To Grant or Not to Grant: Inventor Gender and Patent Examination Outcomes*

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Abstract

The likelihood of a patent application being approved by the USPTO is significantly lower for female inventors than for male inventors, even within narrow technological groups. We investigate the reasons for this gap, focusing on the role of gender bias, and analyze the implications for the quality and value of the granted patents. We find that the gender gap in examiners' first-action approval decisions declines significantly and becomes close to zero when inventor names are rare and thus more gender-blind. Additionally, granted patents authored by female inventors are associated with higher estimated market values, but this difference diminishes for the gender-blind group—a pattern also reflected in forward-citations. Consistent with the effects of statistical discrimination, gender gap in approval rates is smaller for more experienced inventors and in technological art units with higher female representation. We estimate that more than half of the residual gender gap in the patent grant rates (of 5.4%) can be attributed to gender bias, with the remainder likely due to female inventors' greater tendency to abandon applications after receiving negative feedback. Our findings shed light on the causes of gender differences in patent examination outcomes and offer implications for policies aimed at creating a level playing field in patenting.

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Understanding women's role in the labor market is critical for society… If women do not have the same advantages and opportunities as men, or they participate on unequal terms, labor, skills, talent go wasted.

- Jakob Svensson (Chair, Economic Sciences Nobel Prize Committee 2023)

1 Introduction

A large body of literature documents gender differences across a wide range of economic activities and outcomes. Women tend to innovate less, are less represented in STEM fields, are less likely to be founders or entrepreneurs, and are less likely to receive venture capital (VC) funding.[1] The literature has identified several potential reasons for these gaps, ranging from gender discrimination to gender differences in abilities or preferences. This paper aims to shed light on these factors by examining the role of gender in the patenting process – an area in which female participation has been persistently low (as of 2019, women represent 13% of U.S. inventors).

We focus on patenting for two reasons. First, patents provide a legal framework for innovation, so any frictions or biases within this framework can have significant consequences for innovation activities, output, and growth. In particular, ensuring that the system is free from gender bias could help unlock talent and creativity, benefiting not only women but society at large. Second, the setting offers a unique laboratory to study gender effects. Patent data includes large samples of patent applications within narrowly defined fields and details on how they progress through the examination process, enabling researchers to study individual decision-making and outcomes. The data also allows for the use of statistical methods to help identify causal effects, as we explain below. Importantly, insights gained from this research can inform other, often more opaque settings where women compete with men in traditionally male-dominated fields.

We examine the patenting process, from the initial submission of a patent application to its final approval or rejection. Our focus is on the decision of the patent examiner to accept or reject the application at the first review (called first-action decision), which provides an attractive setting from an identification standpoint. While prior literature has examined elements of this process, it

[1] See, for example, Ewens and Townsend (2020), Calder-Wang and Gompers (2021), and Hebert (2023).

has reached conflicting conclusions.[2] In addition to establishing key facts, our goals are to shed light on the mechanisms driving the gender differences in patenting, and to provide evidence on how these forces affect the quality and value of the granted patents.

As a starting point, it is worth noting the substantial disparity in the ultimate grant rates in patent applications authored by male and female inventors. Conditional on filing an application, 'all female' inventor teams are 20.9% less likely to have their patents eventually granted compared to 'all male' teams (this compares to the grant rate in the full sample that is 68.5%). This gap shrinks to a residual 5.4 percentage points within narrowly defined patent subclasses and after controlling for other patent, inventor, and examiner attributes.

To investigate the reasons for this gap, we first focus on the examiner's initial decision to accept or reject an application. These decisions provide the cleanest setting for our purpose because they are not affected by selection biases introduced in subsequent rounds of review.[3] Using this setting, we find a significant residual gender gap in acceptance rates between male and female inventors. On average, 7.5% of applications are accepted in the first round, with acceptance rates being 0.4 to 0.6 percentage points lower for women than men, depending on specifications. This represents a decline of 5.3% (= 0.4 / 7.5) to 8% (= 0.6 / 7.5) in initial acceptance rate for female inventors compared to male inventors within highly comparable patent technological categories.

This disparity does not necessarily imply bias on the part of patent examiners because some residual gender differences in patent quality could persist even within the otherwise homogenous technology groups. To address this possibility, we take advantage of the fact that examiners are likely to infer an inventor's gender from the first name listed on the application. We use the Social Security Application database to categorize names as rare vs. common as applications with rare first names offer a relatively gender-blind subsample. We then test whether having a gender-blind name affects the gender gap in the initial acceptance rates (first-action allowance).[4]

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[2] For example, Jensen, Kovács, and Sorenson (2018) report that overall rejection rates are higher for female inventors, suggesting gender bias, while Aneja, Reshef, and Subramani (2024) find no significant gender differences in rejection rates at the first-action decision. We are able to reconcile and provide an explanation for these conflicting findings.

[3] Patent examination involves many rounds of revise-and-resubmit (called amendment/appeal). The acceptance rate in the later rounds is a joint decision of the examiner's approval and the inventor's willingness to resubmit.

[4] We are not the first to use a gender-blind setting to test for the presence of bias. Prominent examples include Goldin and Rouse (2000), who show that gender-blind orchestra auditions resulted in higher success rates for female

The results are striking. We find that the gender gap in acceptance rates for the first-round applications decreases significantly for applicants with rare (gender-blind) names. Moreover, the remaining gap within rare-name applications becomes statistically insignificant. The effects are not caused by patent attributes associated with rare names and are robust to imposing different cutoffs for rare names. Instead, the findings suggest that examiners reject applications submitted by women at significantly higher rates than otherwise comparable applications submitted by men. Subsequent tests (discussed below) reveal that over a half of the total gender gap in ultimate grant rates (of 5.4%) can be attributed to gender bias in examiners' decisions.

This tilt in acceptance rates towards male-authored patent applications is consistent with a large literature on gender stereotypes in economics and sociology, which we review below. A pervasive finding in this research is that the tendency to stereotype based on gender – that is, to hold preconceived and biased beliefs about a person's ability – increases when the person's true ability is more difficult to assess due to limited information. In such cases, people infer individual traits using information about group statistics, a phenomenon known as statistical discrimination (Arrow, 1998; Phelps, 1972). Another common finding is that stereotyping is more prevalent in settings where one group dominates the other (Bordalo, Coffman, Gennaioli, and Shleifer, 2019). The patenting process is a good example of such a setting as a vast majority of inventors are men.

These regularities have two testable implications in our context: if the gap in the initial acceptance rate we estimate is driven by statistical discrimination rather than outright taste-based discrimination, the gap should decrease within a subset of more experienced inventors, as their quality is more evident to examiners. It should also decrease within a subset of technological units where female inventors are more strongly represented. This is precisely what we find. The gender gap in the first-round acceptance rate shrinks and becomes statistically insignificant in applications by experienced inventor teams. Among art units with below-sample median female representation, the gender gap in first-round acceptance rate roughly doubles relative to that in the overall sample. The evidence is consistent with examiners relying on gender heuristics to form beliefs about patent quality, especially when information about quality is scarce.

We turn next to exploring the effects of inventor gender on the quality of patents that have

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musicians and Bertrand and Mullainathan (2004) who identify racial bias in employment choices based on applicants' first names. Similarly, Jensen, Kovác, and Sorenson (2018) use inventor first names to study the role of gender in a patent setting (we discuss this paper in more detail below).

been ultimately granted. The examiner bias we document thus far implies that women face higher hurdles in the application process than men, which should increase the average quality of the accepted female patents. Other mechanisms could reinforce this effect: prior literature shows that receiving an initial rejection causes women to abandon the application process more often compared to men (we confirm this finding in our data). This tendency could impose an additional filter on female applications, further increasing the quality of the granted pool.

To explore the combined effect of these forces, we begin by comparing the economic values of granted patents authored by male vs. female teams, using stock price reactions to patent grant announcements (following the methodology in Kogan, Papanikolaou, Seru, and Stoffman (2017)). As predicted, we find that female-authored patents are associated with significantly higher economic values than male-authored patents, even within narrow technology groups and controlling for patent, inventor, and examiner characteristics. Importantly, this difference shrinks significantly (and becomes close to zero) when we restrict the sample to inventors with gender-blind names. This finding suggests that gender bias on the part of examiners is an important mechanism behind the gender difference in values. It also suggests that counteracting this bias could increase the overall value of patents granted to U.S. firms.

Stock returns provide useful insight into patent values, but the estimates are limited to publicly traded firms. To evaluate patents' broader impact, the literature often examines the extent to which patents are cited by other inventors. In our context, this approach presents an additional challenge because, according to recent research, patent citations themselves can be subject to gender bias (in the sense that female-authored patents are 'under-cited').[5] Our data on gender-blind applications allows us to overcome this challenge. Within this group, neither examiners nor other inventors can easily discern the authors' gender, so citations should be unaffected by biases from either source. Consistently, we find that among granted patents with common inventor names, female patents have significantly fewer citations than male patents, but this gap shrinks significantly among patents with gender-blind (that is, rare) names. In fact, in the gender-blind sample, female-authored patents perform better based on citation counts than patents authored by men.

[5] Hochberg, Kakhbod, Li, and Schdeva (2023) provide evidence that female-authored patents are 'under-cited' using machine learning to identify comparable patents.

While our focus is on gender bias in how patents are evaluated by examiners (and cited by other inventors), prior literature suggests that gender differences in the inventors' own behavior could also contribute to the disparities in patenting outcomes. A large experimental literature shows that, in a variety of settings, women exhibit less overconfidence than men and respond more strongly to negative feedback.[6] Consistently, recent evidence in Aneja et al. (2024) suggests that otherwise comparable patent applications are more likely to be abandoned after initial rejections when they are authored by women compared to men. We examine the abandonment decisions in our data to offer a more complete picture of the different sources of the gender gap in patenting outcomes, including their relative importance.

The analysis, combined with our findings on examiner choices, allows us to decompose the total gender gap in ultimate grant rates (of 5.4 percentage points) into a portion attributed to examiner bias (3.0 percentage points) and that attributed to gender differences in inventors' persistence (2.4 percentage points). Thus, our findings indicate that bias is responsible for over half of the overall gender difference in the likelihood that a patent application is ultimately approved.

Overall, our paper provides strong evidence that examiners rely on gender heuristics when evaluating patents, contributing to lower success rates for female inventors. Additional mechanisms, such as women's stronger response to negative feedback and a bias in citation counts favoring men, reinforce these effects. While our tests focus on the initial stage of the patenting process—where these effects are easier to identify—the findings likely reflect broader phenomena in the innovation space and may extend to other male-dominated fields where women seek to compete. The findings suggest that a shift in attitudes toward women in STEM fields has a potential to increase value not only for inventors and firms but also for society as a whole.

The paper contributes to the broader literature on women's participation and outcomes in professional settings. Existing research documents significant gender differences, particularly within high-skill professions, and attributes them to institutional barriers, career interruptions, preferences, and stereotypical beliefs (see reviews by Blau and Kahn (2017) and Goldin (2014)). Several studies focus specifically on gender stereotypes, documenting their presence across multiple fields, such as finance (Egan, Matvos, and Seru, 2022), medicine (Sarsons, 2017),

[6] See, for example, Bordalo et al. (2019), Gneezy, Niederle and Rustichini (2003), Niederle and Vesterlund (2007).

academia (Sarsons, Gërxhani, Reuben, and Schram, 2021), sales (Benson, Li, and Shue, 2022), corporate leadership (Lewellen, 2024), and entrepreneurship (Hebert, 2023; Guzman and Kacperczyk, 2019).

A few recent studies explore the role of gender in the patenting process. Jensen, Kovác, and Sorenson (2018) are the first to document lower ultimate approval rates for female-authored patent applications, pointing to both gender bias among examiners and lower persistence among female inventors as potential causes. Aneja, Reshef, and Subramani (2024) focus on the second mechanism and show that an initial rejection has a greater negative causal effect on the likelihood of resubmission for women than for men. However, in contrast to Jensen et al. (2018), they find no evidence of gender bias in examiners' decisions to approve or reject applications and conclude that such bias is not a significant source of gender disparity in patent approval rates. [7]

Our contribution to this literature is two-fold. First, our focus is on understanding the role of gender bias in the patenting process. Given the conflicting findings in earlier research, we believe the question merits closer examination. Thus, we test for the existence of bias, explain the sources of discrepancies in earlier studies, and provide evidence of statistical discrimination as the underlying cause. Second, unlike the earlier studies, we explore the effects of gender bias on the quality and value of the patents ultimately granted. Our findings suggest that this effect is significant, and that 'leveling the playing field' for female inventors could have a meaningful impact on both firm values and the overall innovation output.

Taken at face value, our findings suggest that adopting a more 'gender-blind' application process—such as omitting first names—could help reduce gender bias and improve overall outcomes. While we believe that such reforms are worth considering, the trade-offs would need to be carefully weighed. For instance, our results indicate that examiners consider an inventor's track record when evaluating patent applications, and a fully blind process could inadvertently remove this potentially valuable signal of patent quality.

The rest of the paper is organized as follows. In section 2, we describe the institutional background of patent examination at the USPTO. Section 3 describes the data and methodology. Sections 4, 5, and 6 present the empirical results, and section 7 concludes the paper.

[7] In related research, Hegde and Raj (2022) document gender differences in work quality among patent examiners while Hochberg, Kakhbod, Li, and Schdeva (2023) focus on gender gaps in patent citations.

2 Institutional Background

We examine gender differences in the U.S. patent examination process through which patent applications are converted to granted patents. A patent application contains a group of claims outlining the legal rights that the inventor is aiming to obtain as well as disclosure of existing patents related to the patentability of the invention ("prior art"). After the applicant submits the application to the USPTO and pays the submission fees, the office will review it for completeness. Then, the application is given an initial technology classification and assigned randomly to one of the examiners who are responsible for that technology group (Art Unit).[8] The initial application fees generally entitle the applicant to two rounds of examination. During the first round, the assigned examiner will read and understand the application, and conduct a 'prior art' search for earlier material related to the claimed invention. The examiner evaluates the viability of inventor's claims with respect to eligible subject matter (35 U.S.C. 101), novelty (35 U.S.C. 102), and non-obviousness (35 U.S.C. 103) and decides whether to accept the patent claims.

Table A1 in the Internet Appendix summarizes the patent evaluation process and the statistics using data on U.S. patent applications from 2001 through 2017. In the first round review, the examiner issues an action document (first-action letter) mailed to the applicant, in which she/he details the reasons for rejection (including restriction required, non-final rejection, or final rejection), or an allowance if the patent is granted.[9] Table A1 shows that of the 988,125 applications, the majority (92.5%) are rejected in the first round (first-action decision), with the rejection rates being higher for all-female teams (95.5%) compared to all-male teams (92.1%). Applicants may respond to an initial or any subsequent rejection, including final rejection, by amending their claims or submitting appeals. Of the initially rejected applications, 15.2% are ultimately abandoned, and of the remaining (amended) applications, 76% are approved in the second round. The rest receives a 'final rejection,' whereby applicants retain the opportunity to

[8] Every art unit is led by a supervisory patent examiner, who verifies the technological classification of a patent application, and assigns it to an examiner in her/his art unit. Lemley and Sampat (2012) show that some art units assign applications using a "first-in-first-out" rule, whereas others use the last digit of the (randomly assigned) application serial number to assign patents. Though the assignment process varies from one art unit to another, the assignment methods used by the USPTO are consistent with that applications are assigned to examiners randomly in regard to the quality of the application or of the applicant. (e.g., Lemley and Sampat 2012; Sampat and Lemley 2010; Sampat and Williams 2019).

[9] Only a small fraction of first-action decisions are final rejections (0.2% in our sample). The decision 'restriction required' can be viewed as a special form of non-final rejections. It refers to cases in which the patent application's claims encompass multiple independent inventions, so the claims are required to be restricted to one invention.

continue addressing examiners' comments by amending their claims and paying additional fees until they satisfy the examiners. Patent applications are not terminated until the inventor implicitly or explicitly abandons the application (Lemley and Sampat, 2008). Overall, 68.5% of all patent applications are ultimately approved, with the approval rates being much higher for all-male teams (69.7%) than for all-female teams (48.9%).

3 Data and Sample

3.1 Patent Data

The patent data come from two sources: the Patent Examination Research Dataset (PatEx), which provides detailed information on USPTO patent applications and grants, along with their entire examination histories up to 2020, and the USPTO PatentView database, which covers assignee information, inventor name and location, technological classifications, and citations.[10] We focus on all utility patent applications filed at the USPTO between 2001 and 2017. We start our sample in 2001 because the PatEx dataset provides full coverage of all patent applications starting from that year. We end the sample period in 2017 to mitigate data censoring issue since it typically takes 2-3 years for a patent to be granted after its application (Hall, Jaffe, and Trajtenberg, 2001). Following prior literature, we also exclude re-exam, re-issue, and provisional patent applications, as they may be handled differently in the examination process (Jensen et al., 2018; Graham, Marco, and Miller., 2018). Finally, we drop patent applications authored by foreign inventors to ensure that the results are not driven by the prevalence of rare names among foreign inventors.

3.2 Inventor Gender

We use name-gender dictionaries to infer inventor gender based on their first names, similar to Jensen et al. (2018) and Whittington (2018). Our primary data source is the U.S. Social Security application record which provides counts of applicant first names by gender. We code an inventor as female (or male) if their first name is associated with that gender more than 95% of the time. We choose this conservative cutoff to reduce coding errors due to unisex names. For the names that we cannot identify gender using the U.S. Social Security application record, we use

[10] Available at https://patentsview.org/.

genderize.io—an online service that aggregates data from social media—again applying the 95% threshold to categorize names as either female or male.

Using these filters, we are able to infer gender for about 90% of our sample inventors. To ensure accuracy of our team-level measures of gender, we exclude patent applications where one or more inventor's gender cannot be identified. Consequently, our sample consists of 80% of the applications with clearly identifiable genders for all inventors, totaling 988,125 U.S. utility patent applications filed from 2001 to 2017.

3.3 Descriptive Statistics for the Baseline Sample

Summary statistics for the main patent application sample are presented in Table 1. Our two key patenting outcome variables are *First Action Allowance*, which is set to one if the application is approved (granted) in the first round, and *Patent Granted*, which is set to one if the patent is ultimately granted at any stage. The table shows that 68.5% of patents are eventually granted, while 7.5% are granted in the first round. The table reports several measures of female participation on inventor teams, which we use as the key independent variables in the subsequent tests. They include the fraction of female inventors on the team (average of 8.1%) and indicators for inventor teams that are majority female (4.0%), all female (3.1%), all female (3.6% of unisex teams), or solo female (6.9% of all solo teams).

Table 1 also includes measures of patent application, examiner, and inventor attributes suggested by prior literature, which we use as control variables in our tests (detailed variable definitions are in Appendix A). Following Farre-Mensa, Hegde, and Ljungqvist (2020), we use two examiner-level measures: *Examiner Leniency*, [11] refers to the proportion of reviewed patents that an examiner ultimately approved in an art unit, and *Examiner Review Speed*, which measures the average time lag, in years, between the application and the first-action decision.[12] Consistent

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[11]Specifically $Examiner\ Leniency_{j,a,\tau} = \frac{\#patents\ granted_{j,a,\tau}}{\#patents\ reviewd_{j,a,\tau}}$, is the ratio of the cumulative number of patents granted by examiner j belonging to art unit a to the total number of patent applications reviewed by the same examiner, prior to date τ. It reflects how frequently an examiner grants patents relative to the number of applications they have reviewed, with higher values indicating a more lenient examiner. Our calculation of examiner leniency is based on data from 2001 onward, when rejection information became publicly available.

[12]Specifically, $Examiner\ Review\ Speed_{i,j,a,\tau} = \frac{t_{first-action\ time_{j,a,\tau}}}{\#patents\ reviewd_{j,a,\tau}}$, where $t_{first-action\ time_{j,a,\tau}}$ is the total first-action time taken by examiner j across all applications he/she reviewed before the first-action date τ of the focal patent application i, and $\#patents\ reviewd_{j,a,\tau}$ is the total number of patent applications reviewed by examiner j prior to τ.

with Jensen et al. (2018), we also include the logarithm of one plus *Examiner Experience*, defined as the number of years the examiner has reviewed patent applications in the USPTO. The average examiner review speed in our sample is 1.7 years, and the average examiner experience is 12 years. An average application has 2.35 inventors and includes 3.6 initial claims. Of all applications, 74% are filed by an *Experienced Inventor Team*, defined as a team with at least one inventor who has filed a patent application in the past.

4 Inventor Gender and Patent Grant Decisions

4.1 Baseline Tests

We begin by estimating a baseline relationship between inventor gender and the outcome of a patent application using the following regression model:

$$Outcome_{i,j,k,t} = \beta_0 + \beta_1 Female\ Inventor_{i,t} + \lambda X_{i,t} + ArtUnit\ Subclass \times Year_{k,t} + \epsilon_{i,t}, \quad (1)$$

where *i* indexes application, *j* indexes examiner, *k* indexes the application's technology art unit subclass, and *t* is filing year. The dependent variables are the two patent application outcomes discussed in Section 3.3: the *First-Action Allowance,* set to one if the application is granted in the first round, and *Patent Granted*, set to one when the application is ultimately granted in any round. The key independent variable, *Female Inventor*, represents the different measures of female participation on inventor team discussed in Section 3.3. The vector of control variables ($X_{i,t}$) includes the application, inventor, and examiner characteristics, including *Examiner Review Speed, Examiner Leniency, Ln(1+Examiner Experience), Small Entity, Foreign Priority, Continuation, Number of Inventors, Solo Inventor, Initial Num. of Claims, Inventor Experience* (see descriptive statistics in Table 1 and definitions in Appendix A). The regressions include $ArtUnit\ Subclass \times Year_{k,t}$ fixed effects, which allows us to compare applications by male and female inventors within highly specialized technology groups.[13]

Table 2 presents the regression results of Equation (1) estimated using Ordinary Least Squares (OLS), where the dependent variable is *First-Action Allowance* (Panel A) and *Patent*

[13] Our sample includes 741 art units and a total of 37,320 subclasses. Examples of art units are Semiconductors/Memory industry (Art unit of 2817 with subclasses such as Organic Semiconductor Material) or Immunology, Receptor / Ligands, Cytokines Recombinant Hormones, and Molecular industry (Art unit of 1643 with subclasses such as Tumor Cell or Cancer Cell).

Granted (Panel B). The key independent variables (*Female Inventor*) are the five measures of female participation on inventor teams as indicated in the table heading.

Table 2 shows that both the likelihood of first-action approvals and the ultimate patent grants are significantly negatively related to female participation on inventor teams. This finding holds for all five *Female Inventor* measures and after controlling for the narrow art unit subclasses×Year fixed effects and a host of application, inventor, and examiner attributes listed above. The coefficient estimates of *Female Inventor* range from 0.004 to 0.006 in columns (1) through (5), implying that the first-action acceptance rate is 0.4 to 0.6 percentage points lower for women than men, depending on specifications. This represents a decline of 5.3% (= 0.4 / 7.5) to 8% (= 0.6 / 7.5) relative to the average approval rate of 7.5 percentage points (reported in Table 1) compared to male inventors within highly comparable patent technological categories.

Based on Panel B, ultimate grant rates are also significantly lower for female inventors. For instance, all-female applications are 5.4 percentage points less likely to be granted, representing a 7.9% decline relative to the 68.5% unconditional grant rate, consistent with the findings by Jensen et al. (2018). This gender gap in ultimate grant rates could arise either because female-authored applications are less likely to be approved by examiners or because female inventors are less willing to amend the applications and re-submit them after receiving a rejection. Our analysis in Panel A focuses on the first-action decisions by examiners, so the estimates are unaffected by inventors' subsequent withdrawals from resubmission. Based on these regression results, examiner decisions contribute significantly to the gender gap in ultimate grant rates.

Our findings differ from those in Aneja et al. (2024) who find no gender effects at the first-action stage and conclude that examiner bias is not a significant factor in the patenting process. We replicate their results and find that the discrepancy arises from their sample selection procedure, which results in non-utility patents being included in their sample. These non-utility patents have substantially lower initial rejection rates (0.147 compared to 0.891 for utility patents) and are more frequently associated with female inventors. We find that excluding these non-utility patents from their sample yields similar results to those reported in Panel A of Table 2.[14]

[14] Non-utility patents include design patents, which protect a product's appearance rather than its functionality, and plant patents, which protect new or distinct varieties of plants. In contrast, utility patents protect inventions or discoveries, covering processes, machines, articles of manufacture, or compositions of matter.

The coefficients on control variables (reported in the Internet Appendix, Table A2) are consistent with estimates in prior literature. For example, we find that approval rates are higher for historically more lenient and more experienced examiners (Sampat and Williams, 2019), and for examiners with higher review speeds (Frakes and Wasserman, 2017). The approval rates are also higher for more experienced inventors and applications with a lower number of claims (Farre-Mensa et al. 2020).

Finally, in the Internet Appendix Table A3, we re-estimate the baseline OLS regressions from Table 2, first excluding control variables (Panels A & B) and then excluding both control variables and fixed effects (Panels C & D). The results show that omitting the control variables has no significant impact on the key coefficients, suggesting that the fixed effects absorb the relevant cross-sectional variation in patent attributes. However, excluding the fixed effects reveals a substantially larger unconditional gender gap in approval rates, consistent with the findings in Table A1. For instance, among all-female teams, the unconditional gap in ultimate grant rates is 20.9%, compared to the residual gap of 5.4% reported in Table 2. This indicates that women are more likely to patent in technology groups with generally lower approval rates. Whether this is due to preferences, institutional barriers, or other causes remains an open question for future study.

4.2 Gender Gap When Inventor Names Are 'Gender-Blind'

The lower approval rates for female inventors are not necessarily caused by gender bias on the part of examiners. While the regressions in Table 2 are estimated within narrow technological groups and include a rich set of controls, we cannot rule out the presence of residual gender differences in patent quality between male and female teams. For example, it is possible that female inventions are less novel or less useful, which could prompt an examiner to issue a rejection, causing the gender gap we estimate in Table 2.

To disentangle these effects, we test whether applications submitted by inventors with rare (and therefore more 'gender-blind') first names have a lower gender gap in approval rates. While inventors themselves, their employers, and patent agents or attorneys are aware of the inventors' gender, this is typically not the case for patent examiners. However, examiners may infer gender—either consciously or subconsciously—based on the inventors' first names listed on patent

(https://www.uspto.gov/patents/basics/apply#types). Non-utility patents are typically excluded from studies focusing on technological innovation.

applications. While gender can be easily inferred from common names, such as ‘John’ or ‘Sarah,’ rare names, such as ‘Manijeh’ (typically female) or ‘Irshad’ (typically male), make this inference more difficult. Thus, if the gender gap in approval rates is caused, at least partially, by gender bias, we expect this gap to diminish among applications with more gender-blind names. Conversely, if the gap is entirely due to residual gender differences in patent quality, there would be no obvious reason to expect such a decline.[15]

We use the Social Security Application database to categorize names as rare or common. Rare (common) first names are those within the bottom (top) 10th percentile or 1st percentile of all names in the database, based on frequency counts. We classify any inventor names not found in the database as rare. To avoid issues in aggregating names with different rarity, we restrict the sample to solo-inventor applications, where we can clearly identify inventors as having a rare or common name, which results in a sample of 269,579 observations using the 10th percentile cutoff. Descriptive statistics for this sample, split by rare versus common names, are presented in Internet Appendix Table A4. The table shows that applications associated with rare versus common names have similar patent approval rates and exhibit small differences among other dimensions. Interestingly, the proportion of women is higher in the rare-name than in the common-name subsample (8.5% vs. 6.8%).

Table 3 presents our tests conditional on rarity of inventors’ first names. The table shows regressions similar to those in Table 2 but estimated on the solo-inventor sample and including an interaction term for *Solo Female Inventor* with an indicator for *Rare Name*, which is set to one if an inventor's first name is rare, and zero if it is common. Rare (common) names are defined using the 10th percentile cutoff in columns (1) and (2), and the 1st percentile cutoff in columns (3) and (4).

The results provide strong support for the hypothesis that gender bias contributes to the gender gap in patent examination outcomes. We find that, when inventors' names are common,

[15] For differences in quality to explain this effect (i.e., a decline in the gender gap for gender-blind names), inventors with rare names would need to differ from those with common names differentially across the two genders. For instance, female inventors with rare names would need to produce better quality patents than female inventors with common names, with no significant difference (or significantly smaller difference) in quality between rare and common names among male inventors. Alternatively, male inventors with rare names would need to produce lower quality patents than male inventors with common names, with no significant difference (or significantly smaller difference) in quality between rare and common names among female inventors. We view this explanation as unlikely.

both first-action and ultimate approval rates are significantly lower for women than for men; however, this gender gap narrows significantly when inventors' names are rare (more gender-blind). For example, in the first-action allowance regression shown in column 3, the coefficient on *Solo Female Inventor* (*β1*) is -0.8%, similar to the value reported in Table 2 (column 5), while the coefficient on the interaction term *Solo Female Inventor* × *Rare Name* (*β2*) is 1.7%, with the coefficients significant at the 1% and 5% levels, respectively. These findings are consistent across the different cutoffs for rare/common names.

The sum of the coefficients *(β1 + β2*) reported in Table 3 indicates the effect of gender on approval rates when inventor names are rare and, thus, more gender-blind. This sum is positive yet statistically insignificant for the first-action allowance decisions in columns (1) and (3), suggesting that the gender gap in the first-round decisions is eliminated when applications are gender-blind. The result speaks against gender differences in application quality as an explanation for the gender gap in first-round approval decisions by examiners.

In contrast, the sum of (*β1* + *β2*) is negative and marginally significant for ultimate grant rates in columns (2) and (4), indicating that the gender gap in ultimate grant rates remains significant when names are rare but the magnitude becomes half. Note that ultimate grant rates depend not only on examiners but also on inventors, who decide whether to amend/resubmit or abandon a rejected application. Prior research (e.g., Aneja et al. (2024)) shows that abandon rates are higher for female inventors, consistent with the significant estimates on (*β1* + *β2*) in columns (2) and (4). Based on the estimates in column (2), gender bias accounts for approximately 54% of the overall gender gap (=1 – 2.5/5.3), with the remaining portion being attributed to the tendency of abandoning an application after receiving an initial rejection. We examine the resubmit/abandon decisions in more detail in Section 6.

4.3 Gender Gap, Inventor Experience, and Female Participation

This section sheds light on the potential sources of gender bias in the patent examination process. A large literature in economics and sociology shows that biased beliefs can emerge when information about an individual's traits is limited, causing people to infer these traits from data on broader groups, a phenomenon known as statistical discrimination (Arrow, 1998; Phelps, 1972). This can result in biased beliefs, as people often amplify minor differences between groups or make judgments based on how strongly a group is represented in an activity or a profession

(Bordalo et al., 2016; 2019). For instance, women may be perceived as less capable in math or science because these fields have traditionally been dominated by men. Consistent with these theories, several studies find that 'unexplained' gender gaps tend to diminish when information about an individual's quality is more accessible (Botelho and Abraham, 2017; Bohren, Imas, and Rosenberg, 2019), or in areas where women are more strongly represented (Shurchkov, 2012; Reuben, Sapienza, and Zingales, 2024; Hebert, 2023).[16]

In our setting, these theories have two testable implications. If the gender gap in patent approval rates is caused by statistical discrimination rather than outright taste-based discrimination, the gap should diminish (1) when the examiner is better informed about the inventor's quality, and (2) in technological areas in which women are more strongly represented (less male-dominant). To examine the first implication, we assume that examiners can learn about the inventor's quality via his/her prior experience in patenting (Bohren et al., 2019). Thus, we test whether the gender gap in approval rates narrows for experienced inventor teams with an existing history of applications. To examine the second implication, we categorize art units each year based on the percentage of female inventors on patent applications reviewed by that art unit over the past three years (the results are robust to alternative windows). We then test whether the gender gap diminishes in art units with above-sample median female inventor shares.

The tests of the first implication are reported in Table 4. The regressions are similar to those in Table 2, except that they include an interaction of *Female Inventor* with an indicator for *Experienced Inventor Team*. The latter dummy takes the value of one if at least one inventor listed on the patent application has previously filed for a patent application. Table 1 shows that about 74% of applications in our sample are filed by an experienced inventor team.

We find that for all five measures of *Female Inventor*, the gender gap shrinks significantly for the more experienced inventor teams. In the first-action allowance regressions in Panel A, the coefficients on the interaction terms ($\beta 2$) are all positive and statistically significant in four out of the five columns. Moreover, the regressions indicate that gender bias is concentrated in the sub-sample of teams with no prior experience: the coefficient on *Female Inventor* ($\beta 1$) is negative and

[16] Hsu (2007) and Hallen (2008) find that entrepreneurial teams with prior founding experience are more likely to receive venture capital funding due to demonstrated skills and knowledge related to building startups. Bohren et al. (2019) find that individuals can signal their abilities through prior evaluations, thus reducing discrimination against women. Hebert (2023) finds that VC funding is more readily available to entrepreneurs in more typically-female fields.

significant, and the sum of the coefficients ($\beta 1 + \beta 2$) is statistically indistinguishable from zero. The results are similar for the patent grant regressions in Panel B, except that a significant gender gap remains even within the experienced inventor sample, though it becomes smaller in magnitude. This is consistent with the gender gap in ultimate grant rates reflecting a combined effect of gender bias and the persistence effect in the amending/resubmission process. Our results suggest that gender differences in persistence are significant even among the more experienced inventors.

The test of the second implication (that gender bias declines in less male-dominated fields) is reported in Table 5. The regressions are analogous to those in Table 4, except that they include an interaction term of *Female Inventor* with an indicator for *Art Unit (More Female Shares)*, which is set to one for art units with the fraction of female inventor participation during the past three years (year *t-2* to year *t*) above the sample median. Table A5 in the Internet Appendix shows that female participation in art units ranges from 1.3% to 28.2%, with a median of 7.2%. Art units with the highest female participation are 1676 (Process, Nucleic acid, Protein, Carbohydrate Chemistries, and Diagnostics), and those with the lowest participation are 3655 (Planetary gear transmission systems or components).

We find that the gender gap shrinks significantly in art units with a higher representation of women on inventor teams. In the first-action allowance regressions in Panel A, the coefficients on the interaction terms ($\beta 2$) are positive in all five columns and statistically significant in four out of the five columns. Moreover, the gender gap in the more male-dominated art units roughly doubles relative to the overall sample. For example, based on the $\beta 1$ estimate in column 4 in Panel A, all-female teams are 1.0 percentage points less likely to obtain first-action allowance relative to 0.5 percentage points in the full sample in Table 2. This represents a 13% decline relative to the average acceptance rate of 7.5 percentage points. In contrast, the gender gap in the less male-dominated art units is substantially smaller (in column 4, ($\beta 1 + \beta 2$) is -0.3%) though it remains marginally significant. The results are similar for the patent grant regressions in Panel B, again, consistent with the gender gap in ultimate grant rates reflecting the combined effect of gender bias and gender differences in inventor persistence in the amending/resubmission process.

In summary, gender disparities in patenting are significantly stronger for inventors with no application track record or in technological fields that are more strongly dominated by men. This evidence is consistent with the gender gap being caused by statistical discrimination—examiners forming stereotypical beliefs about inventor quality based on limited information. Consistently with evidence from other settings, this bias is attenuated when examiners have access to more inventor-specific data, and in environments in which female representation is less rare.

5 Inventor Gender and Patent Quality

This section explores gender differences in patent quality. The presence of gender bias implies that female-authored patents face higher hurdles during the application process than patents authored by men. As a result, marginal patents granted to women may be of higher quality than those granted to men. This effect could be reinforced by the fact that female inventors are more likely to abandon their applications after receiving rejections (see Aneja et al. (2024) and Section 6). If these abandonment decisions occur disproportionately at the lower end of the quality spectrum, they could further increase the average quality of the female patents that are ultimately granted.[17]

In this section, we investigate the combined effect of these factors on the quality of the granted patents. Specifically, we compare patent quality across inventor genders using estimates of the market values of patents (Section 5.1) or forward citation counts (Section 5.2).

5.1 Economic Value of Patents

We begin by examining the economic value of patents to inventor firms, as estimated by Kogan et al. (2017). To approximate patent values, Kogan et al. (2017) rely on information about the stock market reactions to the patent's approval announcements for the issuing firms. The key assumption in their approach is that, upon learning that a patent has been approved, the issuing firm's market value increases by $\Delta V_j = (1 - \pi)\xi_j$, where ξ_j is the value of the patent conditional on being approved, and π is the market's expectation immediately prior to the announcement.[18] The resulting estimates of ξ_j (henceforth referred to as KPSS values) approximate the private values of the patents to the issuing firms. The estimates are forward-looking, as they reflect the

[17] Prior literature suggests that female inventors face higher hurdles at the earlier stages of the innovations process leading up to patent applications (e.g., Hebert, 2023), and if so, quality of applications may be also higher form women than men.

[18] Kogan et al. (2017) make several additional distributional assumptions, such as that market value of a patent expressed in percent of the firm value is a truncated normal distribution, and that the market's expectation of an application being successful is constant across firms. We discuss their implications below.

stock market's expectations of future cash flows generated by the patent at the time of its approval.

We obtain the KPSS value estimates from Noah Stoffman's website for all patents in our sample issued by public firms with available data, which restricts the sample to 404,551 granted patents (the descriptive statistics for this sample are in Table A6 in the Internet Appendix). To start with, we regress patent values on measures of inventor gender, a set of control variables suggested in prior literature (e.g., Gu, Mao, and Tian, 2017), and firm and year-fixed effects.[19] The standard errors are clustered at the firm level.

The regression results are presented in Panel A of Table 6. We find that all five measures of female participation are associated with higher KPSS values, with the effects being statistically significant in three out of the five models. For example, patents with all-female inventor teams are associated with an additional $788,000 in KPSS value compared to those with primarily male inventor teams (column (4)), representing a 5.7% increase from the median KPSS value in our sample (2.8% increase from the average value).

Though the estimates in Panel A could be interpreted as reflecting gender differences in the patents' actual values to the issuing firms, there are important caveats to this interpretation. First, this assumes that while examiners' assessments of patent quality may be subject to gender bias, investors' assessments are not. However, if gender biases are pervasive, the stock market might underreact to announcements of patents granted to female inventors, understating the true difference in patent values between female and male inventors. Second, Kogan et al. (2017) assume that the extent to which the stock market anticipates a patent's approval (and thus incorporates its value into the stock price before the grant announcement) does not vary across genders. However, it is possible that the stock market assigns higher probabilities of success to male applications compared to female ones, based on the observed history of patent approvals. If this is the case, the KPSS values could overstate the true difference in patent values between female and male inventors.

As discussed in Kogan et al. (2017), the extent of market anticipation is challenging for researchers to infer. Moreover, it is unclear whether, and to what extent, investors use information

[19] The control variables include firm size (*LN_Asset*), return on assets (*ROA*), R&D expenditures (*R&D/Asset*), capital expenditures (*CAPEXTA*), leverage (*Leverage*), market-to-book ratio (*Market-to-book*), institutional holdings (*Institutional Holding%*), firm age (*Ln(Age)*), tangibility (*PPE/Asset*), industry competition (*HHI*) and squared *HHI*, and the Kaplan and Zingales (1997) index (*KZ-INDEX*).

about inventor gender to fine-tune their expectations, which complicates the interpretation of the estimates in Panel A. To address this challenge, we focus on a sample of patents where inventor gender is less discernible to both examiners and investors. If investors cannot easily determine inventor gender, they are less likely to differentiate between male and female patents when forming expectations about the likelihood of patent approval, making the assumption in Kogan et al. (2017)—that this likelihood does not vary across patents—more plausible. Importantly, if examiners also cannot readily observe inventor gender, any differences in approval thresholds (hurdle rates) driven by gender bias would diminish. Consequently, the gender disparity in patent values should significantly decrease in a subsample of patents associated with gender-blind names. We test this conjecture in Table 6, Panel B.

The regressions in Panel B are similar to those in Panel A, except the sample consists of solo-authored patents where the inventors have a rare or common first name, and the regressions include an interaction term for *Solo Female Inventor* × *Rare Name*. Consistent with the results in Panel A, we find that patents authored by women with common names have significantly higher KPSS values than those authored by men with common names, as indicated by the positive and significant coefficients on *Solo Female Inventor* ($\beta 1$). However, the coefficients on *Solo Female Inventor* × *Rare Name* ($\beta 2$) are negative and significant, suggesting that the observed difference in patent values decreases significantly when inventor gender is not easily discernible. Based on the F-test reported in Panel B, the sum of the two coefficients ($\beta 1 + \beta 2$) is negative and statistically insignificant. This result indicates that when inventor names are gender-blind, granted patents by women are not more valuable than those authored by men.

The findings suggest that the higher values we estimate for female-authored patents in Panel A are a consequence of examiners (or investors) observing the inventor's gender and adjusting their behavior (or expectations) accordingly. These results closely align with our earlier finding that patent approval rates are lower for female inventors, but this disparity diminishes when the inventor's gender is less discernable. Taken together, this evidence provides further support for the presence of gender bias in the patenting process and suggests that some valuable female patents may not receive approvals as a result.

5.2 Forward Citations

Forward citations are a widely used proxy for the value or quality of a patent, as they indirectly signal its scientific impact and importance.[20] However, prior research finds that citation counts are a noisy measure and can be influenced by factors unrelated to the patent's intrinsic value.[21] A contemporaneous study by Hochberg et al. (2023) is especially relevant in this context. Using a machine-learning technique, the study shows that patents authored by female inventors are significantly 'under-cited' compared to otherwise similar patents authored by men. This suggests that a straightforward comparison of citation counts between male and female patents does not accurately reflect their relative quality.

With this in mind, we begin by presenting such a comparison as a baseline for the analysis. The sample is restricted to 627,195 granted patents. The results are reported in Table 7, Panels A and B. The dependent variable in both panels is *Ln(1+Citations)*, which is the logarithm of one plus the number of forward citations received by a patent. The key dependent variable *Female Inventor* measures the female participation on inventor team as indicated in the table heading. In Panel A, we count all citations while in Panel B, we break down citations by the citing inventor's gender. The regressions include $ArtUnit\ Subclass \times Year$ fixed effects and the same set of control variables as in Table 2.

Consistent with Hochberg et al. (2023), we find that female-authored patents receive fewer overall citations than male-authored patents, but this effect is driven by citations made by male inventors. For example, all-female patents receive 8.1 percentage points fewer citations overall (Panel A, column 4). However, they receive 17.6 percentage points more citations from female inventors and 23.6 percentage points fewer citations from male inventors (Panel B, columns 7 and 8). Since the number of male inventors exceeds that of female inventors by a factor of more than six, the effect on the overall citation count is significantly negative and large in magnitude. The tendency to 'under-cite' (or 'over-cite') patents authored by inventors of the opposite (or same) gender—investigated further in Hochberg et al. (2023)—suggests that a comparison of citation counts paints a misleading picture of the relative quality of the male and female patents.

We address this challenge using our sample of patents with gender-blind names. Since inventors and examiners cannot easily discern the gender of a patent's authors, their decisions to

[20] Larger citation counts could indicate that the patent serves as a building block for more future innovations, or that it is relevant to a broader set of technologies. Prior studies have found that higher citation counts are associated with other measures of the patents' quality, including private values (Hall, Jaffe, and Trajtenberg (2005), Kogan et al. (2017)).

[21] Allison and Lemley (1998), Roach and Cohen (2013), Breschi and Lenzi (2016).

approve or cite the patent should less likely be influenced by gender bias. Consequently, we expect the difference in citation counts between female- and male-authored patents to decline within the subset of patents with gender-blind inventor names.

We test this conjecture in Panel C of Table 7. Mirroring the tests in Table 3, the sample in this panel is restricted to patents with solo inventors, where we were able to classify the inventor's first name as either rare or common. The regressions are similar to those in Panel A of Table 7 but include an interaction term of *Solo Female Inventor* × *Rare Name.* Consistent, with Panel A, the coefficient on *Solo Female Inventor* (*β1*) indicates that solo female inventors with common names receive 9.5 percentage points fewer citations than solo male inventors with common names in column (1). However, having a rare name reduces this gap by a statistically significant 22.7 percentage points (*β2*).

Interestingly, we find that among solo inventors with gender-blind names, female inventors receive significantly *more* overall citations than male inventors. For example, in column (1), (*β1* + *β2*) is a positive 0.132 and is significant at the 1% level, implying a higher quality of female granted patents than those granted to males in the gender-blind group. This result is not surprising given that, as discussed in more detail in Section 6, female inventors are more likely to abandon their applications in the face of initial rejection. This tendency to 'give up' likely filters out a higher proportion of less-promising patents. Additionally, barriers faced by female inventors at the earlier stages of the innovation process (that is, prior to application filing) may further increase the quality of female innovations that ultimately succeed.

Overall, the results in this section are consistent with those reported earlier: throughout the paper, we observe significant gender gaps across multiple patenting outcomes. However, these gaps diminish—or even reverse—when inventors' names are more gender-blind. Together, these findings provide strong support for the presence of gender bias in the patenting process, potentially leading to valuable female patents being overlooked by examiners and other inventors. The evidence suggests that adopting a more gender-blind process in patenting could help mitigate these biases, ultimately improving outcomes for inventors, firms, and society as a whole.

6 Inventor Gender and Persistence in the Patenting Process

The analysis thus far has focused on the effects of examiner bias on gender disparities in patenting outcomes. However, prior research suggests that gender differences in inventors' behaviors may also contribute to these disparities. Experimental studies in psychology and economics indicate that women are generally less overconfident than men and less inclined to engage in competitive situations (Bordalo et al., 2019; Gneezy et. al. 2003; Niederle, and Vesterlund, 2007). There is also evidence that women are more likely to withdraw from competition after receiving negative feedback (Buser and Yuan, 2019; Wasserman, 2023; Avilova and Goldin, 2018). Recent research suggests that the women's lower persistence may extend to the patenting context: Aneja et al. (2024) show evidence that marginal patent applications rejected at the first-action stage are more likely abandoned when their authors are female.[22]

In this section, we examine the differences between men and women in their propensity to continue or abandon the patenting process after receiving rejections. Though not the primary focus of this paper, the analysis, combined with our findings on examiner bias, allows us to provide a more complete picture of the different sources of gender differences in patenting outcomes, including an estimate of their relative importance.

We report our baseline test on persistence in Table 8. The sample in these regressions consists of 888,786 patent applications that have been rejected at the first-action stage, which represents 90% of all initial applications.[23] The dependent variable is an indicator set to one when the initially rejected application is subsequently amended and resubmitted (*Initial Amendment*). Based on Table A1 in the Internet Appendix, this constitutes 84.8% of the rejected applications. As before, the key independent variables are measures of female participation on the inventor team shown in the table heading. The regressions control for the same set of patent and inventor attributes and fixed effects as those included in Table 2.

We find that, as expected, female-authored patent applications are significantly less likely to be amended/resubmitted after initial rejections. For example, the likelihood of filing an initial amendment is 2.6 percentage points lower for all-female than majority-male teams (column 4),

[22] Aneja et al. (2024) instrument for marginal rejections using the random assignment of lenient patent examiners, assuming that examiners exhibit no gender bias. As discussed earlier, the sample in their study includes non-utility patents, so it is not comparable to ours. In particular, the key assumption of no gender bias at the first-action stage does not hold in our sample.

[23] This sample excludes about 2.5% singleton observations where there is only one observation in a subclass-year group. As shown in Table A1 in the Internet Appendix, the fraction of non-final rejections in the full sample is 92.5%.

compared to the average likelihood of 84.8% in the full sample. Note that this estimate could understate the true gender gap in inventor persistence: if examiners are more likely to reject female-authored patents (which we show in Section 4), the average quality of the rejected patents could be higher for women than for men, increasing the likelihood that women amend their applications. To account for this possibility, in Internet Appendix Table A7, we re-estimate the regressions in Table 8 by correcting for sample selection at the first-action stage and find that the results remain robust.[24]

These findings provide additional insights into the sources of the overall gender gap in patenting outcomes. According to Table 3 (column 4), the gender gap in ultimate grant rates is 5.4% for inventors with common names, which shrinks to 2.4% for inventors with gender-blind names. Assuming that inventors with gender-blind names experience no gender bias, the 2.4% gap can be attributed to the persistence effects (while the remaining 3.0% is due to bias). This magnitude is consistent with the direct estimates of the 'persistence gap' in Table 9. Our results further indicate that the majority of this 2.4 percentage point 'persistence gap'—1.8 percentage points—is driven by resubmission decisions following rejections at the first-action stage.[25] The remaining 0.6 percentage points (= 2.4 - 1.8) arise from resubmission decisions in subsequent rounds.

In sum, we find that the reasons for the sizable gap in the male and female inventors' patenting outcomes are complex and can be traced to at least two sources: differences in how examiners evaluate patents by men versus women (examiner gender bias) and differences in how men and women respond to examiner feedback (inventor gender difference in persistence). Our analysis indicates that these two factors contribute roughly equally to the overall gap in patenting. This suggests that efforts to close the gap could focus on either (or both) of these sources.

[24] To do so, we estimate a Heckman selection model (Heckman, 1976) using the random assignment of lenient examiners as a source of exogenous variation in rejection rates. We find that the selection effect is not large enough to cause a significant bias: the estimates from the Heckman selection model in Table A7 are similar to the OLS estimates in Table 8. This is likely due to the small overall acceptance rates (for both men and women) at the first-action stage.

[25] This estimate corresponds to the 2.0% gender gap in resubmission rates right after the first-action decision estimated in column 5 of Table 8 multiplied by the 90% rejection rate at the first-action stage. Thus, it reflects the 'persistence gap' expressed as a percentage of all submitted applications (rather than the rejected applications).

7 Conclusions

This paper examines gender differences in the outcomes of U.S. patent applications submitted to the U.S. Patent and Trademark Office. We begin with the observation that female inventors are significantly less likely to have their applications approved than male inventors, even when comparing otherwise similar applications within narrowly defined technological fields. Our goal is to gain a better understanding of the reasons for this disparity, focusing on gender bias in the examiners' decisions as a potential source.

Identifying the effects of gender bias is challenging because unobserved aspects of patent quality may differ across genders. For instance, patent applications submitted by female inventors might, on average, be less novel or more obvious, leading to higher rejection rates. To address this challenge, we analyze a subsample of inventors with rare names, assuming that their gender is less discernible to examiners. In such cases, we expect examiner decisions to be less influenced by gender bias, thereby reducing the gender gap. Consistently, we find that the gender gap in first-round approval rates declines significantly when names are gender-blind and becomes statistically indistinguishable from zero. Additionally, we estimate that more than half of the overall gender gap in ultimate approval rates (of 5.4 percentage points) can be attributed to examiner bias. The remaining portion is likely due to female inventors' stronger tendency to abandon the application process following initial rejections.

Further analysis suggests that statistical discrimination and social stereotypes (rather than outright taste-based discrimination) drive the observed examiner bias. First, we find that the gender gap in patent approval rates declines significantly when inventors have a prior history of patenting, allowing examiners to better assess their quality. Second, the gender gap doubles in technological groups where female inventor share falls below the sample median, suggesting that female representation influences evaluators' beliefs.

Finally, we examine gender differences in the quality and economic value of patents that are ultimately approved. If women face higher hurdles during the examination process or are more likely to abandon the less promising applications, granted patents authored by women may exhibit higher average quality than granted patents authored by men. Our analysis supports this hypothesis. Using the methodology from Kogan et al. (2017), we find that female-authored patents have higher average market values than male-authored patents, but this difference decreases significantly and becomes negligible when inventors have gender-blind names. Similarly, we find that forward citations are higher for female inventors in the gender-blind group, reversing the gender effect estimated in the full sample.

Our findings are significant on two levels. First, they shed light on the reasons for the substantial gender disparities observed in the patenting process. We show that these disparities arise from an interplay of biases in how patent applications are evaluated by examiners and differences in how men and women respond to the examiners' initial rejection. This suggests that efforts to reduce these gaps could focus on addressing either—or both—of these components. For instance, replacing names with inventor-specific identifiers could enable examiners to trace inventors' work over time without revealing their gender.

More broadly, our results suggest that women may face higher hurdles than men in other settings in which female participation has traditionally been low (reinforcing social stereotypes), and in which a person's ability is difficult to assess. While patenting serves as a valuable setting to study these effects, the implications likely extend beyond this area.

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Table 1. Summary Statistics for Patent Applications During 2001 to 2017. The table shows summary statistics for U.S. utility patent applications filed from 2001 to 2017, for which we could identify the gender of all inventors on an application. Variable definitions are in Appendix A.

	N	Mean	Median	SD
First-Action Allowance	988,125	0.075	0	0.264
Patent Granted	988,125	0.685	1	0.464
Fraction Female	988,125	0.081	0	0.214
Majority Female	988,125	0.040	0	0.195
All Female	988,125	0.031	0	0.173
All Female (Unisex Team)	853,233	0.036	0	0.186
Solo Female (Solo Team)	374,847	0.069	0	0.254
Have at Least One Female Inventor	988,125	0.167	0	0.373
Examiner Review Speed	988,125	1.729	2	0.756
Examiner Leniency	988,125	0.642	0.676	0.207
Examiner Experience	988,125	12.121	10	7.891
Small Entity	988,125	0.326	0	0.469
Foreign Priority	988,125	0.004	0	0.061
Continuation	988,125	0.645	1	0.479
Number of Inventors	988,125	2.353	2	1.603
Solo Inventor	988,125	0.379	0	0.485
Initial Num. of Claims	988,125	3.593	3	4.570
Inventor Experience	988,125	21.510	6	58.640
Experienced Inventor Team	988,125	0.737	1	0.440
Art Unit (More Female Shares)	988,125	0.496	0	0.500

Table 2. Female Inventors and Patent Examination Outcomes: Baseline. The table shows regressions of patent examination outcomes on measures of female participation on inventor teams. The sample consists of U.S. utility patent applications from 2001 to 2017, for which we could identify inventors' gender. The regressions are estimated using OLS model. In Panel A, the dependent variable *First-Action Allowance* is set to one if the application is approved in the first round, and zero otherwise. In Panel B, the dependent variable *Patent Granted* is set to one if the patent is eventually granted, and zero otherwise. The independent variable *Female Inventor* measures female participation on the inventor team as indicated in the table heading. In column 1, *Female Inventor* is the fraction of women on the team; in columns 2-5, it is an indicator set to one for majority female, all female, all female among unisex teams, or solo female teams. Control variables include *Examiner Review Speed, Examiner Leniency, Ln(1+Examiner Experience), Small Entity, Foreign Priority, Continuation, Number of Inventors, Solo Inventor, Initial Num. of Claims, Inventor Experience,* which are not tabulated for brevity. See Table A2 for coefficients on the control variables. Variable definitions are in Appendix A. The unit of analysis is at application level. We include Art Unit Subclass×Year fixed effects. P-values based on robust standard errors clustered at the subclass level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Panel A: Dependent Variable = First-Action Allowance (OLS)					
Female Inventor	-0.004***	-0.005***	-0.005***	-0.005***	-0.006***
	(0.005)	(0.000)	(0.001)	(0.003)	(0.003)
Control Variables	Yes	Yes	Yes	Yes	Yes
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.126	0.126	0.126	0.123	0.137
Panel B: Dependent Variable = Patent Granted (OLS)					
Female Inventor	-0.053***	-0.049***	-0.054***	-0.054***	-0.049***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control Variables	Yes	Yes	Yes	Yes	Yes
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.257	0.257	0.257	0.260	0.279

Table 3. Female Inventors and Patent Examination Outcomes: Rare vs. Common Names. The table shows OLS regressions of patent examination outcomes for U.S. utility patent applications from 2001 to 2017, for which we could identify inventors' gender. The sample is restricted to solo-inventor applications, where inventors have a rare or common name. We use the Social Security Application database to categorize names as rare or common. Rare (common) first names are those within the bottom (top) 10th percentile (columns (1) and (2)) or 1st percentile (columns (3) and (4)) of all names in the database, based on frequency counts. In columns 1 and 2, the dependent variable *First-Action Allowance* is set to one if the application is approved in the first round. In columns 3 and 4, the dependent variable *Patent Granted* is set to one if the patent is eventually granted. *Solo Female* is set to one if the solo inventor is a female and zero if the solo inventor is a male. *Rare Name* is set to one if an inventor's first name is rare, and zero if it is common. Control variables are listed in Table 2. Variable definitions are in Appendix A. P-values based on robust standard errors clustered at the subclass level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

	Rare (Common) name in bottom (top) 10%		Rare (Common) name in bottom (top) 1%	
Dependent Variable	First-Action Allowance	Patent Granted	First-Action Allowance	Patent Granted
	(1)	(2)	(3)	(4)
Solo Female (β_1)	-0.008***	-0.053***	-0.008***	-0.054***
	(0.001)	(0.000)	(0.001)	(0.000)
Solo Female × Rare Name (β_2)	0.014*	0.028**	0.017**	0.030**
	(0.078)	(0.050)	(0.042)	(0.041)
Rare Name (β_3)	-0.002	-0.022***	-0.002	-0.022***
	(0.452)	(0.000)	(0.371)	(0.000)
Controls	Yes	Yes	Yes	Yes
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes
Test: $\beta_1 + \beta_2 = 0$	0.006	-0.025*	0.009	-0.024*
p-value	(0.415)	(0.061)	(0.260)	(0.081)
N	269,579	269,579	252,515	252,515
adj. R-sq	0.139	0.28	0.141	0.282

Table 4. Female Inventors and Patent Examination Outcomes: Inventor Experience. The table shows OLS regressions of patent examination outcomes on female participation on the inventor team. The sample consists of U.S. utility patent applications from 2001 to 2017, for which we could identify inventors' gender. In Panel A, the dependent variable *First-Action Allowance* is set to one if the application is approved in the first round. In Panel B, the dependent variable *Patent Granted* is set to one if the patent is eventually granted. The independent variable *Female Inventor* measures female participation on the inventor team as indicated in the table heading. In column 1, *Female Inventor* is the fraction of women on the team; in columns 2-5, it is an indicator set to one for majority female, all female, all female among unisex teams, or solo female teams. *Experienced Inventor Team* is an indicator set to one if at least one inventor on the team has previously filed a patent application, and zero otherwise. Control variables are listed in Table 2. Variable definitions are in Appendix A. P-values based on robust standard errors clustered at the subclass level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Panel A: Dept. Var=First-Action Allowance					
Female Inventor (β1)	-0.005***	-0.006***	-0.006***	-0.006***	-0.006***
	(0.001)	(0.001)	(0.000)	(0.000)	(0.008)
Female Inventor × Experienced Inventor Team (β2)	0.005**	0.004	0.007**	0.009**	0.006
	(0.026)	(0.108)	(0.034)	(0.011)	(0.180)
Experienced Inventor Team (β3)	0.007***	0.007***	0.007***	0.007***	0.008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Test: β1+ β2=0	0.000	-0.001	0.001	0.002	0.000
p-value	(0.905)	(0.529)	(0.745)	(0.435)	(0.999)
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.126	0.126	0.126	0.123	0.137

Table 4, cont. Female Inventors and Patent Examination Outcomes: Inventor Experience.

Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Panel B: Dept. Var=Patent Granted					
Female Inventor (β1)	-0.054***	-0.055***	-0.060***	-0.059***	-0.048***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female Inventor × Experienced Inventor Team (β2)	0.019***	0.033***	0.044***	0.043***	0.036***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Experienced Inventor Team (β3)	0.041***	0.042***	0.042***	0.043***	0.054***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Test: β1+ β2=0	-0.035***	-0.022***	-0.016***	-0.016***	-0.012*
p-value	(0.000)	(0.000)	(0.002)	(0.003)	(0.090)
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.258	0.258	0.258	0.262	0.282

Table 5. Female Inventors and Patent Examination Outcomes: Female Representation in Art Units. The table shows OLS regressions of patent examination outcomes on female participation on the inventor team. The sample consists of U.S. utility patent applications from 2001 to 2017, for which we could identify inventors' gender. In Panel A, the dependent variable *First-Action Allowance* is set to one if the application is approved in the first round. In Panel B, the dependent variable *Patent Granted* is set to one if the patent is eventually granted. The independent variable *Female Inventor* measures female participation on the inventor team as indicated in the table heading. In column 1, *Female Inventor* is the fraction of women on the team; in columns 2-5, it is an indicator set to one for majority female, all female, all female among unisex teams, or solo female teams. *Art Unit (More Female Shares)* is an indicator set to one if the percentage of female inventors on patent applications in an art unit during the past three years (from year t-2 to year t) is above the sample median, and zero otherwise. Control variables are listed in Table 2. Variable definitions are in Appendix A. P-values based on robust standard errors clustered at the subclass level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Panel A: Dependent Variable = First-Action Allowance					
Female Inventor (β1)	-0.008**	-0.012***	-0.010***	-0.010***	-0.010**
	(0.013)	(0.001)	(0.005)	(0.006)	(0.041)
Female Inventor × Art Unit (More Female Shares) (β2)	0.005*	0.009**	0.007*	0.008*	0.005
	(0.100)	(0.015)	(0.076)	(0.065)	(0.342)
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Test: β1+ β2=0	-0.002	-0.003*	-0.003**	-0.003*	-0.005**
p-value	(0.122)	(0.053)	(0.048)	(0.096)	(0.032)
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.126	0.126	0.126	0.123	0.137

Table 5, cont. Female Inventors and Patent Examination Outcomes: Female Representation in Art Units.

Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Panel B: Dependent Variable = Patent Granted					
Female Inventor (β1)	-0.058***	-0.060***	-0.065***	-0.065***	-0.057***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female Inventor × Art Unit (More Female Shares) (β2)	0.008	0.015**	0.015**	0.015*	0.011
	(0.160)	(0.031)	(0.044)	(0.060)	(0.244)
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Test: β1+ β2=0	-0.050***	-0.045***	-0.050***	-0.050***	-0.046***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.257	0.257	0.257	0.260	0.279

Table 6. Inventor Gender and Patent Value. The table shows OLS regressions of KPSS patent values ($ Millions) on female participation on the inventor team. The sample consists of U.S. utility patent applications issued by public firms from 2001 to 2017, for which we could identify inventors' gender and control variables and KPSS patent values are non-missing. In Panel A, the independent variable *Female Inventor* measures female participation on the inventor team as indicated in the table heading. In column 1, *Female Inventor* is the fraction of women on the team; in columns 2-5, it is an indicator set to one for majority female, all female, all female among unisex teams, or solo female teams. In Panel B, the sample is restricted to solo-inventor patents, where inventors have a rare or common name. We use the Social Security Application database to categorize names as rare or common. Rare (common) first names are those within the bottom (top) 10th percentile (columns (1) and (2)) or 1st percentile (columns (3) and (4)) of all names in the database, based on frequency counts. *Solo Female* is set to one if the solo inventor is a female and zero if the solo inventor is a male. *Rare Name* is set to one if an inventor's first name is rare, and zero if it is common. Control variables include *Ln(Asset)*, *ROA*, *R&D/Asset*, *CAPEXTA*, *Leverage*, *Market-to-book*, *Institutional Holding%*, *Ln(Age)*, *PPE/Asset*, *HHI*, *HHI^2*, and *KZ-INDEX*. Variable definitions are in Appendix A. P-values based on robust standard errors clustered at the firm level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Panel A: Inventor Gender and KPSS Patent Value: Full Sample Regressions

Dependent Variable:	KPSS Patent Value ($ Millions)				
Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Female Inventor	1.103***	0.978**	0.687	0.788*	0.611
	(0.009)	(0.025)	(0.122)	(0.087)	(0.215)
Control Variables	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes
N	404,551	404,551	404,551	343,930	112,097
adj. R-sq	0.624	0.624	0.624	0.621	0.620

Panel B: Inventor Gender and KPSS Patent Value: Rare vs. Common Names

Dependent Variable:	KPSS Patent Value ($ Millions)	
	Rare (Common) name in bottom (top) 10%	Rare (Common) name in bottom (top) 1%
	(1)	(2)
Solo Female (β_1)	1.441**	1.243**
	(0.020)	(0.043)
Solo Female × Rare Name (β_2)	-2.437**	-2.255**
	(0.023)	(0.026)
Rare Name (β_3)	-0.568*	-0.607*
	(0.078)	(0.063)
Controls	Yes	Yes
Firm FEs	Yes	Yes
Year FEs	Yes	Yes
Test: $\beta_1 + \beta_2 = 0$	-0.996	-1.008
p-value	(0.270)	(0.259)
N	102,496	97,090
adj. R-sq	0.618	0.617

Table 7. Inventor Gender and Forward Citations. The table shows OLS regressions of the forward citation counts on female participation on the inventor team. The sample consists of U.S. utility patents that were filed from 2001 to 2017 and eventually granted, for which we could identify inventors' gender, and for which control variables are non-missing. In Panels A and C, the dependent variable *Ln(1+Citations)* is the logarithm of one plus forward citations; in Panel B, dependent variables are *Ln(1+Female Citations)* or *Ln(1+Male Citations)*. The independent variable *Female Inventor* measures female participation on the inventor team as indicated in the table heading: it is the fraction of women on the inventor team or an indicator set to one for majority female, all female, all female among unisex teams, or solo female teams. In Panel C, the sample is restricted to solo-inventor patents, where inventors have a rare or common name. We use the Social Security Application database to categorize names as rare or common. Rare (common) first names are those within the bottom (top) 10th percentile (columns (1) and (2)) or 1st percentile (columns (3) and (4)) of all names in the database, based on frequency counts. *Solo Female* is set to one if the solo inventor is a female and zero if the solo inventor is a male. *Rare Name* is set to one if an inventor's first name is rare, and zero if it is common. The same set of control variables is included as those in Table 2. Variable definitions are in Appendix A. P-values based on robust standard errors clustered at the subclass level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Panel A: Inventor Gender and Total Citation Counts

Dependent Variable:	Ln(1 + Citations)				
Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Female Inventor	-0.140***	-0.086***	-0.069***	-0.081***	-0.075***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control Variables	Yes	Yes	Yes	Yes	Yes
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
N	627,195	627,195	627,195	527,226	159,537
adj. R-sq	0.377	0.377	0.377	0.379	0.385

Panel B: Inventor Gender and Citation Counts by Gender of Citing Inventor

Dependent Variable:	Ln(1 + Female (or Male) Citations)									
Female Inventor:	Fraction Female		Majority Female		All Female		All Female (Unisex Teams)		Solo Female (Solo Teams)	
Citations:	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Female Inventor	0.278***	-0.364***	0.164***	-0.231***	0.162***	-0.214***	0.176***	-0.236***	0.182***	-0.204***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control Vars.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	438,906	438,906	438,906	438,906	438,906	438,906	371,691	371,691	108,798	108,798
adj. R-sq	0.272	0.360	0.269	0.358	0.269	0.357	0.268	0.356	0.263	0.361

Panel C: Inventor Gender and Forward Citations: Rare vs. Common Names

Dependent Variable:	Ln(1 + Citations)	
	Rare (Common) name in bottom (top) 10%	Rare (Common) name in bottom (top) 1%
	(1)	(2)
Solo Female (β_1)	-0.095***	-0.100***
	(0.000)	(0.000)
Solo Female × Rare Name (β_2)	0.227***	0.236***
	(0.000)	(0.000)
Rare Name (β_3)	-0.012	-0.010
	(0.408)	(0.508)
Controls	Yes	Yes
Art Unit Subclass × Year FEs	Yes	Yes
Test: $\beta_1 + \beta_2 = 0$	0.132***	0.136***
p-value	(0.008)	(0.007)
N	144,471	135,014
adj. R-sq	0.391	0.393

Table 8. Inventor Gender and Filing an Initial Amendment. The table shows OLS regressions of the indicator for filing an amendment (resubmission) after receiving a non-final rejection in the first-action stage on female participation on the inventor team. The sample consists of 888,786 patent applications that have been rejected at the first-action stage. The dependent variable *Initial Amendment* is an indicator that takes the value of one if the applicant files an amendment after receiving a first-action non-final rejection, and zero otherwise. The independent variable *Female Inventor* measures female participation on the inventor team as indicated in the table heading: it is the fraction of women on the inventor team or an indicator set to one for majority female, all female, all female among unisex teams, or solo female teams. We include the same set of patent and inventor attributes and fixed effects as those included in Table 2. Variable definitions are in Appendix A. P-values based on robust standard errors clustered at the subclass level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Dependent Variable:	*Initial Amendment*				
Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Female Inventor	-0.023***	-0.021***	-0.026***	-0.026***	-0.020***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control Variables	Yes	Yes	Yes	Yes	Yes
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
N	888,786	888,786	888,786	743,048	263,857
adj. R-sq	0.114	0.114	0.114	0.118	0.120

Appendix A. Variable Definitions

Variable	Definition
Patenting Outcome Variables	
First-Action Allowance	An indicator that takes the value of one if the application is approved (granted) upon the first-action decision, and zero otherwise.
Patent Granted	An indicator that takes the value of one if the patent is eventually granted, and zero otherwise.
Non-Final Rejection	An indicator that takes the value of one if the application receives a restriction required or non-final rejection, and zero if the application is approved (granted) upon the first-action decision.
Initial Amendment	An indicator that takes the value of one if the applicant files an amendment after receiving a first-action non-final rejection, and zero otherwise.
Measures of Female Inventor Participation	
Fraction Female	The proportion of female inventors listed on the patent application.
Majority Female	An indicator that takes the value of one if at least 50% of inventor team are females, and zero otherwise.
All Female	An indicator that takes the value of one if the entire inventor team consists of females, and zero otherwise.
All Female (Unisex Teams)	An indicator that takes the value of one if the entire inventor team consists of females and zero if the entire inventor team consists of males.
Solo Female (Solo Team)	An indicator that takes the value of one if the solo inventor is a female and zero if the solo inventor is a male.
Control Variables	
Examiner Review Speed	The average time lag in years between application to the first-action decision of all applications that the examiner has reviewed since she joined the USPTO database.
Examiner Leniency	The proportion of reviewed patents that an examiner ultimately approved in an art unit since she joined the USPTO database.
Examiner Experience	The number of years the examiner has reviewed patent applications in the USPTO database.
Small Entity	An indicator that takes the value of one if the owner of the patent right being applied for is qualified for the USPTO's small-entity discounts on application fees, and zero otherwise.
Foreign Priority	An indicator that takes the value of one if the patent application is based on a patent or patent application previously submitted to a non-US patent office, and zero otherwise.

Continuation	An indicator that takes the value of one if the patent was filed as a continuation of previous patents, and zero otherwise.
Number of Inventors	The total number of inventors listed on a patent application.
Solo Inventor	An indicator that takes the value of one if only one inventor is listed on a patent application, and zero otherwise.
Initial Num. of Claims	The total number of independent claims in the original patent application.
Inventor Experience	The maximum number of patents filed before the focal patent application by an inventor among the inventor team.
Ln(Asset)	Natural logarithm of total assets.
ROA	Operating cash flow scaled by total assets.
R&D/Asset	The ratio of R&D expenditures to total assets.
CAPEXTA	The ratio of capital expenditures to total assets.
Leverage	Book value of total debt scaled by total assets.
Market-to-book	The ratio of the market value of assets to the book value of assets.
Institutional Holding%	The average of the four quarterly institutional holdings divided by the number of outstanding shares, as reported by 13F.
Ln(Age)	The natural logarithm of the number of years since the firm first appeared in Compustat.
PPE/Asset	The ratio of net property, plant, and equipment to total assets.
HHI	The Herfindahl-Hirschman Index of a firm's annual sales within a 4-digit SIC industry.
KZ-INDEX	The financial constraint index as described in Kaplan and Zingales (1997).
Other Patent Variables	
Rare Name	An indicator that takes the value of one if the inventor has a rare first name, and zero if she/he has a common first name. An inventor's first name is considered rare (common) if it falls in the bottom (top) 10th percentile in columns (or in the bottom (top) 1st percentile) in terms of frequency counts among all the names in the Social Security Application database.
Experienced Inventor Team	A binary variable that takes the value of one if at least one of the inventors has ever filed for a patent in the past, and zero otherwise.
Art Unit (More Female Shares)	An indicator that takes the value of one if the percentage of female inventors on patent applications in an art unit during the past three years (from year t-2 to year t) is above the sample median, and zero otherwise,

Citations	The total number of forward citations.
Female Citations	The number of forward citations received from patents with at least one female in the inventor team.
Male Citations	The number of forward citations received from patents with all male inventors.
KPSS Patent Value	The economic value of each patent based on the stock return of the patent grant announcement (Kogan et al., 2017).

Internet Appendix

Table A1. Examination Process of Patent Applications. The table shows statistics for the first and second examination rounds, as well as aggregate statistics for all rounds for a sample of U.S. patent applications from 2001 to 2017, for which we could identify inventors' gender. Each panel shows the total number of applications, the fractions that have been accepted or rejected in that round (or in all rounds). Rejected applications include 'non-final rejections' and 'final rejections.' Applicants can amend and resubmit all rejected applications multiple times, including final rejections. When rejections are final, applicants must pay additional fees to resubmit (appeal) the application. The table also shows the fractions of rejected applications by round that have been abandoned or amended/appealed. All-female (all-male) teams are inventor teams that include only female (only male) inventors.

		All Applications	All-Female Teams	All-Male Teams
First round	Number of Applications	988,125	30,576	822,657
	Accepted (first-action allowance)	0.075	0.045	0.079
	Rejected	0.925	0.955	0.921
	Abandoned	0.152	0.255	0.149
	Amended/Appealed	0.848	0.745	0.851
Second round	Number of Applications	769,385	21,599	640,437
	Accepted	0.760	0.608	0.765
	Rejected	0.240	0.392	0.235
	Abandoned	0.387	0.552	0.376
	Amended/Appealed	0.613	0.448	0.624
All rounds	Accepted	0.685	0.489	0.697
	Rejected	0.315	0.511	0.303

Table A2. Female Inventors and Patent Examination Outcomes: Baseline with Tabulated Control Variables. The table is the same as Table 2, showing regressions of patent examination outcomes on measures of female participation on inventor teams. We tabulate the full list of control variables used in the regressions. The sample consists of U.S. utility patent applications from 2001 to 2017, for which we could identify inventors' gender. The regressions are estimated using OLS. In Panel A, the dependent variable *First-Action Allowance* is set to one if the application is approved in the first round, and zero otherwise. In Panel B, the dependent variable *Patent Granted* is set to one if the patent is eventually granted, and zero otherwise. The independent variable *Female Inventor* measures female participation on the inventor team as indicated in the table heading. In column 1, *Female Inventor* is the fraction of women on the team; in columns 2-5, it is an indicator set to one for majority female, all female, all female among unisex teams, or solo female teams. Variable definitions are in Appendix A. P-values based on robust standard errors clustered at the subclass level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Panel A: Dependent Variable = First-Action Allowance

Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Female Inventor	-0.004***	-0.005***	-0.005***	-0.005***	-0.006***
	(0.005)	(0.000)	(0.001)	(0.003)	(0.003)
Examiner Review Speed	-0.005***	-0.005***	-0.005***	-0.004***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Examiner Leniency	0.142***	0.142***	0.142***	0.147***	0.135***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln(1+Examiner Experience)	0.025***	0.025***	0.025***	0.026***	0.023***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Small Entity	-0.009***	-0.009***	-0.009***	-0.009***	-0.010***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Foreign Priority	-0.003	-0.003	-0.003	0.001	0.005
	(0.513)	(0.514)	(0.514)	(0.793)	(0.568)
Continuation	0.012***	0.012***	0.012***	0.011***	0.010***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of Inventors	-0.001***	-0.001***	-0.001***	-0.001***	
	(0.001)	(0.000)	(0.000)	(0.001)	
Solo Inventor	-0.001	-0.000	-0.000	-0.001	
	(0.435)	(0.637)	(0.666)	(0.218)	
Initial Num. of Claims	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Inventor Experience	0.000***	0.000***	0.000***	0.000**	-0.000
	(0.001)	(0.001)	(0.001)	(0.019)	(0.756)
Constant	-0.066***	-0.066***	-0.066***	-0.068***	-0.055***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.126	0.126	0.126	0.123	0.137

Panel B: Dependent Variable = Patent Granted

Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Female Inventor	-0.053***	-0.049***	-0.054***	-0.054***	-0.049***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Examiner Review Speed	-0.023***	-0.023***	-0.023***	-0.023***	-0.028***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Examiner Leniency	0.660***	0.660***	0.660***	0.656***	0.670***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln(1+Examiner Experience)	0.013***	0.013***	0.013***	0.013***	0.017***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Small Entity	-0.162***	-0.162***	-0.162***	-0.168***	-0.178***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Foreign Priority	-0.042***	-0.042***	-0.042***	-0.043***	-0.039***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.008)
Continuation	0.010***	0.011***	0.011***	0.010***	0.026***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of Inventors	0.005***	0.004***	0.004***	0.005***	
	(0.000)	(0.000)	(0.000)	(0.000)	
Solo Inventor	-0.032***	-0.029***	-0.028***	-0.029***	
	(0.000)	(0.000)	(0.000)	(0.000)	
Initial Num. of Claims	0.001***	0.001***	0.001***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)
Inventor Experience	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)
Constant	0.316***	0.313***	0.313***	0.319***	0.268***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.257	0.257	0.257	0.260	0.279

Table A3. Female Inventors and Patent Examination Outcomes: Regressions without Control Variables or Fixed Effects: The table shows regressions of patent examination outcomes on female participation on inventor teams. The sample consists of U.S. utility patent applications from 2001 to 2017, for which we could identify inventors' gender. The regressions are estimated using OLS. The regressions either have no control variables (Panels A and B) or have neither controls nor Art Unit Subclass × Year fixed effects (Panels C and D). In Panels A and C, the dependent variable *First-Action Allowance* is set to one if the application is approved in the first round. In Panels B and D, the dependent variable *Patent Granted* is set to one if the patent is eventually granted. The independent variable *Female Inventor* measures female participation on the inventor team as indicated in the table heading. In column 1, *Female Inventor* is the fraction of women on the team; in columns 2-5, it is an indicator set to one for majority female, all female, all female among all-female and all-male teams, or solo female teams. P-values based on robust standard errors clustered at the subclass level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Panel A: Dependent Variable = First-Action Allowance (Art Unit Subclass x Year FE & No Controls)					
Female Inventor	-0.006***	-0.006***	-0.007***	-0.006***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Control Variables	No	No	No	No	No
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.115	0.115	0.115	0.112	0.127
Panel B: Dependent Variable = Patent Granted (Art Unit Subclass × Year FE & No Controls)					
Female Inventor	-0.044***	-0.065***	-0.085***	-0.079***	-0.051***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control Variables	No	No	No	No	No
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.196	0.196	0.196	0.198	0.219

Table A3, cont. Female Inventors and Patent Examination Outcomes: Regressions without Control Variables or Fixed Effects:

Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Panel C: Dependent Variable = First-Action Allowance (No controls nor fixed effects)					
Female Inventor	-0.039***	-0.032***	-0.031***	-0.034***	-0.030***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control Variables	No	No	No	No	No
Art Unit Subclass × Year FEs	No	No	No	No	No
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.001	0.001	0.000	0.001	0.001
Panel D: Dependent Variable = Patent Granted (No controls nor fixed effects)					
Female Inventor	-0.181***	-0.183***	-0.203***	-0.209***	-0.165***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control Variables	No	No	No	No	No
Art Unit Subclass × Year FEs	No	No	No	No	No
N	988,125	988,125	988,125	829,781	295,600
adj. R-sq	0.007	0.006	0.006	0.007	0.008

Table A4. Descriptive Statistics for the Solo Inventor Sample by Rare vs. Common Names. This table presents summary statistics for U.S. utility patent applications filed from 2001 to 2017, for which we could identify the gender of all inventors. The sample is further limited to applications with solo inventors whose first names are classified as rare or common, where rare (common) first names are those within the bottom (top) 10th percentile of all names in the Social Security Application database, based on frequency counts (details are in Section 4.2). Variable definitions are in Appendix A.

	Common Names N=247,619		Rare Names N=21,960	
	Mean	Median	Mean	Median
First-Action Allowance	0.073	0	0.075	0
Patent Granted	0.622	1	0.618	1
Citations	10.755	3	9.586	3
Solo Female	0.068	0	0.085	0
Examiner Review Speed	1.686	2	1.767	2
Examiner Leniency	0.628	0.659	0.635	0.670
Examiner Experience	12.234	10	11.718	10
Small Entity	0.469	0	0.396	0
Foreign Priority	0.005	0	0.016	0
Continuation	0.627	1	0.598	1
Initial Num. of Claims	3.340	3	3.490	3
Inventor Experience	13.096	2	12.390	1
Experienced Inventor Team	0.575	1	0.533	1

Table A5. Summary Statistics on Female Inventor Share in Each Art Unit. Panel A shows summary statistics on *Female Inventor Share*, which is the fraction of female inventors on patent applications in an art unit during 2001 through 2017. Panel B shows a list of art units with the top three and bottom three *Female Inventor Share*.

Panel A. Summary Statistics on Female Inventor Share

	Mean	**Median**	**Max**	**Min**
Female Inventor Share	8.7%	7.2%	28.2%	1.3%

Panel B. List of Art Units with Top Three and Bottom Three Female Inventor Shares

	Art Unit Code	**Art Unit Name**	***Female Inventor Share***
Top 3	1676	Process, Nucleic acid, Protein, Carbohydrate Chemistries and Diagnostics	28.2%
	1646	Cytokines Recombinant Hormones, Body treating compositions	27.6%
	1647	Immunology, Receptor/Ligands	27.3%
Bottom 3	3655	Planetary gear transmission systems or components	1.3%
	3672	Wells	1.9%
	3657	Brakes	2.0%

Table A6. Descriptive Statistics for the Sample from Public Firms. This table shows summary statistics for U.S. utility patents that were filed by publicly traded firms from 2001 to 2017 and eventually granted by the USPTO, for which we could identify the gender of all inventors on an application and for which firm-level characteristic variables and *KPSS Patent Value* are available. Variable definitions are in Appendix A.

	N	Mean	Median	SD
KPSS Patent Value ($ Million)	404,551	27.800	13.85	40.320
Prop. of Female Inventor	404,551	0.070	0	0.180
Majority Female Inventor	404,551	0.020	0	0.150
All Female Inventor	404,551	0.010	0	0.120
All Female Inventor-Non-Mixed Team	343,996	0.020	0	0.130
Solo Female Inventor	112,368	0.040	0	0.200
Ln(Asset)	404,551	9.990	10.33	2.020
ROA	404,551	0.130	0	0.130
R&D/Asset	404,551	0.070	0.050	0.080
CAPEXTA	404,551	0.040	0	0.030
Leverage	404,551	0.220	0.21	0.170
Market-to-book	404,551	2.230	1.91	1.360
Institutional Holding%	404,551	0.510	0.61	0.330
Ln(Age)	404,551	3.460	3.71	0.740
PPE/Asset	404,551	0.180	0.14	0.130
HHI	404,551	0.540	0.43	0.320
KZ-INDEX	404,551	-11.260	-4.89	177.330

Table A7. Inventor Gender and Filing an Initial Amendment: Heckman Selection Model. The table shows the Heckman selection model of the likelihood of filing an initial amendment after receiving a non-final rejection in the first-action stage on female participation on the inventor team. In the first stage regression, the dependent variable *Non-final Rejection* is a binary variable that takes the value of one if the application is rejected upon the first-action decision, and zero otherwise. *Non-final Rejection* is regressed on measures of female participation on the inventor team and the same control variables and fixed effects as those in Table 2 in a Probit model. In the second stage, the dependent variable *Initial Amendment* is an indicator that takes the value of one if the applicant files an amendment after receiving a first-action non-final rejection, and zero otherwise. *Initial Amendment* is regressed on measures of female participation, the same set of patent and inventor attributes and fixed effects as those included in Table 2, and the Inverse Mills Ratio from the first stage model. Variable definitions are in Appendix A. P-values based on robust standard errors clustered at the subclass level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

Dependent Variable:	*Initial Amendment*				
Female Inventor:	Fraction Female	Majority Female	All Female	All Female (Unisex Teams)	Solo Female (Solo Teams)
	(1)	(2)	(3)	(4)	(5)
Female Inventor	-0.022***	-0.017***	-0.020***	-0.018***	-0.003
	(0.000)	(0.002)	(0.001)	(0.004)	(0.762)
Inverse Mills Ratio	0.285***	0.285***	0.285***	0.279***	0.299***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control Variables	Yes	Yes	Yes	Yes	Yes
Art Unit Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes
N	234,895	234,895	234,895	186,723	42,371
adj. R-sq	0.096	0.095	0.095	0.099	0.105