications naming at least one male inventor in 2018, this has been decreasing since 2004, when the percentage of applications naming at least one male inventor was 97.1%. *Id.*

[39] In 2015, the number of UK patents involving female inventors was around 12%. 8% of UK patents in 2015 were assigned to mixed gender teams, 4% to individual female inventors, 0.33% to all-female teams. UK INTELLECTUAL PROPERTY OFFICE INFORMATICS TEAM, INTELLECTUAL PROPERTY OFFICE, GENDER PROFILES IN UK PATENTING: AN ANALYSIS OF FEMALE INVENTORSHIP 11 (2016).

team.[40] While the number of patents with at least one female inventor have gradually increased since 1998, the number of patents with an all-female team have remained stagnant.[41] Despite the increase in number of female inventors in other jurisdictions worldwide, female inventors are more likely to be the only woman on their team or are working individually, indicating that collaborative all-female innovation opportunities which lead to patenting are few and far between.

The percentage of female inventors named on patents varies by fields of technology. In 2018, over 25% of inventors named on PCT applications in biotechnology, pharmaceuticals, food chemistry, analysis of biological materials, and organic fine chemistry were female.[42] This is consistent with the UK IPO report in 2016 indicating that the top twelve fields for female inventors on UK patents included eight of the eleven chemistry fields categorized.[43] This was confirmed with the UK IPO's worldwide analysis in 2019, where the chemistry WIPO sector had by-far the largest female presence compared to other sectors.[44] In contrast, the bottom six fields for female inventors included five of eight mechanical engineering fields categorized.[45] WIPO reported that in 2018, the bottom five fields of technology for the share of female inventors named on PCT applications were transport, civil engineering, machine tools, mechanical elements, and engines, pumps, turbines.[46]

In 2016, WIPO also reported that differences in male and female inventors vary between the academic and business sectors.[47] However, there is variation among countries with the gender gap between the academic and business sectors, which "can be partly explained by the countries' industrial specialties."[48] In the academic sector, patents owned by universities have been shown to have the largest share of female participation.[49] However, the share of female inventors on university patents is much lower than their share of number of researchers and authorships in the same context.[50]

According to WIPO, of the top twenty inventor origin countries for PCT applications, only three have more than one-fifth of all named inventors being female.[51] These countries include China, the Republic of Korea (hereinafter "Korea"), and Spain, with the percentage of female inventors on PCT applications being 28.9%, 26.8%, and 24.4%, respectively.[52] Conversely, the United States falls below the global average with only 16% of its named inventors on PCT applications being female.[53] While the percentage

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[40] INTELLECTUAL PROPERTY OFFICE ECONOMICS, RESEARCH, AND EVIDENCE TEAM, INTELLECTUAL PROPERTY OFFICE, GENDER PROFILES IN WORLDWIDE PATENTING: AN ANALYSIS OF FEMALE INVENTORSHIP (2019 EDITION), 8 (2019).

[41] *Id.* at 13 fig.8.

[42] The percentage of female inventors on biotechnology PCT applications was 29.9%, pharmaceuticals 29.2%, food chemistry 28.7%, analysis of biological materials 26.7%, and organic fine chemistry 26.1%. WIPO, *supra* note 37. *See generally* G. Steven McMillan, *Gender differences in patenting activity: An examination of the US biotechnology industry*, 80 SCIENTOMETRICS 683 (2009) (finding that in the biotechnology industry, while women patented less than men, women's patents were valued higher than those of men or joint work between men and women).

[43] UK Intellectual Property Office Informatics Team, *supra* note 39, at 10.

[44] Intellectual Property Office Economics, Research, and Evidence Team, *supra* note 40, at 18 fig.13.

[45] UK Intellectual Property Office Informatics Team, *supra* note 39, at 10.

[46] The percentage of female inventors on transport PCT applications was 10.2%, civil engineering 10.2%, machine tools 9.8%, mechanical elements 8.2%, and engine, pumps, turbines 7.8%. WIPO, PATENT COOPERATION TREATY YEARLY REVIEW 2019: THE INTERNATIONAL PATENT SYSTEM 45 fig.A26 (2019).

[47] PCT applications in 2015 filed by the academic sector had 48% named female inventors, while applications filed by the business sector had 28% named female inventors. Gema Lax Martinez, Julio Raffo & Kaori Saito, *Economic Research Working Paper No. 33: Identifying the Gender of PCT Inventors* 15 (WIPO, Working Paper No. 33, 2016). https://www.wipo.int/edocs/pubdocs/en/wipo_pub_econstat_wp_33.pdf.

[48] *Increasing Number of Women Inventors Named in International Patent Filings Over Past Two Decades but Gender Gap Persists*, WIPO (Nov. 15, 2016), https://www.wipo.int/pressroom/en/articles/2016/article_0015.html#:~:text=2016-,Increasing%20Number%20of%20Women%20Inventors%20Named%20in%20International%20Patent%20Filings,Decades%20but%20Gender%20Gap%20Persists&text=New%20analysis%20shows%20that%2029,according%20to%20a%20WIPO%20study.

[49] Cassidy R. Sugimoto, Chaoqun Ni, Jevin D. West & Vincent Larivière, *The Academic Advantage: Gender Disparities in Patenting*, PLOS ONE, May 27, 2015, at 5.

[50] In this 2015 study, 11% of university patent inventors were female, while 33% of university researchers were female and 30% of university authorships were by females. *Id.* at 8.

[51] WIPO, *supra* note 46, at 24.

[52] WIPO, *supra* note 37.

[53] *Id.* at 45 fig.A35.

of female inventors on PCT applications is only one measurement for a complex issue, this information provided by WIPO spurs an examination into why the United States falls behind these countries and what it can learn from this information. Even though China is closer to the United States in terms of total patent filing activity worldwide,[54] there are more reliable studies and data available for Korea. Interestingly, as displayed in Figure 1,[55] among the top five and bottom five fields of technology that female inventors are named on PCT applications, the United States is consistently below the worldwide average, and Korea is consistently well above the worldwide average.

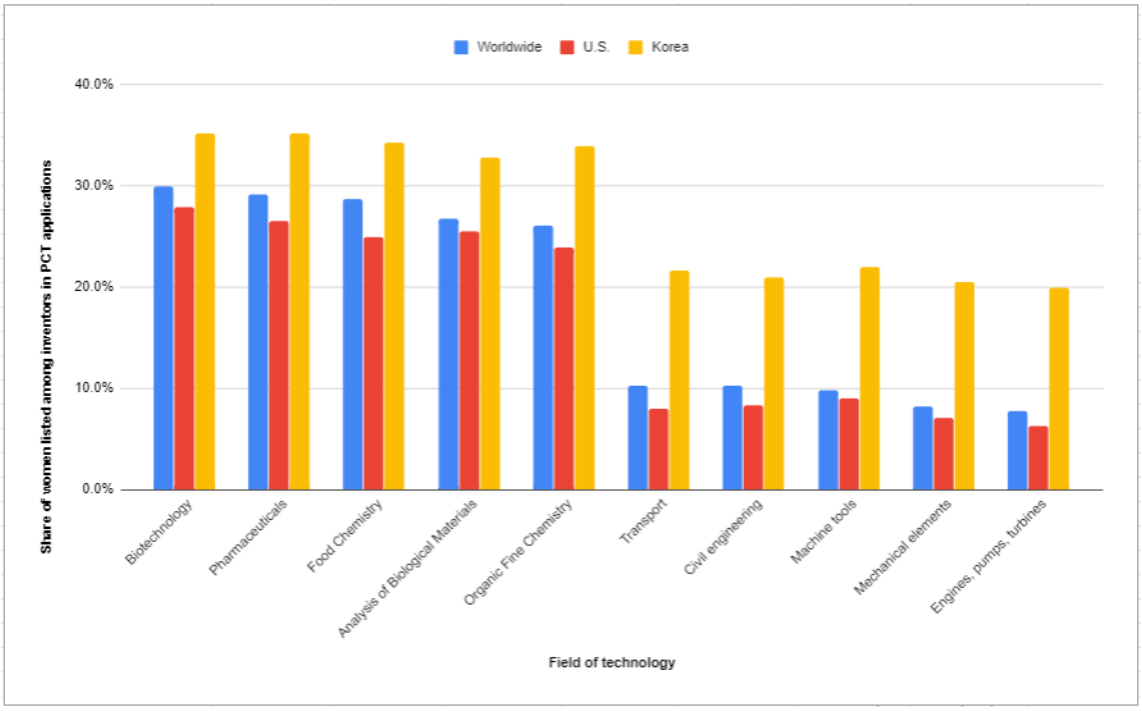

Figure 1: Rate of women inventors in PCT applications by field of technology

Further, despite the fact that the rate of Korean female inventors is consistently higher than that of American female inventors in various fields of technology, reports have shown that the United States has a larger share of female tertiary (any education beyond high school) graduates than Korean tertiary female graduates in three of four reported STEM fields.[56] The United States has a greater share of female tertiary graduates in science, agriculture, and health & welfare, with Korea outperforming the United States in engineering.[57] These paradoxes show that while Korea has a larger gender gap in STEM fields, Korea may be more successful at encouraging female inventors in STEM to patent their creations. On the other hand, while the United States has a smaller gender gap overall in STEM fields compared with Korea, the rate at which female inventors participate in the patent system may note a failure in the United States patent system.

This paper will examine the dynamics of female participation in STEM in Korea, as well as their interactions with the Korean patent system (Section II). Then, these results will be compared to the United States Patent and Trademark Office (USPTO) findings in their 2019 Report to Congress and their legislative recommendations, followed by critiques and further suggestions in order to improve the number of female inventors in the United States and worldwide (Section III).

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[54] China ranks first for total patent filing activity in 2018 and the United States ranks second. Korea ranks fourth. *Id.* at 8 tbl.1.
[55] WIPO, *supra* note 46, at 45–46 fig.A26 & A27.
[56] UNESCO, *supra* note 18, at 92 tbl.3.2.
[57] Specifically, in science, engineering, agriculture, and welfare, the United States share of female tertiary graduates is 40.1%, 18.5%, 48.3%, and 81.5%, respectively. In Korea, the share is 39%, 24%, 41.1%, and 71.4%, respectively. *Id.*

II. THE KOREAN PATENT SYSTEM

A. Female Participation in STEM

The reported WIPO percentage of female inventors on PCT applications from Korea is surprising due to Korea's struggle to attract and keep women in the STEM fields. The percentage of females graduating in natural sciences and engineering is around 29%, and only about 17% of research & development (R&D) researchers are female.[58] Aware of the lack of women pursuing STEM in Korea, the Korean government has implemented a number of policies over the years based on the 2002 Act on Fostering and Supporting Women in Scientists and Technicians (WISAT).[59] The 2002 Act resulted in increased numbers of: female graduates of doctoral degrees in STEM, female employees in STEM at public institutes, female participants in government committees for STEM fields, female STEM degree holders participating in the economy, female employees for STEM R&D, female faculty members at STEM universities, as well as the formation of the Korean Advanced Institute of Women in Science, Engineering and Technology (WISET).[60] These policies showed significant results.[61]

Despite the number of women pursuing and entering STEM fields early in their career though, only 18% of researchers in Korea are female.[62] UNESCO reported in 2015 that gender disparity in STEM is a known trait of Korean public and private industry.[63] This indicates that a large portion of the women pursuing STEM end up leaving shortly after their careers begin.[64] Studies have suggested many factors that contribute to this retention issue for women in STEM. It has been found that the Confucian influence on Korean culture pressures students to pursue education.[65] When the government emphasizes the need to increase the number of Koreans pursuing STEM education, parents and educators can reflect that desire, and students therefore feel pressured to achieve in STEM despite their disinterest or low self-confidence in those fields.[66] This disinterest therefore leads to more STEM graduates leaving the field in a shorter span of time than their interested counterparts.[67] These roles follow the norms of women being homemakers and men being the breadwinners.[68] As such, many women end up leaving the workforce due to societal pressures to have and care for children.[69]

Therefore, Korean female students are pressured to pursue STEM due to government policies and parental influence, despite their general disinterest in pursuing science careers when compared to male students.[70] Once female students complete their education, they leave the STEM fields either due to their disinterest or with the intention to start and care for a family, or a combination of both. This conclusion is

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[58] Sein Shin, Arif Rachmatullah, Fenny Roshayanti, Minsu Ha & Jun-Ki Lee, *Career Motivation of Secondary Students in STEM: A Cross-Cultural Study Between Korea and Indonesia*, 18 INT'L J. EDUC. & VOCATIONAL GUIDANCE 203, 206 (2018).
[59] WISAT, NATIONAL ASSESSMENTS ON GENDER EQUALITY IN THE KNOWLEDGE SOCIETY: GENDER IN SCIENCE, TECHNOLOGY AND INNOVATION 51 (2012).
[60] *Id.*
[61] UNESCO, *supra* note 18, at 95 ("In [Korea], women make up about 40% of graduates in science and agriculture and 71% of graduates in health sciences.").
[62] *Id.*
[63] *Id.* at 99 ("Science in both the public and private sectors in [Korea] . . . is characterized by a strong, persistent gender imbalance in scientific research and industry.").
[64] *See id.*; *see also* WISET, 2018 WISET BROCHURE 14 (2018) (reporting that while 27% of newly recruited R&D employees in STEM are female, overall only 19.3% of R&D employees in STEM are female, according to 2016 data).
[65] *See* Shin et al., *supra* note 58, at 207.
[66] *Id.*
[67] *Id.* at 224.
[68] *Id.*
[69] Shin et al., *supra* note 58, at 226.
[70] *Id.* at 225.

best reflected by the percentage of female tertiary (any education beyond high school) graduates in STEM fields in comparison to the mere 18% of female researchers in Korea.[71]

However, WISET responded to this trend and implemented a R&D Career Re-entry Program for Women, which in their 2018 report showed a 74.5% retention rate after three years.[72] This program matches women who previously worked in STEM fields to universities and public and private institutions, as well as federally funded grants for research.[73] In 2016, 74% of the female beneficiaries selected for this program were either placed in a public research institution or university.[74]

B. Female participation in the Korean patent system

Korea is an avid supporter of strong patent protection in order to "promote and sustain healthy economic development."[75] The government cares so much about having an effective patent system that the Korean Patent act has been amended at least sixteen times since the late 1990s.[76] Korea also places emphasis on having a dynamic and involved patent office that fosters local innovation.[77] Erstling summarized the success of the Korean patent system with three factors: (1) the value the government places on patents in order to further develop the country; (2) the trust that the public, industries, and government have in patent law and policy; and (3) the establishment of the Korean Intellectual Property Office (KIPO)'s services, programs, and institutions that impact Korean development.[78]

In a 2003 publication, KIPO outlined its long-term plan to foster more female inventors to utilize the patent system.[79] The main focus of the plan was to develop programs that would promote female inventions, allow room for businesses owned by female inventors to prosper, and implement government infrastructure which would foster female innovations.[80]

One such KIPO contribution to increasing female participation in the Korean patent system is the Korea Women Inventors Association (KWIA), which was approved by KIPO in 1999.[81] KWIA provides many resources to female inventors, including classes and workshops, a newsletter, free attorney consultations, and more.[82] The highlight event is the Korea International Women's Invention Exposition, which is hosted by KWIA, KIPO, and WIPO with the purpose "to encourage female inventors to create and commercialize their inventions."[83]

In addition to KIPO, the Korean government in general has implemented programs to foster more female inventors. For the first five years of the WISET R&D Career Re-Entry Program, forty-seven patent applications were filed by female beneficiaries of the program.[84] However, raw data on the participation of women in the Korean patent system (not PCT applications), is hard to come by and it is undeterminable how successful Korea's efforts have been to encourage female inventors to patent with KIPO.

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[71] The share of female tertiary graduates in STEM fields in Korea: science (39%), engineering (24%), agriculture (41.1%), health and welfare (71.5%). UNESCO, *supra* note 18, at 92.
[72] WISET, *supra* note 64, at 21.
[73] *Id.* at 15.
[74] SO YOUNG KIM & YOON JUNG LEE, EVIDENCE-BASED APPRAISAL OF THE PROGRAM FOR WOMAN RETURNERS TO RESEARCH AND DEVELOPMENT 29 fig.4-4 (Eun-suk Oh et al. eds., 2017), https://www.wiset.or.kr/eng/contents/ebook_view.jsp?sc_page=1&pk_seq=1416&sc_type=3&sc_tab=1&sc_cond=1&page=1.
[75] Jay A. Erstling & Ryan E. Strom, *Korea's Patent Policy and Its Impact on Economic Development: A Model for Emerging Countries?*, 11 SAN DIEGO INT'L L.J. 441, 443 (2010).
[76] *Id.* at 448.
[77] *Id.*
[78] *Id.* at 479.
[79] KIPO, KOREA'S INVENTION PROMOTION ACTIVITIES 25 (2003), https://www.kipo.go.kr/upload/en/download/KoreaInventionPromotionActivities.pdf.
[80] *Id.*
[81] *History*, KWIA, http://www.inventor.or.kr/eng/contents/introduce/history.asp#history.
[82] *Main Business*, KWIA, http://www.inventor.or.kr/eng/contents/business/info01.asp.
[83] KIPO, ANNUAL REPORT 2018, at 50 (2019), https://www.kipo.go.kr/upload/en/download/annualreport_2018.pdf.
[84] WISET, *supra* note 75, at 32 tbl.5-1.

C. Why is there a large share of Korean female inventors on PCT applications despite the low participation of females in STEM in Korea?

An indication of the large share of Korean female inventors on PCT applications is the fact that many of these female inventors are patenting while they are still a part of academic institutions. As mentioned earlier, university patents have the highest rate of female inventors. Of the top fifty PCT institutional applicants in the academic sector, twenty are Korean universities, five of which are in the top ten.[85] In addition, Korea places a large emphasis on patents and their role in the country's development. This suggests that Korean academic institutions promote patenting amongst their members, including female inventors, which contributes to Korea's high share of female inventors named on PCT applications. These female inventors are patenting early in their STEM careers if they are still students, before they may leave the STEM fields to start and raise a family, or due to other societal pressures. This is also supported by the fact that worldwide women tend to stay in the academic sector longer than the business sector, which could also be the case in Korea. Another possible explanation, in conjunction with the above, is the number of women re-entering R&D positions through government programs at public institutions and universities, which take in more re-entry beneficiaries than private institutions.

According to WIPO, while about 26.8% of all Korean inventors named on PCT applications were female, around 50.7% of the Korean PCT applications name at least one female inventor.[86] This follows the previously mentioned trend that female inventors have a tendency to either be sole-female inventors or the only female on an otherwise all-male inventor team. This explanation accounts for the still lacking participation and retention of women in STEM fields while making sense of the high percentage of Korean female inventors named on PCT applications.

Further, the approach of the Korean government, including KIPO, could explain the high percentage of Korean female inventors on PCT applications. The government and KIPO have implemented a variety of concrete programs and resources for women in STEM and female inventors since the late 1990s. Because of the variety, female inventors at all stages in the pipeline are empowered to pursue patent protection for their inventions. The barriers discussed in Part I are weakened (though not eliminated) with the implementation of government-sponsored female inventor networks (like KWIA), and the government actively funneling female mentors back into R&D careers (WISET R&D Career Re-Entry Program) in sectors where female inventors are more likely to thrive (public and academic). It cannot be determined, though, whether the implicit biases that may be innate in patent laws have been weakened by the Korean government's efforts. Given the numerous times that the government has amended the patent act in a span of twenty years, though, their dedication to a productive and useful patent system may have an impact on these biases over time.

III. THE UNITED STATES PATENT SYSTEM

A. The SUCCESS Act

The "Study of Underrepresented Classes Chasing Engineering and Science Success Act of 2018" (the SUCCESS Act, hereinafter "the Act") was passed on October 31, 2018.[87] The Act requires the USPTO, in collaboration with the SBA, to conduct a study that would (1) identify publicly available data on the number of women applying for and obtaining patents as well as the benefits of increasing the number of patents that women apply for and obtain and (2) provide legislative recommendations of how to promote the participation of women in entrepreneurship activities and increase the number of women who apply for

[85] Martinez, *supra* note 47, at 19 tbl.4.
[86] WIPO, *supra* note 37, at 45.
[87] Study of Underrepresented Classes Chasing Engineering and Science Success Act of 2018, Pub. L. No. 115-273, 132 Stat. 4158.

and obtain patents.[88] The USPTO submitted its report to Congress in October 2019.[89] The USPTO limited its study to inventor-patentees who are residing in the United States or its territories.[90] The USPTO limited its study to inventor-patentees who are residing in the United States or its territories.[91]

B. Summary of Findings and USPTO Legislative Recommendations

The USPTO reported that the percentage of female inventors who successfully obtained patents from the USPTO increased from 3% in 1976 to 12% in 2016.[92] Similar to WIPO and UK IPO findings, these female inventors are predominantly on teams of otherwise all male inventor teams.[93] The USPTO also reported that in a majority of the science fields, women participate at a higher rate than the rate of female inventors in those fields.[94] Furthermore, the STEM fields that have the least amount of female representation also happen to be the most patent-intensive.[95] Corporations have a tendency to have the lowest female inventor rates in USPTO filings.[96]

Generally, patents are beneficial to inventors personally due to increased prestige, income, and number of job opportunities.[97] In addition, innovation is further encouraged, growth of companies is stimulated, and company access to financial capital and licensees increases.[98] Female-owned businesses are more likely to have higher revenues if they own patents.[99]

Increasing the number of female inventors obtaining patents could also be beneficial to the American government and public.[100]

The USPTO also highlighted and proposed initiatives to help close the gender gap in United States patenting. For example, the USPTO hosts the Women's Entrepreneurship Symposium annually.[101] The USPTO plans to prepare IP toolkits for corporations in order to encourage more female inventor participation in the United States patent system.[102]

The USPTO Legislative Recommendations were as follows[103]:

1. With the authorization of Congress, a biennial survey of named inventors on filed United States patent applications to provide demographic information, such as gender. The USPTO recommends that it would collect this information on a voluntary and confidential basis.
2. More federal data transfer between the USPTO and other federal agencies in order to gather more information on the lack of female inventors obtaining United States patents.
3. An increased use of federal grants and funds, authorized by Congress, directed towards promoting invention and entrepreneurship among underrepresented groups, like female inventors, as well as the protection of inventions and innovations created by those groups.

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[88] The act also required the USPTO to look at similar data, benefits, and legislative recommendations for minorities and veterans. What is reported in part A in this paper is specifically for information regarding women. *Id.*
[89] Iancu & Peter, *supra* note 7.
[90] *Id.* at 6.
[91] *Id.* at 6.
[92] *Id.* at 8.
[93] *Id.*
[94] The exception to this is in engineering, where the rates are the same. *Id*. at 9.
[95] This includes electrical and mechanical engineering, and development and design. *Id.* at 19.
[96] *Id.* at 23.
[97] *Id.* at 2.
[98] *Id.*
[99] *Id.* at 17.
[100] *Id.* at 4 ("[I]ncreasing the rate of invention by women [and other underrepresented groups] could quadruple the total number of inventor-patentees in America.").
[101] *Id.* at 22.
[102] *Id.* at 23.
[103] *Id.* at 26.

4. With the authorization of Congress, the creation of quarters and postage stamps which feature American inventors from a variety of backgrounds, such as female inventors, in order to increase the public's awareness of American invention.
5. Similar to Recommendation 4, the creation of national museum exhibits which highlight inventions and entrepreneurship contributions from female inventors and other underrepresented groups.

C. Critiques of USPTO Legislative Recommendations and what the United States can learn from the Korean Patent System

One reason why comparing the United States and Korean patent system would be beneficial to the United States is because of the similarities in United States and Korean patent filing activity. Of the top fifty PCT institutional applicants in the academic sector, the United States is only three behind Korea with seventeen academic institutions, both of which individually have more institutions in the top fifty than the other seven represented countries combined.[104] A limitation of this, however, is that the business sector is responsible for most patents in the United States, and while increasing innovation in the academic sector may improve the female inventor rate, more progress would be made by implementing policies to expand female participation in business innovative activity.[105] Nevertheless, comparing the United States and Korean patent systems may serve as a helpful insight to the USPTO's recent legislative recommendations pursuant to the SUCCESS Act.

The first and second legislative recommendations implicate that research on female inventor participation in the patent system, specifically with respect to raw data, is a newer area of study and therefore a lack of data hinders progress towards gaining greater insights. Up until this point, "the USPTO has never required inventors to self-identify their sex or requested such information be provided even non an optional basis."[106] The USPTO, WIPO, and other entities have accumulated their data by relying on name-matching to females and males.[107] However, this methodology can be proven ineffective for a variety of reasons. First, this methodology disproportionately skews the amount of data known for non-Western non-Latin character languages as the entities compiling this information may have less knowledge of those languages.[108] Second, this methodology does not account for unisex names, which have grown substantially in popularity in past decades.[109] Third, this methodology discriminates against those female inventors who may still be assigned male birth names, and vice versa. While the last two reasons may represent a smaller population of female inventors in the United States, societal changes and progress indicate that the need to collect data from the voluntary input of the inventor is the best way to approach increasing the number of female inventors in the United States patent system. In addition, collecting voluntary data on inventor gender and other demographics could encourage the USPTO and international entities to expand research and programs for inventor representation in other areas of gender, such as non-binary inventors.

These two legislative recommendations also reflect issues and progress in the Korean patent system. With respect to the first legislative recommendation, the United States is similar to Korea in its struggle to accumulate substantial data on the number of female inventors participating in their respective patent system, and brings light to the fact that the lack of data is a worldwide one rather than just an issue in the United States. For the second legislative recommendation, the USPTO and other federal agencies

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[104] The number of academic constitutions by country are as follows: Korea (20), U.S. (17), China (3), Israel (3), France (2), Singapore (2), Germany (1), India (1), and Spain (1). Martinez, *supra* note 47, at 19 tbl.4 (2016).
[105] Iancu & Peter, *supra* note 7, at 11.
[106] Kahler, *supra* note 8, at 775–76.
[107] UK Intellectual Property Office Informatics Team, *supra* note 39, at 2.
[108] Of the top 10 inventor countries represented on UK patent applicants over a 15-year span, the known gender of Taiwanese and Korean inventors was disproportionately lower than that of Western country inventors (less than 20% in comparison to over 89%). *Id.* at 7.
[109] *See generally*, Pamela Redmond Satran, *Unisex baby names are on the rise and these are the 25 most popular*, TODAY (August 19, 2016, 5:15 PM), https://www.today.com/parents/unisex-baby-names-are-rise-these-are-25-most-popular-t102057.

could look to the Korean government for its progress in collaborating governmental entities to improve the number of female inventors in Korea. Over the span of a couple decades, the Korean government introduced entities such as KWIA and WISET, which are a part of KIPO and the Korean Ministry of Education, Science and Technology. Some success has been shown with this model in Korea, and could also be successful in the United States if the right policies are implemented and correct information exchanged to develop a more cohesive plan to increase the number of female inventors in the United States.

The third legislative recommendation addresses concerns that were brought up by United States female patent holders. Public commentary invited by the USPTO pursuant to the SUCCESS Act mainly focused on post-patent acquisition rather than the pre-acquisition pipeline (STEM education to underrepresented groups, for example).[110] Female inventors who participated in the public hearings focused on how the United States patent system disadvantages small businesses and individual inventors, who are more likely to be female inventors.[111] Without increased protection for small business or single inventor patents, larger corporations can use the USPTO's inter partes review process to target small businesses at minimal cost on their end but at the cost of the entirety of a small business's resources and livelihood.[112]

Not only does the third proposed legislative recommendation address the concerns of United States female patent holders, but also reflects the motivations of the Korean government to advocate for female inventors in their own patent system. WISET and KIPO's programs are federally funded and granted in Korea in order to promote female inventors and entrepreneurs in Korean industry. In particular, WISET's program for R&D women re-entry has shown successful results. Hopefully, similar programs will be implemented by Congress to address the maintenance and re-entry of women in STEM fields in order to develop them into female inventors.

Finally, the fourth and fifth legislative recommendations are a result of findings that early exposure to female inventors increases the chances of later female inventors. The studies referenced by the USPTO in their report focused on exposure to female inventors in young girls' *communities* rather than the broad United States community generally, but these are both admirable recommendations. Given the reality of the times, though, I would argue that not many young girls will be exposed to the commemorative stamps and coins honoring female inventors, as both mail and money are becoming more digitized each year. Also, national museum exhibits without corresponding webpages on free national museum websites or applications would limit the number of young girls who would have access to these resources, as a national museum can only reach so many people before monetary and social barriers kick in, such as inability to pay for travel to see these exhibits.

In Korea, expanding the number of women in STEM and number of female inventors has been implemented by providing comprehensive online resources and expansive social networks that some women would otherwise be unable to have access to. The USPTO should reexamine legislative recommendations four and five to adapt to modern times in order to foster engagement of young girls in STEM and female innovation. This could be utilized through short documentary specials highlighting female inventors on YouTube or popular streaming services, social media campaigns, podcasts, and increased publicity in local and national news outlets. The benefit of utilizing internet tools is to introduce young girls to an online network of other people who are also interested in female innovation in the United States, which has been helpful to increasing the number of women in STEM in Korea. Another source of exposure to young girls could be collaborating with the Department of Education or other government entities to develop free lesson plans and resources for teachers to use in their classrooms. Similar to Inventors' Day on February 11,[113] the USPTO could ask Congress or the Presidential Office to establish a day to recognize the achievements of female or minority inventors in United States history.

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[110] Eileen McDermott, *SUCCESS Act Comments Are In: Access, Enforceability, Predictability Concerns Underscored*, IP WATCHDOG (October 2, 2019), https://www.ipwatchdog.com/2019/10/02/success-act-comments-access-enforceability-predictability-concerns-underscored/id=114181/.

[111] *Id.*

[112] *Id.*

[113] United States Census Bureau, National Inventors' Day: February 11, 2019, https://web.archive.org/web/20200603143450/https://www.census.gov/newsroom/stories/2019/inventors-day.html.

IV. CONCLUSION

The desire to increase the number of female inventors on a national and global scale is reflected in the increased amount of scholarship and studies to assess why a persistent gender gap exists in patenting. Studies have shown that the gender gap could be attributed to implicit biases existing in STEM fields of technology as well as the patent system itself, which is supported by recent data on female inventors and female participation in STEM. An interesting observation is that Korea has a higher female rate than the United States, despite the fact that the United States has a higher rate of female participation in STEM. Upon further analysis, the successful policies that the Korean government has implemented into improving women in STEM and in patenting provide helpful insight to the United States' study under the SUCCESS Act. The legislative recommendations proposed by the USPTO to Congress at the conclusion of this study are a step in the right direction to increase the participation of female inventors in the United States patent system, however they could be improved by looking to techniques used by other countries that address this problem as well, like Korea.