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THE IDEA GAP IN PINK AND BLACK

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ABSTRACT

Previous studies have found large gender and racial differences in commercialization of invention. Using novel data that permit enhanced identification of women and African American inventors, we find that gender and racial differences in commercial activity related to invention are lower than once thought. This is despite relatively lower patent activity among women and African Americans. Further, among determinants of commercialization, the evidence suggests that advanced training in engineering is correlated with better commercialization outcomes for women and African Americans than for U.S. inventors as a whole, for whom advanced training in life sciences is more important.

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1 Introduction

The two critical endpoints in the innovative process are basic scientific research and commercialization of invention. Women and African Americans have increasingly participated at the beginning and end of this process. The share of women receiving doctoral degrees in science and engineering increased from nine percent in 1970 to 40 percent in 2005. For African Americans, this share grew from less than 0.01 percent to four percent over the same period.[1] With respect to the commercialization of ideas, the gap appears to be closing, as well. From the best data available in 1998, women inventors assigned 51 percent of their patents to firms in 1977-1982, and, by 1998, they assigned 75 percent of their patents to firms.[2] Among African Americans, in 1975, 44 percent of patents were assigned to firms, and, by the year 2000, it was 56 percent compared to 82 percent for all inventors who obtained U.S. patents that year.[3]

Using techniques that allow enhanced identification of inventors by gender and ethnicity, we collect new data on women and African American patentees. The evidence suggests that disparities related to commercialization are indeed much smaller than previously thought. We calculate that, on average, between 2001 and 2008, women and African American inventors commercialized 79 and 77 percent of their inventions compared to 80 percent for all U.S. inventors.[4] Between 2001 and 2006, for the largest firms, patent assignments by women and African Americans exceeded those of all U.S. inventors – 56 percent and 59 percent compared to 50 percent. These findings stem largely from more comprehensive identification of women and African Americans in patent data and from more recently available patent data.

Related to commercialization, we ask several questions with the new data. In general, among women and African Americans, what are the patterns and determinants of differences

[1] Authors' calculations, NSF(2009a),and NSF(2009b).
[2] USPTO (1999).
[3] Cook (2007a) and USPTO (2009).
[4] USPTO (2009).

in rates of patenting and commercialization relative to all U.S. inventors? Are there social and professional networks that are more salient for commercial activity than others? If so, do these vary by gender or race? Are certain fields of inquiry better at allowing diverse patent teams to emerge that may change the probability of commercialization?

From these inquiries we also find that increases in advanced engineering degrees predict increases in assigned patents, including to the largest firms, by women and African American inventors, while increases in life-sciences doctorates predict this outcome in the total population of U.S. patentees. Nonetheless, female and African American patents are associated with a lower probability of assignment to firms, although there are appreciable differences across technology categories. Increases in citations received are correlated with patents assigned for women but vary by type of firm for African Americans. All-male and all-female patent teams commercialize their patents less than mixed-gender patent teams. Importantly, while we find that the commercialization gap is closing, the evidence suggests that the gap in patent activity is wide for women and wider still for African Americans.

Given the burgeoning literature on the importance of ethnic and social networks on creative and scientific outcomes, the contributions of this paper are three-fold. First, we extend the data used by previous papers on women patentees by taking advantage of greater ethnic heterogeneity to identify gender and by using more recently available data. The share of non-U.S. citizens in U.S. Ph.D. recipients in science and engineering increased from 18 percent in 1978 to 42 percent in 2008, which implies that new identification methods could be useful in capturing an increasing number of patent-holders.[5] Second, our analysis uses the new data to build on earlier work that identifies and analyzes patenting and commercialization patterns among women. Third, to the authors' knowledge, this is the first systematic analysis of recent African American patenting and patent-related commercialization behavior.

[5]NSF (2009c)

2 The Literature

For some time researchers have attempted to understand the innovation production problem, especially inventors or scientists who participate in this process, e.g., Schmookler (1957). Patenting differentials between certain groups have begun to receive attention. Ding, Murray, and Stuart (2006) employ longitudinal data from a random sample of 4,227 academic life scientists and find that women faculty members patent at approximately 40 percent of the rate of men. Ashcraft and Breitzman (2007) present patterns of women's inventive activity in the IT sector from 1980 to 2005. They show that nine percent of IT patents have at least one female inventor and that this share has increased over time. Similarly, Agarwal, Kapur and McHale (2007), Kerr (2008), and Cook (2007b) examine patent differences by ethnicity and race.

Less attention has been given to differences in commercialization of invention. The research that does exist suggests that patent commercialization activity differs along gender and racial lines. Differences by gender were first documented by the National Science Foundation (NSF (1995)). Morgan, Kruytbosch, and Kannankutty (2001) use survey data from NSF's Scientists and Engineers Statistical Data System (SESTAT) and compare activity related to commercialized products or processes and related to licenses between scientists in the academic and industrial sectors. They find that success rates of female scientists in commercializing their innovations are three and 13 percent lower than for their male counterparts in both academia and industry. Murray and Graham (2007) suggest that characteristics of female scientists, such as attitudes toward risk and competition and commercial experiences play an important role in the commercial activity of female academic scientists. They also find that social networks and venture capitalists' views of female scientists widen the gender gap in commercial science at academic institutions.

Systematic differences in patent-related commercialization activity by race were first examined by Cook (2007b). Using data on African American inventors before and after the Bayh-Dole Act of 1980, the author finds that changes in commercialization activity among

African Americans do not correspond to changes in the commercialization activity of other U.S. inventors over the same period.[6]

While the literature on the gender gap in commercialization is growing, the data used in existing studies are primarily limited to women in academia and to those with English or American names. This study builds on the current literature by broadening the scope of inquiry to include all women inventors and African American inventors and to include new sets of questions to increase our understanding of their invention-related behavior.

3 The Data

This paper focuses on two groups of inventors - women and African Americans. Patents are considered women's patents or African American patents if they have at least one woman or one African American inventor.[7] Female patentee data are derived from matching names of inventors who obtained patents from the USPTO between 1975 and 2008 to commonly-used women's names. Female names are matched using commercial name-matching software, discussed in the Data Appendix, which includes identification of Asian- and Slavic-origin names, among other ethnicities. Each record from the USPTO contains information on the invention, e.g., title, citations, and patent classification, and on the inventor, e.g., name and address. This method yielded more women's patents than in other studies, such as the U.S. Patent and Trademark Office (USPTO, 1999), because women's names of foreign origin were not identified or may have been underidentified previously. In total, we find 169,061 U.S. women's patents granted between 1975 and 2008. Between 1977 and 1998, the number of U.S. women's patents in our dataset is 66,967 compared to 60,065 utility patents identified by the USPTO.[8]

[6]The Bayh-Dole Act of 1980 provides for the transfer of exclusive control of government-funded inventions to universities and firms for further development and commercialization.

[7]In this paper, patents refer to utility patents, the largest category of patents.

[8]Unless otherwise stated, women's patents in this study refer to patents for which one inventor is a woman, and the first-named inventor resides in the United States. Following USPTO (1999) and related studies, a patent in which a woman inventor resided in the United States but the first-named inventor does

In our research, two African American inventor data sets are used. First, the African American Inventors data set from Cook (2004, 2005, 2007a) is the most extensive data-collection effort of its kind to date. It was constructed by matching African American inventors and potential patentees to USPTO patent data for the period 1963 to 2006, yielding 1,861 patents and 427 inventors.[9]

A second data set is created by using the Census Bureau's (2009) list of common names by race, USPTO data, and commercial technology. Inventor names are randomly drawn from the USPTO inventor file, which contains 7,881,906 inventor-invention units between 1975 and 2008. Using the Census list and inventor address and zip-code data from the USPTO, we generate unique first-, middle-, and last-name matches.[10] From this method we obtain 1,626 inventors and 4,657 patents. Finally, these data are merged with the Cook (2007a) data, resulting in 6,518 patents and 2,053 inventors, 305 of which are African American women. Given our conservative approach in identifying female and African American inventors (ambiguous cases considered to be male or not African American), in the empirical analysis that follows our results will be biased towards zero, i.e., not finding the gaps of interest.

A central challenge in this study is to identify individual-level commercialization activity. Forms of commercialization considered in the literature have often been in the secondary market, e.g., licensing (Arora and Ceccagnoli, (2006)), the achievement of first sale (Nerkar and Shane, (2007)), having a product under review, having a product in market, or having a start-up company (Campbell et al., (2004)). We consider assignment to a corporation, university, organization, or anyone other than oneself a proxy for commercialization activity. That is, the assignment represents commercialization activity at the date of patent issue.

not reside in the United States is excluded. The authors acknowledge that we adopt a crude but widely-used measure of women's and African Americans' patents.

[9]Sources used include directories of scientists and engineers, data from national organizations, and obituaries. See Cook (2009) for a detailed description of the data.

[10]Names that have zero probability of being African American names, as determined by the Census list, are not included in the matching process. See Data Appendix for a detailed explanation of the name-matching process.

Further data on female and African American patents are obtained by matching patent numbers of women and African American inventors to Hall, Jaffe and Trajtenberg (2001, updated 2009), the National Bureau of Economic (NBER) patent database. These data comprise the patent number, number of citations, assignee code, USPTO patent class and sub-class, and NBER-Hall, Jaffe, and Trajtenberg technological class.

Many patent-commercialization studies focus on the commercialization activity of federal laboratories or universities with a small group of institutes or one institute. The measure of commercialization by assignment to firms is clear, because the main objective of firms is to seek a return on their investment. Some researchers, e.g. Morgan et al. (2001), obtain commercialization data from inventors' surveys. Data on licensing or commercialization activities are, however, unavailable on a large scale. As an indirect approach, we connect potential commercial activity with assignment to firms with the following argument. Generally, patent owners will renew their patents if they calculate that a patent's future value is higher than its renewal cost, e.g., Pakes and Schankerman (1998) and Serrano (2008). And the patent value should have a strong relationship with future revenue from licensing, selling, or launching a new product. Using data from 1983 to 2001, Serrano (2008) finds that the proportion of patents expired in firms is less than one in the individual-owner or unassigned category. Consequently, we assume that patents owned by firms have a higher propensity to gain pecuniary benefit than patents owned by non-firms.

To better understand commercialization outcomes and opportunities, women's and African American patents are matched to COMPUSTAT data by using a company-matching file in the NBER patent database (2006). COMPUSTAT data comprise all publicly-traded firms on the New York, American, NASDAQ, and regional stock exchanges in the U.S. We expect firms in the COMPUSTAT data set to engage in higher levels of patent commercialization relative to other firms. Between 1976 and 2006, there were 841,341 patents assigned to COMPUSTAT firms out of 1,748,776 U.S.-origin patents. Women and African Americans assigned 78,938 and 1,808 of their patents to COMPUSTAT firms.

4 Graphical Evidence

Prior to inspecting and testing data on commercialization of patents, we begin by summarizing data from the revised data on women inventors and new data on African American inventors. To recall, the central questions are: Has the gender gap in commercialization remained, or has it closed over time? Is there evidence that African Americans are becoming more active in the process of commercializing new technologies?

General

Figures 2 and 3 and Table 1A present patents per million obtained by U.S. inventors, U.S. women inventors, and African American inventors. Since the mid-1980's, the population-weighted number of patents has increased for all three groups. On average, U.S. inventors were granted 168 patents per million between 1980 and 1989 and 278 patents per million annually between 1990 and 1999. Over time, the share of advanced degrees in science and engineering (S&E) fields has risen for women and African Americans. Figures 4 and 5 show that the largest share of S&E doctorates among women and African Americans has been in the life sciences, but there is significant heterogeneity otherwise. Data on the distribution of patents by technological field and assignment status for each inventor group are given in Tables 1B, 1C, and 1D and Figures 6 to 8. Fields of invention are broadly similar for U.S. and African American inventors and are only similar in computers and communications and other fields for U.S. and female inventors.

Related to ownership, the proportion of patents assigned to firms is relatively stable for U.S. inventors between 1963 and 2008 as can be seen in Figures 9 to 11 and Table 1C, which gives the evolution of assignment behavior by decade. For women and African Americans, shares of patents assigned to firms have increased markedly since 1963. Evidence from assignment to COMPUSTAT firms is in Figure 12 and in Table 1D and shows that the share of total U.S. patents assigned to publicly-traded corporations declined slightly from 50 percent between 1976 and 1980 to 47 percent for the period between 1996 and 2000. These data imply that U.S. inventors are increasingly less likely to rely on large corporations to pursue commercialization of invention.

Forward citations and backward citations for each group are presented by technology category in Figures 13 and 14.[11] Forward citations of U.S. inventors, U.S. women inventors, and African American inventors are similar and growing over the period of study.

Women

Changes in patent activity among women have been in tandem with changes among U.S. inventors. U.S. women inventors were granted between 17 patents per million between 1980 and 1989 and 56 patents per million annually between 1990 and 1999. On average, women inventors participate more actively in the drugs and medical field than other U.S. inventors. This observation is consistent with relatively higher shares of women receiving life sciences degrees and relatively lower shares receiving engineering degrees since 1970 (Figure 4). The share of electrical inventions among women's patents is six percentage points lower than that of U.S. inventors between 1975 and 2008. The share of chemical patents for female inventors drops slightly over time but is still higher than for that of U.S. inventors.

The average annual share of women's patents assigned to firms increased from 54 percent between 1975 and 1980 to 79 percent between 2001 and 2008. The share of unassigned women's patents dropped from 39 percent between 1975 and 1980 to 12 percent between 2001 and 2008. In contrast to U.S. trends, the share of female patents assigned to COMPUSTAT firms grew in the late 1970's and early 1980's and has stayed above 50 percent. Similar to the U.S., individuals, government, and other non-firm entities own 26 percent of patents granted to women inventors over the period 1963 to 2008.

[11]Citations received in the NBER data set are weighted by the method proposed in Hall, Jaffe and Trajtenberg (2001, updated 2009). Citations made are calculated from citations among patents granted between 1976 and 2006 using the NBER U.S. patent citations data set.

Considering each technology, quality, as measured by the median number of citations for patents, is increasing in tandem with those of all U.S. inventors. However, since 1980, the median number of citations received for women's patents has been higher than for U.S. inventors' patents for most technology categories, except drugs and medical.

Single-sex and mixed patent teams perform very differently. From Table Appendix 1, we observe that female-only teams assign their patents to firms only 42 percent of the time, compared to 74 and 80 percent for all-male and mixed teams. Moreover, more than half of female-only patents are not assigned to any organization, while just one fifth and one-tenth of all-male- and mixed-gender-team patents are not assigned to any organization. Further, all-female patents are less commercialized in drugs and medical, mechanical, and other technological categories than in chemical and computer and communications. The finding that the assignment rate to firms is higher for mixed-gender teams than single-gender teams is consistent with but a more general finding than that of Ashcraft and Breitzman (2007), who find a similar pattern among IT patents.

African Americans

Corresponding to patent activity for U.S. inventors and women inventors, the population-weighted number of patents has increased for African Americans. African American inventors obtained between 3.7 and 4.5 patents per million between 1980 to 1989 and 1990 to 1999. This finding is intuitive, given significant increases in the supply of potential patentees, e.g., advanced degree recipients in the sciences, among African Americans. For African American inventors, the distribution of fields of invention mirrors that of all U.S. inventors. This observation also corresponds to shares of African Americans receiving science and engineering degrees (Figure 5). As is the case for women, the share of chemical patents falls slightly but is still higher than that of U.S. inventors.

The average annual share of African American patents assigned to firms was relatively unchanged at 60 percent between 1963 and 1990 but jumped to 77 percent between 2001 and 2008. Assignment patterns by organization are not uniform across groups. Individuals, government, and other non-firm entities own 33 percent of African American patents, which is substantially higher than the share for women and U.S. inventors between 1963 and 2008.

Quality, as measured by the median number of citations for African American patents, is increasing, which is consistent with those of women and all U.S. inventors.

From the initial evidence, we do not find a significant commercialization gap for the most valuable firms. From a t-test of mean shares of patents assigned to COMPUSTAT firms, we can reject the null hypothesis that the U.S. mean is greater than or equal to the mean for women and for African Americans. Given the aforementioned significant increase in the number of women patentees gleaned using new methods, the gap closes at least partly as a result of including women with non-English names in the analysis, which has not been done in previous work. While this finding is different from most in the literature, it is consistent with the findings of Morgan et al. (2001). They use the National Science Foundation workforce survey data to show that, conditional on a patent being granted, rates of commercialization between men's and women's patents are similar, although not identical.

Nonetheless, a similar test of means for patent activity and general assigned-patent activity reveals significant differences across groups. We reject the null hypothesis that the U.S. means are less than or equal to those of women and African Americans. The evidence implies that the broader patent and commercialization gaps are not yet closed.

5 Empirical Evidence

In this section, we extend the analysis to ask if the gaps found above persist when accounting for other factors. Specifically, we will test whether determinants of patent and innovative activity differ across groups for patents, assigned patents, and patents assigned to COMPUSTAT firms. With the new data on women and African Americans, we can proceed by estimating standard models of patent activity from the literature.

Following Griliches (1990), in the knowledge production function innovative activity, measured by patents, is determined by observable investment, e.g., R&D expenditure, or number of research scientists, and unobservable error. Many researchers have tested this relation between innovative activity and inputs using firm-level data, e.g., Hall, Griliches, and Hausman (1986), and Pakes and Griliches (1984). Aggregate innovative activity using country-level data has also been studied.

Chellaraj, Maskus, and Mattoo (2009) modify the "national ideas production function" proposed by Porter and Stern (2000) to incorporate the contribution of skilled immigration and foreign graduate students to U.S. innovative activity. Chellaraj, Maskus and Mattoo (2009) propose an approach to disentangle the allocation-of-resources variable into R&D expenditure, stock of scientists and engineers, flow of total graduate students, flow of international graduate students, and flow of immigrants. We adopt the Chellaraj, Maskus and Mattoo (2009) model to study patterns of patenting activity for all U.S. inventors, U.S. women inventors, and African American inventors. Specifically, the R&D resources we use are R&D expenditure, number of employed S&E doctoral researchers, and number of doctoral graduates.

To formally test the implications of Chellaraj et al. (2009), two types of data are used to investigate patent and commercialization activity for each inventor group. We use time-series data to explain changes in patent and commercialization over time. We then use cross-section data and discrete-choice analysis to better account for unobserved heterogeneity among inventor groups.

A. Time-Series Estimation

Patent Activity

We would like to answer the question: "Are there observable differences in patenting and commercial activity between inventor groups over time?" Specifically, we estimate the following time-series model for each group:

$$
\begin{aligned}
PATENT_t = \alpha + \beta_1 RD_{t-1} + \beta_2 SEEMP_{t-1} + \beta_3 SEGRAD_{t-1} \\
+ \beta_4 ENGMGRAD_{t-1} + \beta_5 DUMMY_t + \beta_6 TIME_t + \epsilon_t,
\end{aligned} \tag{1}
$$

where $PATENT_t$ is log of U.S. patents granted by application year, RD_{t-1} is lag of log of total U.S. R&D expenditure (deflated), $SEEMP_{t-1}$ is lag of log of employed doctorate scientists and engineers, $SEGRAD_{t-1}$ is lag of log of S&E PhD graduates, and $ENGMGRAD_{t-1}$ is lag of log of engineering Master's graduates. All variables are weighted by population.[12] Following Griliches (1990), each variable is lagged one year to capture time to innovate.[13,14] Models estimated include time trend and a dummy for extension to a 20-year patent term in 1995, which is believed to have induced a sizeable increase in the number of patent applications.

Data used in estimation are patents granted between 1976 and 2008. As is customary, we drop the last four application years to avoid truncation lag problems.[15] Baseline statistics for each variable are given in Table 2. A Phillips and Perron (1988) test is used to determine the presence of a unit root. We find evidence of a unit root in the patent sample, and each variable is first-differenced before OLS models are estimated. OLS regressions are executed for U.S., U.S. women, and African American inventors to shed light on differences among these three inventor groups.[16]

The endogeneity bias problem in R&D expenditure is well known in the literature. Fol-

[12] See Data Appendix for data sources.

[13] Chellaraj, Maskus, and Mattoo (2009) suggest five- and seven- year lags for models with patent applications and grants, respectively, as the dependent variable.

[14] Dummies for years 1980 and 1984 are included to capture the effect of the Bayh-Dole Act of 1980 and its amendment which allow universities to retain intellectual property rights and to license innovation developed by federal funds.

[15] The range of the African American data set from Cook (2007a) is shorter, between 1976 and 2002.

[16] Baseline statistics are reported for four samples of African American inventors. Data from Cook (2007a) are the AA1 sample, data from commercial encoding are the AA2 sample, and the combined AA1 and AA2 samples are the AA3 sample. The AA4 sample is the AA3 sample plus African-origin names. Results do not differ substantially between those obtained among samples. Therefore, results from the combined AA4 sample are the ones generally reported. The combined sample drops duplicate patents.

lowing Kanwar and Evenson (2009) and Liu and La Croix (2008), we execute two-stage least squares estimation (2SLS) using lag of log of GDP per capita ($GDPPC_{t-1}$), high-school enrollment rate ($HSER_t$), and degree-institution enrollment rate ($DIER_t$) as instruments.[17] The first-stage equation is

$$RD_t = \gamma_1 + \gamma_2 GDPPC_{t-1} + \gamma_3 HSER_t + \gamma_4 DIER_t + \epsilon_t. \tag{2}$$

From Table 3, for U.S. inventors, a one-percent increase in the growth rate of engineering doctorates is correlated with a 0.74-percent increase in the growth rate of patent activity. The results from 2SLS estimation mirror the results from OLS, and this result is robust across models estimated in the full sample.

We use multiple inventors' discounting to assign the same weight to each patent.[18] Women's patent activity measured by multiple inventors' discounting is presented in the fourth and eighth columns of Table 3 (summary statistics for all groups appear in Table 1A). The results are similar to those without discounting.

In equation (1), we establish context for examining commercialization activity by first examining patent activity in each group. To address patent differences across inventor groups, we define the dependent variable as the difference in U.S. inventor patents per million and each group's patents per million. Estimates are presented in Table 4. For African Americans, a one-percent increase in the growth rate of doctoral S&E employment is correlated with a 1.4-percent decrease in the growth rate of the difference between U.S. inventors' and African American patent activity. This implies that an increase in African American doctoral S&E employment narrows the gap between U.S. inventors and African American patent activities.

[17] See Data Appendix for data sources. Kanwar and Evenson (2009) argue that we expect enrollment rate to change with scientific development or R&D expenditure but not patenting activity.

[18] Computation of fractional contribution to a patent using multiple inventors' discounting has been executed in the literature, e.g., in Ashcraft and Breitzman (2007) and Kerr (2009). The interpretation should be that if one of six inventors on a patent team is a woman, the patent is one sixth of a woman's patent.

Commercialization Activity

Patterns of commercial activity, measured by number of patents assigned to firms and number of patents assigned to firms in COMPUSTAT, are investigated and presented in this section. Patent activity by firms is assumed to be driven by profitability.[19] In the Griliches (1990) knowledge model, profitability is one of the ultimate ends of knowledge and depends on valuable knowledge growth, which is unobservable. Additions to the stock of knowledge rely on R&D resource allocation, or R&D expenditure. A simple model can be derived from Griliches (1990) in which profitability is a function of R&D allocation. Using this simple relationship, we can write down the model to be estimated for commercial activity as in the previous section:

$$\begin{aligned} ASSIGNMENT_t = \alpha + \beta_1 INDRD_{t-1} + \beta_2 SEEMP_{t-1} + \beta_3 SEGRAD_{t-1} \\ + \beta_4 ENGMGRAD_{t-1} + \beta_5 DUMMY_t + \beta_6 TIME_t + \epsilon_t, \end{aligned} \tag{3}$$

where $ASSIGNMENT_t$ is log of percentage of patents assigned to firms by application year and $INDRD_{t-1}$ is lag of log of U.S. R&D spending in the industrial sector. The results for assignment to firms are presented in Table 5. After controlling for policy change, a 10-percent increase in the growth rate of industrial R&D expenditure is associated with a 0.7-percent increase in the growth rate of assignment to firms for U.S.-inventor patents. A 10-percent increase in the growth rate of life-science doctorates is correlated with a 1.8-percent increase in the growth rate of U.S. patents assigned to firms. For women inventors, a 10-percent increase in the growth rate of physical-science Ph.D.'s is correlated with a 1.5-or 1.8-percent decrease in the growth rate of patents assigned to firms. Among African Americans, a 10-percent increase in the rate of growth of physical science Ph.D.'s is correlated with a 1.9- or 1.7-percent increase in the rate of growth of assigned patents. In contrast, a 10-percent increase in the growth rate of African American life-science doctorates is correlated with a decline of 5 percent in the growth rate of African American patents assigned to

[19] Other factors, e.g., defensive patenting, as in Hall and Ziedonis (2001), are omitted in this analysis.

firms. A review of NSF 2003 survey data on employment in S&E disciplines shows that 37 percent of African American Ph.D.'s employed as biological scientists teach at postsecondary institutions, while only 17 percent of African Americans employed as physical scientists teach at postsecondary institutions.[20] Since the lion's share of patenting occurs at industrial laboratories, i.e., not at postsecondary institutions, and since most of that activity is assigned to firms, a negative relation between the rate of arrival of life-science doctorates and the rate of arrival of assigned patents is not surprising.

In line with Griliches (1990) and related papers, we find that a one-percent increase in the growth rate of expenditure on industrial R&D is associated with a 1.1-percent increase in the growth rate of assignment to firms.[21] A 10-percent increase in the growth rate of master's in engineering graduates is correlated with a 9.5-percent increase in the growth rate of assignment for African American inventors. These results suggest that there may be relatively more or fewer scientific or commercial spillovers for African American inventors in certain fields of invention. For 2SLS estimation, the correlations between R&D expenditure and growth rate of assignment are statistically insignificant. Estimated coefficients on other independent variables are similar to those from OLS estimation.

Estimates from the sample of COMPUSTAT firms are presented in Table 6. For African Americans, an increase of 10 percent in the growth rate of engineering doctorates is correlated with an increase of 1.4 or 1.5 percent in the growth rate of assignment to COMPUSTAT firms. Other results remain largely the same as for all assigned patents.

Differences in commercialization activity, measured by percentage of U.S. inventors' patents assigned to firms (or COMPUSTAT firms) minus percentage of each group's patents assigned to firms (or COMPUSTAT firms), are presented in Tables 7 and 8. Results from Tables 7 and 8 are consistent with those from Tables 5 and 6. These results are suggestive that advanced engineering degrees may play an important role in closing gaps between U.S.

[20] NSF (2007a).

[21] In general, given a shorter time series than that used by Griliches (1990), Chelleraj, et al. (2009), and others estimating the relation between patent output and measures of R&D, we expect that our results may be similar but not identical to these papers.

inventors and each group examined.

Older and newer results from the literature on women in science and engineering may shed light additional light on our findings. A number of papers document relatively higher exit rates, rates of departure from degreed field of study, among women compared to men in science and engineering, e.g., Hall (2007), Hewlett, et al. (2008), Hill, et al. (2010), Hunt (2010), Morgan (2000), Preston (1994, 2004, 2006), Sonnert and Holton (1995), and Stephan and Levin (2005). Among the explanations given are isolation related to being a minority with less mentoring and fewer networks, difficulty of balancing extended work days in science and engineering with family commitments, and discrimination, including negative stereotypes associated with women in science. Hunt (2010) finds that excess exit rates among women are concentrated in engineering and that this is largely due to dissatisfaction over pay and promotion opportunities. Given higher exit rates in science and engineering and especially engineering, it is likely that these constraints are less binding for those “survivors” who remain in corporate laboratories, where it can be assumed that much patent-related work is done. If the perception is that the contributions of “survivors” are highly valued, the correlation between assignment to COMPUSTAT firms and the presence of a woman on a patent is not surprising.

Both NSF data and the literature suggest that explanations offered for outcomes for women may extend to African Americans. In general, exit rates are higher for African American doctorates in S&E fields than for their counterparts. The 2003 NSF survey also establishes that, 35 percent of African American S&E doctorates were employed in non-S&E occupations, in comparison to 25 percent of all S&E doctorates. Further, unlike women in the larger S&E population, African American women constitute the majority of total African American S&E graduates. In addition, women make up 45 percent of all African American doctorates who are employed in S&E occupations, while women make up only 28 percent of all doctorates in the total S&E occupations. While the research on African Americans is limited, related work, e.g., Price’s (2009) study of the economics profession, also suggests that the literature on women S&E graduates may be applicable to African Americans.

Given limited comparable data and scholarship on African Americans and to shed light on the mechanisms underlying our findings, between 2003 and 2009 we conducted interviews in a small sample of African Americans. Those in the sample have at least one of the following characteristics: patentee, entrepreneur, former employee of a government laboratory, former employee in S&E field, or current employee in S&E field.[22] Two thirds are entrepreneurs, the majority of whom have firms related to self-generated patents or other forms of intellectual property (IP) or licenses for the use of another firm's intellectual property. One entrepreneur notwithstanding, all have training in math or science, which was not a selection criterion. There are two significant findings from the interviews. First, social, professional, and financial networks for inventive and business activities were cited as important but often missing. This finding is broadly consistent with the evidence from data on black business ownership and performance from Fairlie and Robb (2009) and from female academic scientists studied in Murray and Graham (2007). Generating networks to compensate for missing ones, e.g., through internships, small-business programs, golf-club memberships, seemed to feature prominently in the allocation of firm resources. Not surprisingly, those with the least binding network constraints were previously at large firms or who are licensees or affiliates of well-known (IP) firms (or both). Second, as was found for women, most entrepreneurs reported encountering more perception problems than their white and Asian counterparts due to the small number of African American IT and IP-related firms. While this evidence is not extensive, it is suggestive that there may be common features between women and African Americans in science and in science-related employment that may help to explain patterns of commercialization activity.

[22]Employees in S&E fields could be employed in industry or in government. See Data Appendix for information on the sample.

B. The Inventor's Commercialization Decision

Time-series estimation using aggregate data allowed us to study patterns of patenting and commercialization by women, African American, and U.S. inventors. However, the aggregate data and analysis are limited, because they sum female and African American patents in different technologies and team characteristics in the same year together. Therefore, we use cross-section data to exploit patent and team characteristics to more closely evaluate commercialization activity. We examine the inventor's decision to assign a patent to a firm and treat each patent as a unit of observation. With this slightly different approach, our main question is: "How do gender and race covary with commercial activity measured by assignment to firms?" Specifically, we estimate the following probit model:

$$\begin{aligned} Pr(ASSIGNFIRM_i = 1) = F(&\alpha + \beta_1 W_i + \beta_2 AA_i + \beta_3 TEAM_i + \beta_4 CITATION_i \\ &+ \beta_5 W_i \times TEAM_i + \beta_6 AA_i \times TEAM_i + \beta_7 W_i \times CITATION_i \\ &+ \beta_8 AA_i \times CITATION_i + \sum_{j=1}^{5} \beta_{9,j} TECH_i^j \\ &+ \sum_{j=1}^{5} \beta_{10,j} W_i \times TECH_i^j + \sum_{j=1}^{5} \beta_{11,j} AA_i \times TECH_i^j + \epsilon_i), \end{aligned} \tag{4}$$

where $ASSIGNFIRM_i$ is a dummy variable with the value one if patent i has been assigned to a firm; W_i and AA_i are dummy variables with the value one if there is a woman or African American inventor on a given patent team; and $TEAM_i$ is number of inventors on patent team, which is a proxy for patent collaboration; $CITATION_i$ is number of forward citations[23]; $TECH_i^j$ is a dummy variable with the value one if patent i is in technological

[23]Patent citations are used in the innovation literature to measure knowledge spillovers and quality of patents, e.g., Hall, Jaffe and Trajtenberg (2001, updated 2009). Citations received or made inform linkages between inventors and innovations, and patent quality is positively associated with the number of forward citations, or patents citing a given patent. If the original patent is cited by a number of following patents, this indicates that the original patent is important or has high quality, e.g., Hagedoorn and Cloodt (2003) and Trajtenberg (1990). In addition to patent counts, citations received may be used to measure patenting activity, e.g., Hall, Jaffe and Trajtenberg (2005) and Acharya, Baghai and Subramanian (2009).

category j. We expect the number of inventors to increase with the probability of assigning a patent to a firm.[24] Moreover, dummies for women's and African American patents as proxies for networks and discrimination are included in the regressions. Using taste-based preferences of the employer proposed by Becker (1971), we would predict that the probability of patents assigned to a firm may be negatively correlated with the share of women or African Americans on the patent team. Controls for technological categories and forward citations are also included. We pool patents granted between 1976 and 2008 together to estimate model (7) as a probit model. Further, we estimate probit models with two five-year-subsamples, between 1976 and 1980, and between 2001 and 2005 to capture changes in commercialization activity for women and African Americans.

We are concerned that the assignments of some patents may be driven by a few prolific inventors. It is possible that the error terms are correlated for the observations relating to the same prolific inventors. To address this issue robust standard errors that are clustered on the identity of the most prolific inventor in a patent team are reported for probit models.[25]

Results are presented in Tables 9A and 9B. For the population of U.S. inventors between 1976 and 2006, having women or African American inventors on the patent team reduces the probability of assigning patents to firms by 0.11 and 0.07. An additional inventor increases the probability of assigning patents to firms by 0.09. In the 1970's subsample, if other variables are held constant, women have a lower probability of assigning to firms than men by 0.22. For African Americans, the probability of assigning patents to corporations is lower than other races by 0.09. These gaps remain in the 2000's subsample. The opportunity for women and African American inventors to assign their patents to firms, compared to men and other races, is worse. Given the nonlinearity of probit estimation, the marginal effects cannot be summed directly.[26] The predicted probabilities of having women and African Americans

[24] Jones (2009) proposes that an increase in size of patent team is caused by an increasing specialization requirement and an increase in the burden of knowledge.

[25] Singh and Fleming (2009), for example, address the possibility of correlation among error terms involving the same inventor by clustering on the identity of the first inventor.

[26] Moreover, the method and code in the literature, e.g. Ai and Norton (2003) who use only one interaction term, cannot be used in our estimation. Our dummy variables for women and African Americans are

on a patent team are calculated and presented in Figures 15A and 15B. Gaps between women and men and African American and other races in most technological categories are evident. For example, predicted probabilities of assigning patents to firms for women and African Americans are lower than their counterparts by 0.11 and 0.08 in the field of mechanical invention.

The difference between technological categories is considered in Tables 10A and 10B. Pooled data between 1976 and 2006 are separated into six technological categories. From results in Table 10A, the gender gap in commercialization is large in the mechanical and miscellaneous categories. For mechanical patents, having team members who are women reduces the probability of assigning patents to firms by 0.18. The gap between African Americans and other races is also large in the computer, electrical, mechanical, and miscellaneous categories. The results for COMPUSTAT firms are presented in Tables 11A, 11B, 12A, and 12B. Having a female or African American inventor renders ambiguous results for the entire period, but this result varies by subperiod for women. We would expect significantly higher rates of assignment to COMPUSTAT firms in four of six categories if a woman inventor participates on the patent team. We would expect significantly lower assignment rates if an African American inventor participates in a mechanical or miscellaneous invention. Fewer patents assigned to the most valuable firms are anticipated when the size of a female inventor's patent team increases. More COMPUSTAT patents are expected when women and African American inventors receive citations for their drug and miscellaneous patents.

C. The Inventor's Post-Invention Decisions

In the probit models, the inventor's decision is whether or not to assign a patent to a firm or a publicly-listed firm. In fact, the inventor's decision is broader and not taken in isolation. She must decide among firms, government agencies, universities, and individuals as potential assignees. To capture this decision more completely, we estimate the following

interacted with several variables, such as number of team members and number of forward citations.

multinomial logit regression:

$$
\begin{aligned}
\ln\left(\frac{P_k}{P_n}\right) &= \alpha_{kn} + \beta_{kn,1}W_i + \beta_{kn,2}AA_i + \beta_{kn,3}TEAM_i + \beta_{kn,4}CITATION_i \\
&+ \beta_{kn,5}W_i \times TEAM_i + \beta_{kn,6}AA_i \times TEAM_i + \beta_{kn,7}W_i \times CITATION_i \\
&+ \beta_{kn,8}AA_i \times CITATION_i + \sum_{j=1}^{5} \beta_{kn,9,j}TECH_i^j \\
&+ \sum_{j=1}^{5} \beta_{kn,10,j}W_i \times TECH_i^j + \sum_{j=1}^{5} \beta_{kn,11,j}AA_i \times TECH_i^j + \epsilon_{kn,i}, \\
& k = F, G, U,
\end{aligned}
\tag{5}
$$

where P_f, P_g, P_u, and P_n are the probabilities of assigning a patent to firm, government, university, and individual. The model in Equation (5) is estimated using both data on assignment to firms and on assignment to COMPUSTAT firms. Results are reported in Table 13A and 13B. Holding other variables constant, the probability of assigning to a COMPUSTAT firm (a non-listed firm) is lower for women's patents than for men's patents by 0.01 (0.1). For African Americans, the probability of assigning to a non-listed firm is lower than for U.S. inventors by 0.06. Among women, we expect more patents assigned to universities in all specifications. Moreover, women and African Americans are more likely to assign their patents to government entities than their counterparts. This may be due to a number of factors, such as greater employment and contracting opportunities, relatively more penalties for discrimination, and preference for working in the government sector. However, our data will not allow us to rule out any of these alternative explanations.

6 Conclusion and Future Research

Using unique data on women and African American inventors, we find that commercialization behavior among women and African American inventors is closer to that of U.S. inventors than previously thought. This evidence emerges despite significantly lower patent activity among women and African Americans. A common feature of the two groups is that increases in advanced engineering degrees predict increases in commercialization. In contrast, for all U.S. inventors, greater investment in life-science doctorates is correlated with greater commercialization activity. Increasing citations received or the number of participants on a patent team is not systematically associated with better commercial outcomes for African Americans and women, as it is for the broader population of inventors. We find that expected assignment rates are higher for women and African Americans when the assignee is a government entity. Finally, the evidence indicates that mixed-gender patent teams are better at commercialization than all-male and all-female teams. Our findings partly result from enhancing identification of women and African American patentees and taking advantage of more recently available data. These results are all the more striking, given our conservative strategy of identifying female and African American inventors.

Indeed, this research may raise more questions than it answers. The evidence is suggestive that experience in organized and sustained groups dedicated to scientific discovery, as in engineering programs, may provide a critical link to invention-related commercial activity. Future work may focus on further explorations of these mechanisms; racial and gender differences by innovative field, especially scientific and commercial spillovers for women and African American inventors; and examination of additional commercialization activities.

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Data Appendix

Data Sources

Data on utility patents between 1963 and 2006 come from the NBER patent database, Hall, Jaffe, and Trajtenberg (2001, updated 2009) and between 2007 and 2008 come from USPTO (2009). The NBER patent database is available at `http://www.nber.org/patents`. The NBER patent database 2006 edition is extended in 2008 by matching USPTO data by assignment and technology codes to NBER files. All patents granted between 1976 and 2006 have a unique assignee number that can identify them as COMPUSTAT firms. Data on science and engineering doctorates are from NSF (2009a). Data on science and engineering master's graduates are from NSF (2009b). Data on employed science and engineering doctorates are taken from Commission on Professionals in Science and Technology (2006). Data on population by race and gender are from U.S. Census Bureau (various issues). Data on total U.S. and industrial R&D expenditure are from NSF (2007b). Total U.S. R&D expenditure data are used in Tables 3 and 4. Industrial R&D expenditure data are used in Tables 5 to 8. GDP data are from the Bureau of Economic Analysis (2009). R&D expenditure per capita is deflated by GDP deflator from the Bureau of Economic Analysis (2009). Data on high-school enrollment rates and degree-institution enrollment rates are from U.S. Department of Education (2009).

Female Name-Matching

Female-inventor patents have been identified systematically by matching first names using professional software developed by the Melissa Data Corporation.[27] Inventors with first names which are male-only or which could not be easily characterized as male or female were assumed to be male. Patent origin is determined by the residence of the first-named inventor. From 7,881,906 inventor-invention units in the USPTO inventor file between 1975 and 2008, there are 197,850 female inventor-invention units with first-named inventor residing in the U.S. If we use simple unique

[27]Other methods have been used in the literature. For example, Ashcraft and Breitzman (2007) identify inventor gender in their IT inventor database by scanning name, matching with Social Security Administration top 1000 boys' and girls' names, and searching websites for "not typical" American names, e.g., Sanjay.

last-, first-, and middle initial, there are 86,962 U.S. women inventors. These inventors account for 169,061 U.S. women's patents.

African American Encoding Process

From 7,881,906 inventor-invention units in the USPTO inventor file between 1975 and 2008, we generated unique last-, first-, and middle name. After dropping repeated names and foreign inventors, we obtained 1,167,019 unique U.S. inventor names. Then, 500,000 names were drawn to encode ethnic groups using software developed by Ethnic Technologies. In order to reduce inefficiency from submitting low-probability African American last names, e.g., Indian or Chinese last names, we used the probability of African Americans using a particular surname from U.S. Census Bureau (2008) as a threshold for selecting data. The surname was not drawn if the probability of African Americans using that surname is zero. Ethnic groups, including African Americans, are encoded by their first name, last name, and address. Inventor address and zip code data from the USPTO data are used in the matching process. As these data are not always available, data are collected using various online databases of addresses and zip codes, e.g., Google. From this process we obtain 1,167 African American inventors.

Overlapping Patents and Patentees

There is a small number of overlapping patents and patentees, and they are counted once in the merged series. It is not surprising that the two methodologies produce overlapping but not identical data sets. The Cook (2007a) data, which begin in 1963, capture a larger cohort of older inventors, whose names would be less distinct than those in more recent cohorts. Identifying black names, e.g., as in done in Bertrand and Mullinathan (2004) and Fryer and Levitt (2004), is more straightforward in data starting from the mid-1970's when increasing heterogeneity is observed among African American first names, which the software exploits. In addition, the approach in Cook (2007a) is more conservative, as it matches inventors, engineers, and other potential patentees who are African American to patent data rather than matching patentees to names that are potentially African American.

African American Interviews

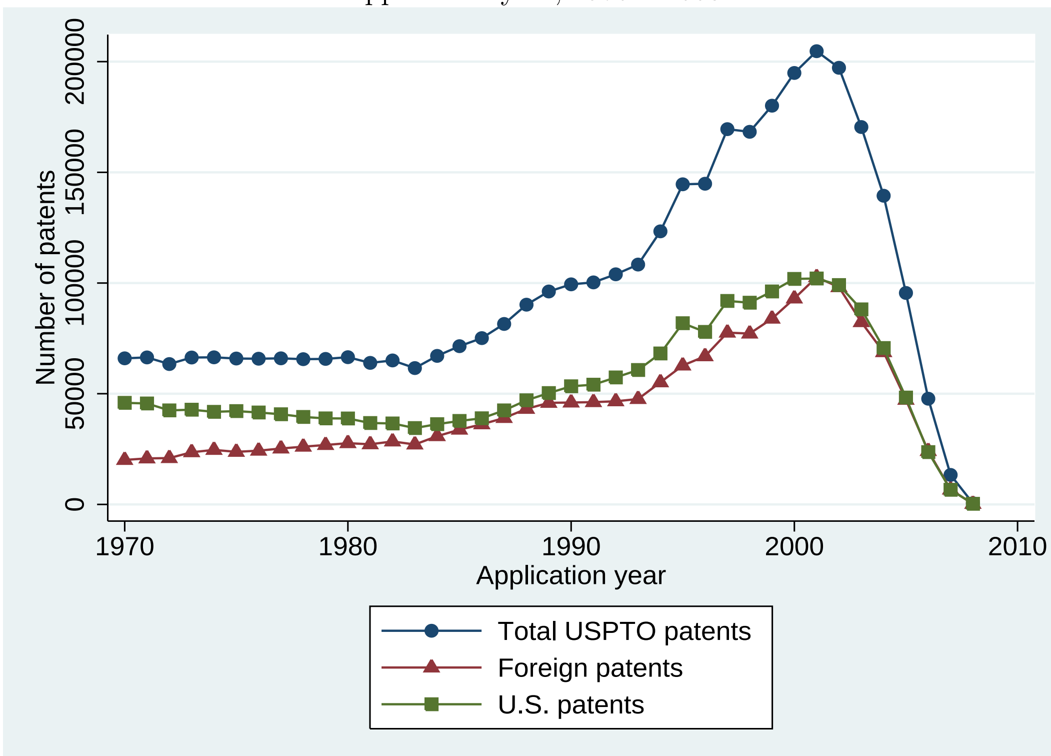
Participants were selected from the African American patent database, professional directories, conference proceedings, and industry lists, e.g., at blackenterprise.com. The sample is not random but is meant to be representative. Interviews were conducted in Stanford, CA; Oakland, CA; Atlanta, GA; Decorah, IA; Ann Arbor and East Lansing, MI; the greater Boston, MA area; and the greater Washington, DC area. Nine interviews were conducted in person, by phone, and by email between 2003 and 2009.

Distinct Inventor

A distinct inventor is defined by having same last name, first name, and middle initial. If the initial middle name is blank but the first and last names overlap with another record with the same first name, last name, and NBER subcategory, we treat them as the same inventor.[28]

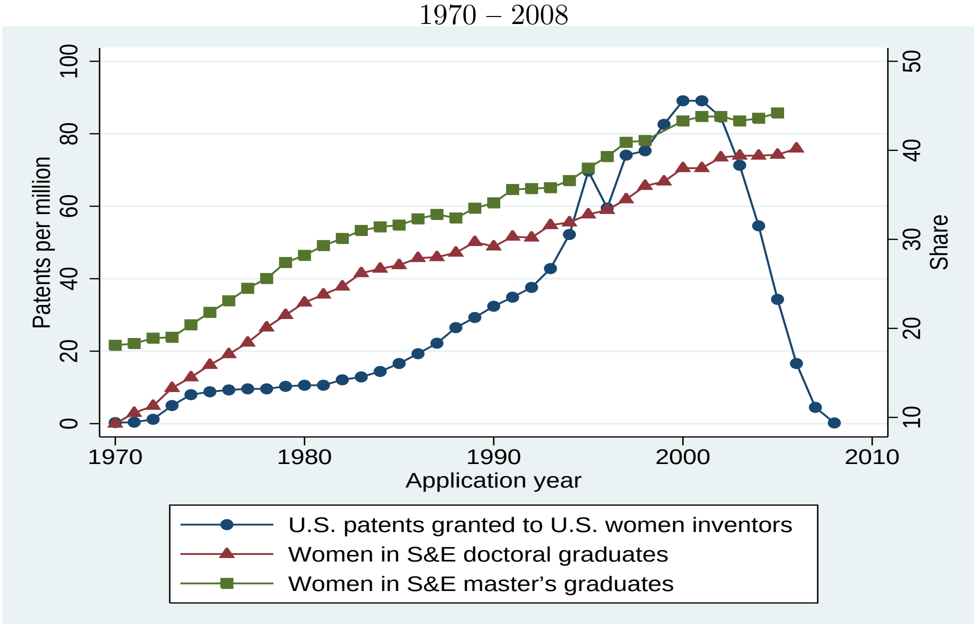
[28] This practice is consistent with that of the literature, e.g., Jones (2009) and Singh (2004). Another algorithm can be found in Trajtenberg, Shiff, and Melamed (2006).

Figure 1: Total USPTO patents, foreign patents, U.S. patents,
Application year, 1970 – 2008



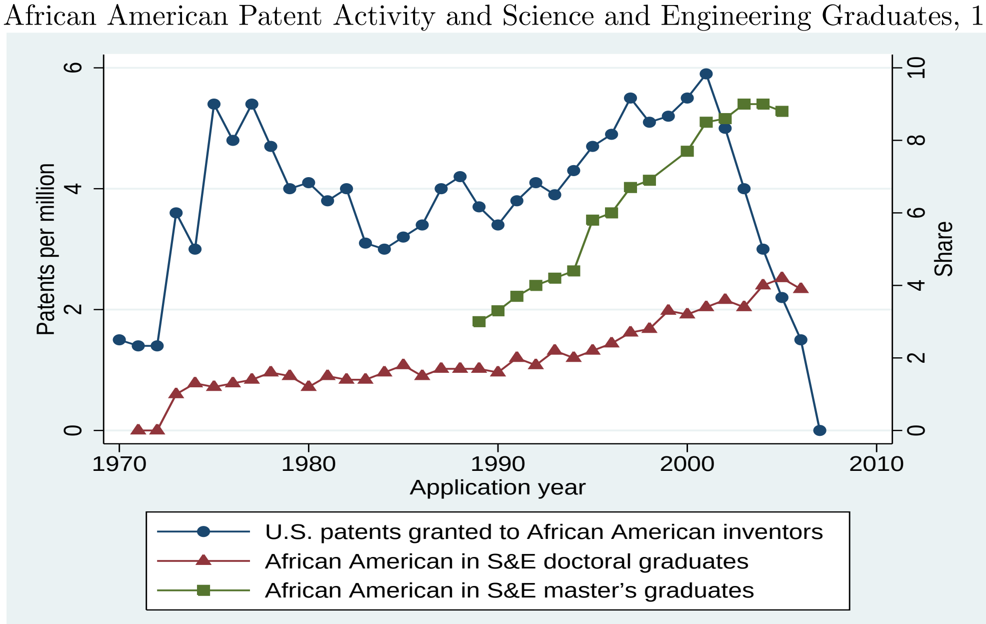
Source: Authors' calculation from Hall, et al. (2001, updated 2009) and USPTO (2009).
Note: Patent data are truncated beginning in 2002, because patents from more recent patent applications had not been granted by 2008.

Figure 2: Female Patent Activity and Science and Engineering Graduates, 1970 – 2008



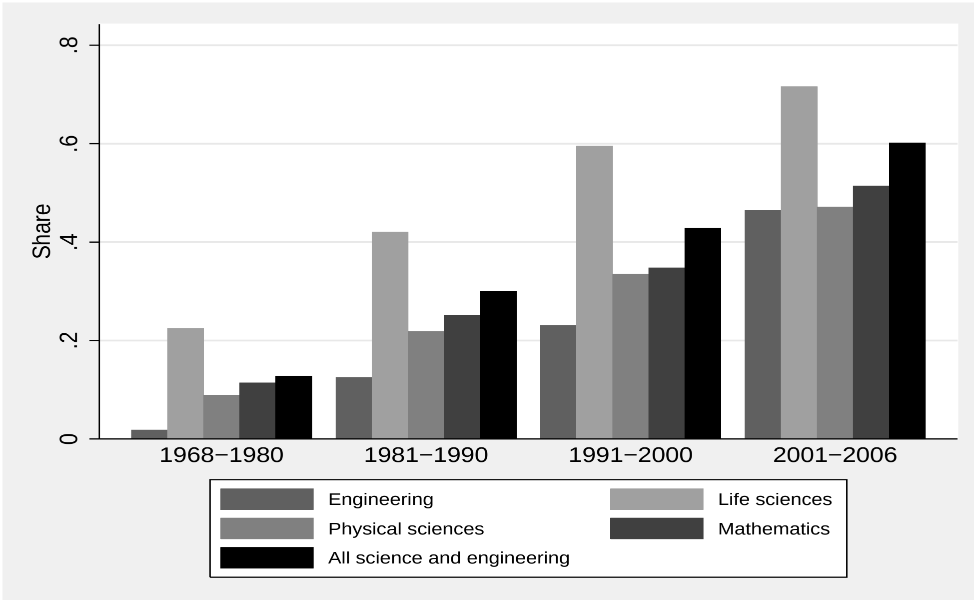
Source: Authors' calculation from USPTO (2009), NSF (2009a), NSF (2009b), and U.S. Census Bureau (Various years). Patent data are truncated beginning in 2002, because patents from more recent patent applications had not been granted by 2008.

Figure 3: African American Patent Activity and Science and Engineering Graduates, 1970 – 2008



Source: Authors' calculation from USPTO (2009), Cook (2007a), commercial encoding, NSF (2009a), NSF (2009b), and U.S. Census Bureau (Various years).
Note: African American inventor patents are sum of Cook (2007a) data and commercially encoded data (see Data Appendix). Patent data are truncated beginning in 2002, because patents from more recent patent applications had not been granted by 2008.

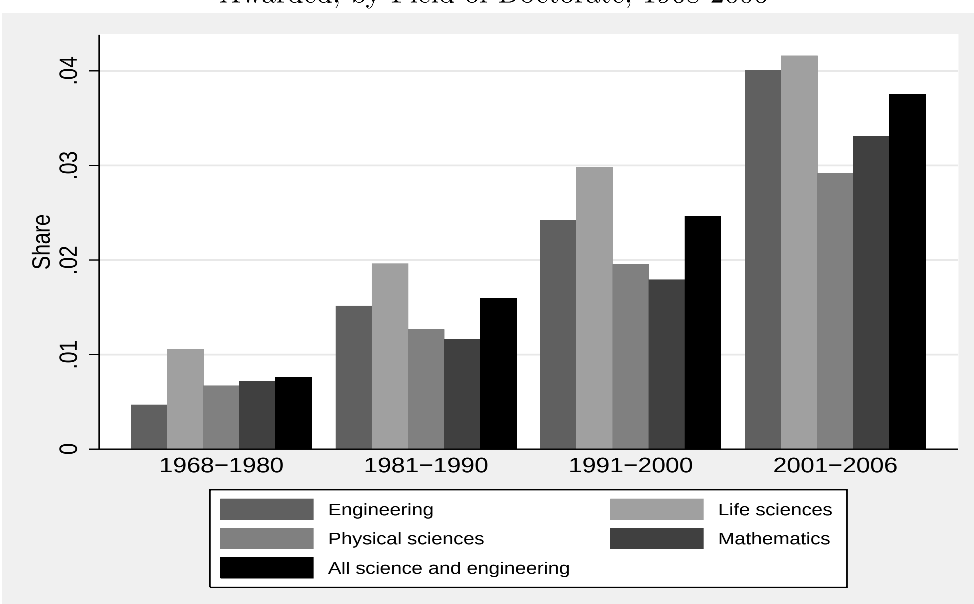
Figure 4: Share of Women in Science, Engineering, and Health Doctoral Degrees Awarded, by Field of Doctorate, 1968-2006



Source: Authors' calculation from National Science Foundation (2009a).

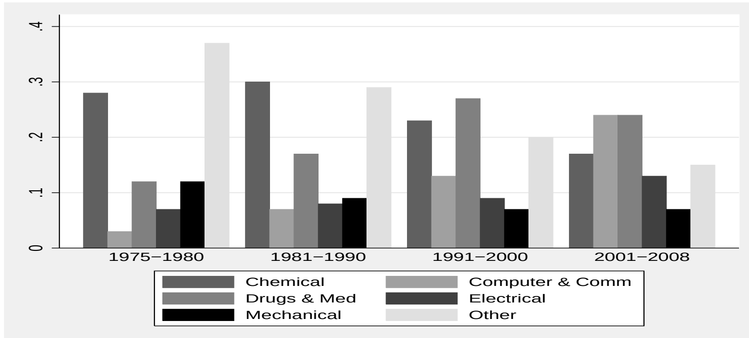
Note: All science and engineering includes engineering, geosciences, life sciences, mathematics and computer sciences and physical sciences.

Figure 5: Share of African Americans in Science, Engineering, and Health Doctoral Degrees Awarded, by Field of Doctorate, 1968-2006



Source: Authors' calculation from National Science Foundation (2009a)
Note: All science and engineering includes engineering, geosciences, life sciences, mathematics and computer sciences and physical sciences.

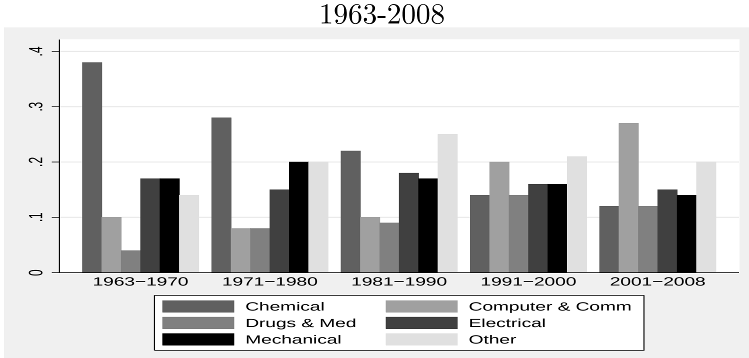
Figure 6: Distribution of Patent Grants, U.S. Women Inventors, by Technological Category, 1975-2008



Source: Authors' calculation from Hall, et al. (2001, updated 2009) and USPTO (2009).

Note: Utility patents only. Technological categories are from Hall, et al. (2001, updated 2009).

Figure 7: Distribution of Patent Grants, African American Inventors, by Technological Category, 1963-2008

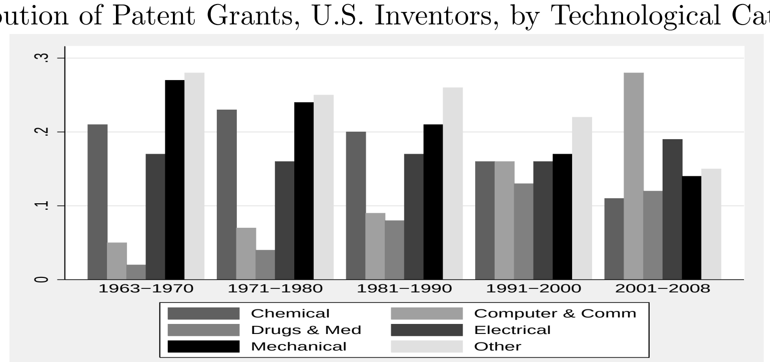


Source: Authors' calculation from Hall, et al. (2001, updated 2009), Cook (2007a), commercial encoding, and USPTO (2009).

Note: 1) African American inventor patents are sum of Cook (2007a) data and commercially encoded data (see Data Appendix).

2) Utility patents only. Technological categories are from Hall, et al. (2001, updated 2009).

Figure 8: Distribution of Patent Grants, U.S. Inventors, by Technological Category, 1963-2008



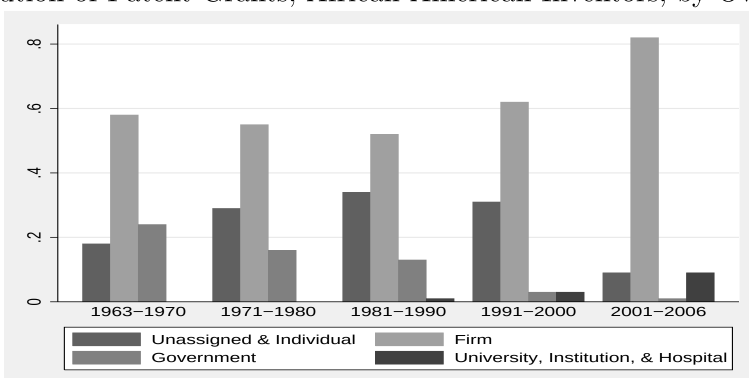
Source: Authors' calculation from Hall, et al. (2001, updated 2009) and USPTO (2009).
Note: Utility patents only. Technological categories are from Hall, et al. (2001, updated 2009).

Figure 9: Distribution of Patent Grants, U.S. Women Inventors, by Ownership, 1975-2008

Source: Authors' calculation from Hall, et al. (2001, updated 2009) and USPTO (2009).

Note: Utility patents only.

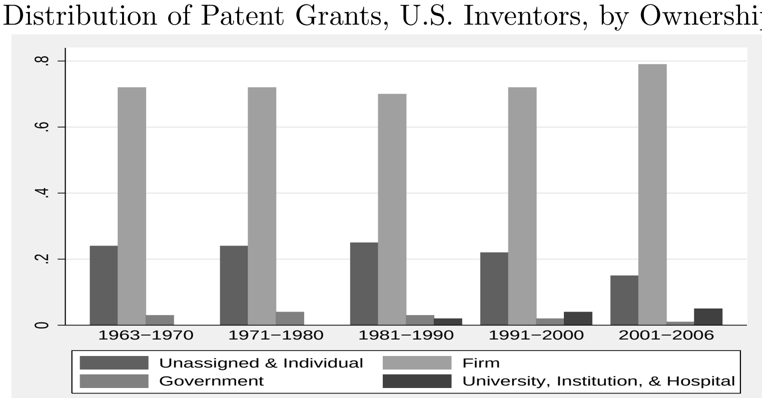
Figure 10: Distribution of Patent Grants, African American Inventors, by Ownership, 1963-2008



Source: Authors' calculation from Hall, et al. (2001, updated 2009), Cook (2007a), commercial encoding, and USPTO (2009).

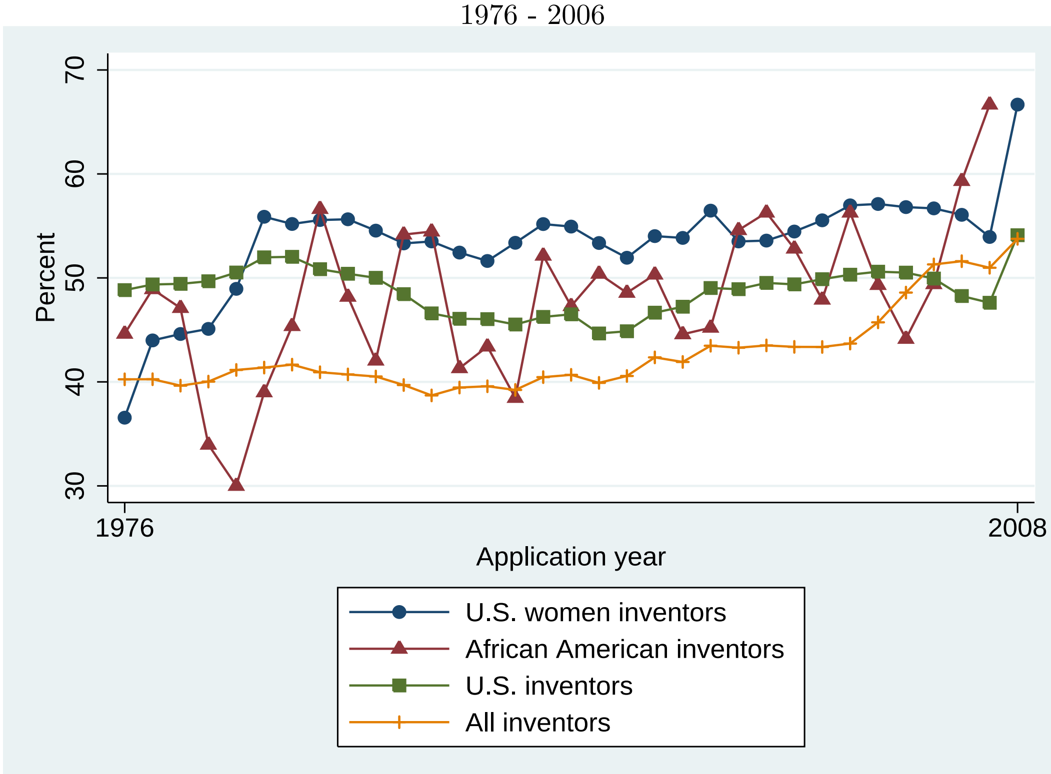
Note: Utility patents only. African American inventor patents are sum of Cook (2007a) and commercial encoding (see Data Appendix).

Figure 11: Distribution of Patent Grants, U.S. Inventors, by Ownership, 1963-2008



Source: Authors' calculation from Hall, et al. (2001, updated 2009) and USPTO (2009).
Note: Utility patents only.

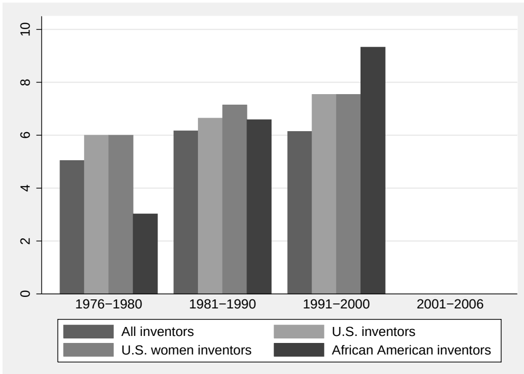
Figure 12: Utility Patents Assigned to COMPUSTAT Firms, Percent of Total Patent Grants, 1976 - 2006



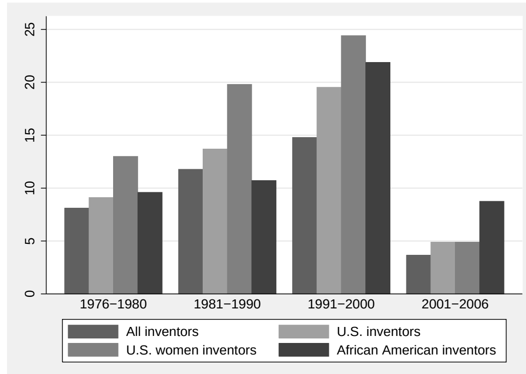
Source: Authors' calculation from Hall, et al. (2001, updated 2009), Cook (2007a), commercial encoding, and USPTO (2009).
Note: 1) African American inventor patents are sum of Cook (2007a) data and commercially encoded data (see Data Appendix).
2) Utility patents assigned to COMPUSTAT firms are patents granted between 1976 and 2006. Total patents granted are patents granted by USPTO between 1976 and 2008.

Figure 13: Median of Forward Citations, 1976 - 2006, by Grant Year

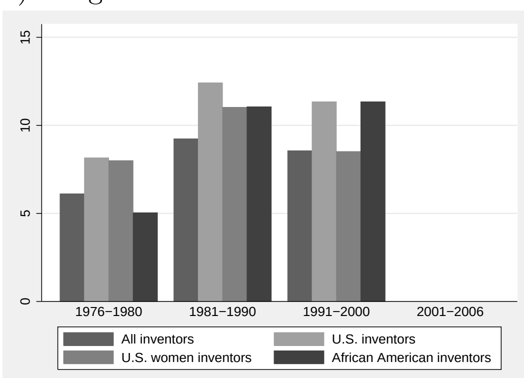
1) Chemical



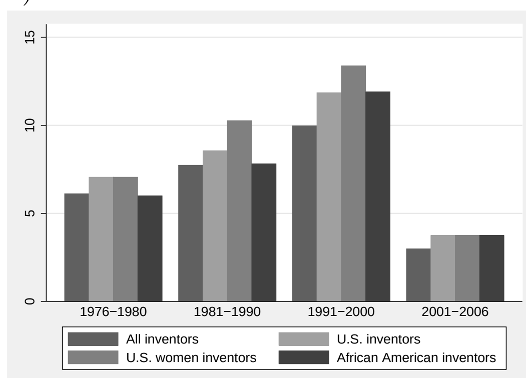
2) Computer & Comm.



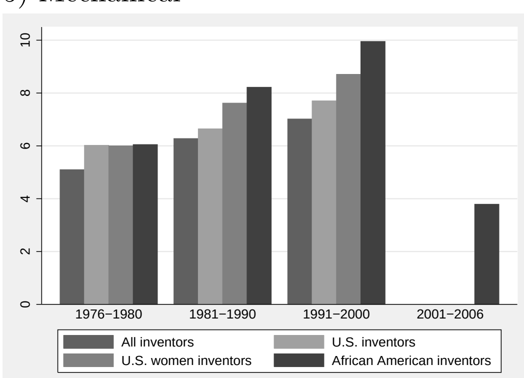
3) Drugs & medical



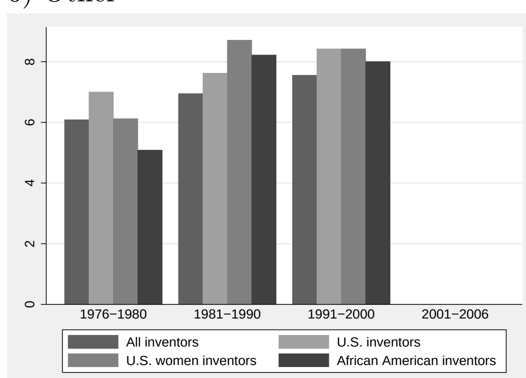
4) Electrical



5) Mechanical



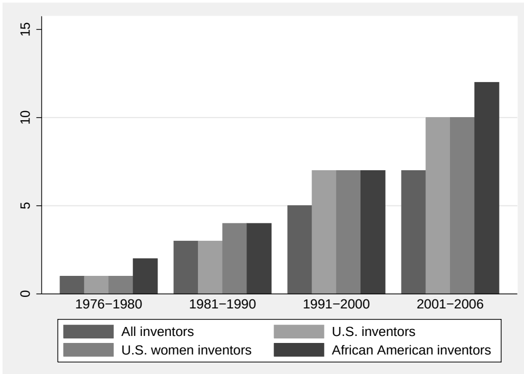
6) Other



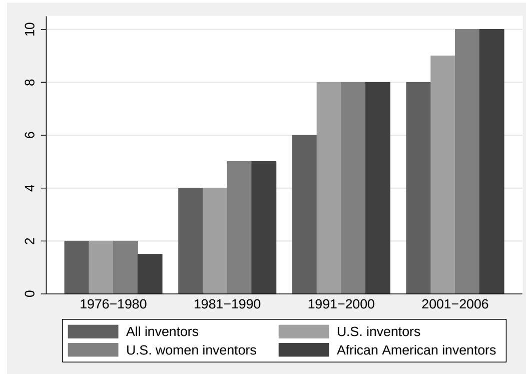
Source: Authors' calculation from Hall, et al. (2001, updated 2009), Cook (2007a), commercial encoding, and USPTO (2009).
Note: 1) African American inventor patents are sum of Cook (2007a) and commercial encoding (see Data Appendix).
2) Technological categories are from Hall, et al. (2001, updated 2009).

Figure 14: Median of Backward Citations, 1976 - 2006, by Grant Year

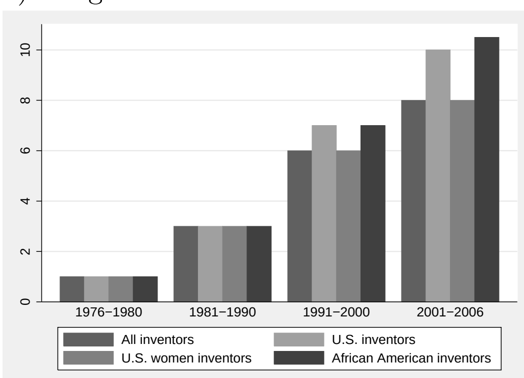
1) Chemical



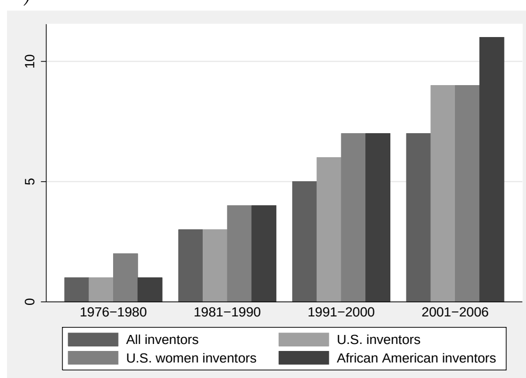
2) Computer & Comm.



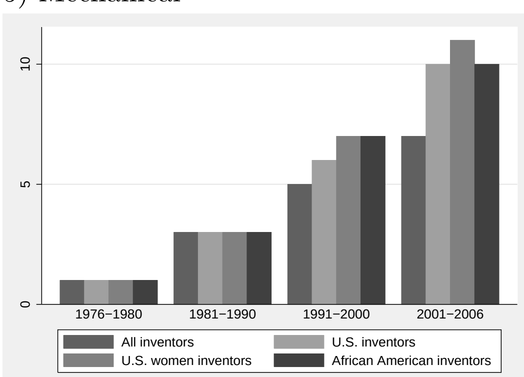
3) Drugs & medical



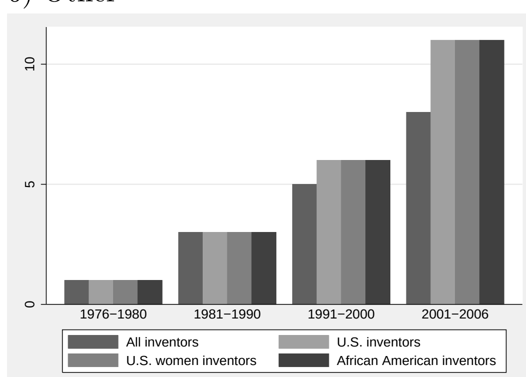
4) Electrical



5) Mechanical

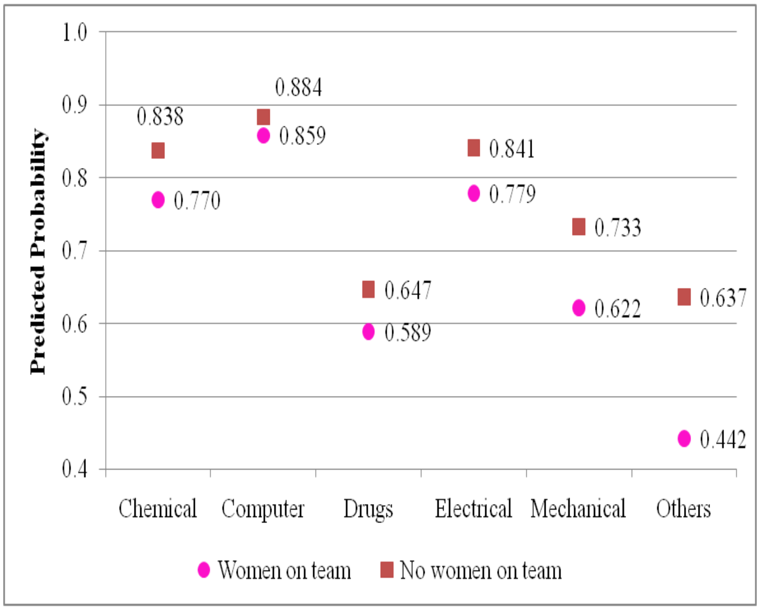


6) Other



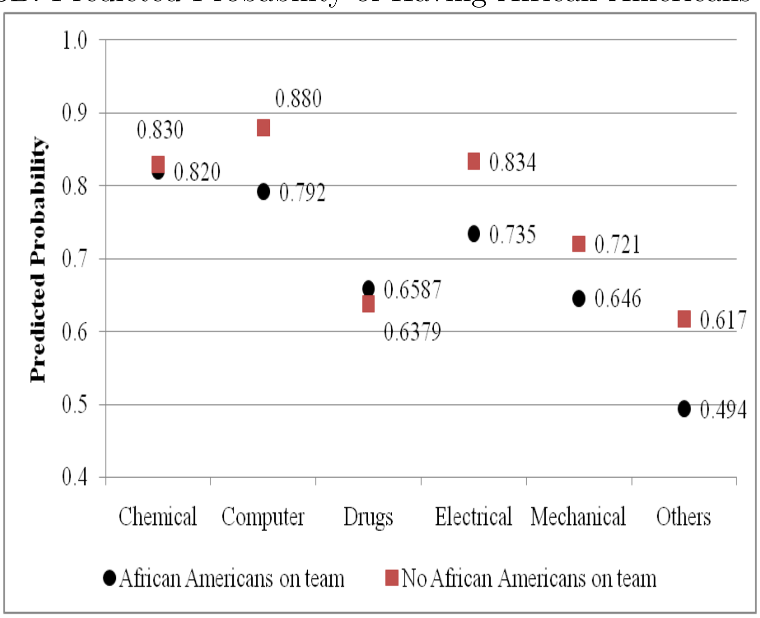
Source: Authors' calculation from Hall, et al. (2001, updated 2009), Cook (2007a), commercial encoding, and USPTO (2009).
Note: 1) African American inventor patents are sum of Cook (2007a) and commercial encoding (see Data Appendix).
2) Technological categories are from Hall, et al. (2001, updated 2009).

Figure 15A: Predicted Probability of Having Women on Team



Source: Authors' calculation from column (1) in Table 9B.

Figure 15B: Predicted Probability of Having African Americans on Team



Source: Authors' calculation from column (1) in Table 9B.

Table 1A: Patents per Inventor, 1976-2008

Inventors	Number of Patents per Inventor		Number of Patents, by Discounting		Patents per million
	Mean	Median	Mean	Median	
U.S. inventors	3.5	1.0	1.7	1.0	234.9
U.S. women inventors	2.4	1.0	1.0	0.5	40.1
African American inventors	3.5	1.0	1.9	1.0	5.9

Source: Cook and Kongcharoen (2009); USPTO; authors' calculation;
U.S. Census Bureau (Various years).
Number of patents obtained by discounting are discounted by multiple inventors (see text).
Patents per million are patents granted between 1976 and 2008, for which applications were made between 1976 and 2004.

Table 1B: Inventor/Patent Ratio, by Classification, 1976-2008

Inventors	Chemical	Computer	Drugs	Electrical	Mechanical	Other	All patents	All multiple-inventor patents
U.S. inventors	2.2	2.3	2.4	2.1	1.8	1.7	2.0	3.0
U.S. women inventors	3.6	3.8	3.8	3.5	3.1	2.4	3.4	3.9
African American inventors	2.8	3.2	3.9	2.8	2.4	2.2	2.9	3.5

Source: Authors' calculation; USPTO (2009), Cook (2007a), Cook and Kongcharoen (2009), Hall, et al. (2001)
Note: See Data Appendix for explanation of matching processes.

Table 1C: Distribution of Patents Granted, Women, African American, U.S., and All Inventors, Share, by Ownership Category and Granted Decade, 1963 - 2008

	U.S. women Inventors	African American Inventors	U.S. Inventors	All Inventors
None or Individual				
1963-1970	n.a.	0.18	0.24	0.24
1971-1980	0.40	0.28	0.24	0.22
1981-1990	0.28	0.33	0.25	0.19
1991-2000	0.19	0.26	0.22	0.16
2001-2008	0.12	0.16	0.14	0.11
1963-2008	0.17	0.25	0.21	0.17
Firm				
1963-1970	n.a.	0.58	0.72	0.73
1971-1980	0.54	0.59	0.72	0.75
1981-1990	0.65	0.57	0.70	0.77
1991-2000	0.71	0.68	0.72	0.79
2001-2008	0.79	0.77	0.80	0.85
1963-2008	0.73	0.66	0.74	0.79
Government				
1963-1970	n.a.	0.24	0.03	0.03
1971-1980	0.04	0.13	0.04	0.03
1981-1990	0.03	0.08	0.03	0.02
1991-2000	0.02	0.02	0.02	0.01
2001-2008	0.01	0.02	0.01	0.01
1963-2008	0.02	0.07	0.02	0.02
University				
1971-1980	0.02	0.00	0.00	0.01
1981-1990	0.04	0.02	0.02	0.02
1991-2000	0.08	0.05	0.04	0.03
2001-2008	0.08	0.05	0.04	0.03
1963-2008	0.07	0.03	0.03	0.02

Source: Authors' calculations from Hall et al. (2001, updated 2009), USPTO (2009), Cook (2007a), and Cook and Kongcharoen (2009).
Notes: 1) African American inventor patents are sum of Cook (2007a) data and commercially encoded data (see Data Appendix).
2) Technological categories are from Hall et al. (2001, updated 2009).
3) The "university" assignee category includes universities, foundations, research institutions, and hospitals.
4) Data for women began in 1975.

Table 1D: Patents Matched to COMPUSTAT, Share, by Application Year, 1976 - 2006

	U.S. women inventors	African American inventors	U.S. inventors	All inventors
1976-1980	0.44	0.46	0.50	0.40
1981-1990	0.54	0.49	0.49	0.40
1991-2000	0.54	0.55	0.47	0.42
2001-2006	0.56	0.59	0.50	0.47

Source: Authors' calculations from Hall et al. (2001, updated 2009), USPTO (2009), Cook (2007a), and Cook and Kongcharoen (2009).
Notes: 1) African American inventor patents are sum of Cook (2007a) data and commercially encoded data (see Appendix).
2) Patents per million are patents granted between 1976 and 2008, for which applications were made between 1976 and 2006.

Table 2: Baseline Statistics

	U.S. Inventors	U.S. Women Inventors	African American Inventors (1)	African American Inventors (2)	African American Inventors (3)	African American Inventors (4)
Patents per million,	234.9	40.1	1.6	2.76	4.2	5.9
by application year	(74.6)	(28.6)	(0.5)	(1.0)	(0.8)	(2.0)
Percentage of patents assigned	73.1	68.8	61.3	67.9	65.3	68.9
to firms, by application year	(4.4)	(8.3)	(13.8)	(7.5)	(8.9)	(9.6)
Percentage of patents assigned	48.6	52.7	45.3	47.9	47.2	51.3
to COMPUSTAT firms,	(2.1)	(4.7)	(12.6)	(7.3)	(6.6)	(6.6)
by application year						
R & D expenditure	719.4	719.4	703.4	703.4	703.4	703.4
per capita, deflated	(159.1)	(159.1)	(153.1)	(153.1)	(153.1)	(153.1)
Industrial R & D expenditure	406.9	406.9	393.4	393.4	393.4	393.4
per capita, deflated	(140.1)	(140.1)	(135.7)	(135.7)	(135.7)	(135.7)
Employed S&E	1727.8	624.9	255.4	263.2	263.2	263.2
doctorates per million	(237.5)	(268.1)	(100.8)	(107.1)	(107.1)	(107.1)
S&E doctorates,	38.0	30.7	7.3	7.6	7.6	7.6
graduates per million	(3.4)	(11.5)	(2.4)	(2.6)	(2.6)	(2.6)
S&E doctorates, graduates	8.8	3.3	1.4	1.5	1.5	1.5
per million, engineering	(2.0)	(2.2)	(0.8)	(0.8)	(0.8)	(0.8)
S&E doctorates, graduates	20.3	19.7	4.0	4.2	4.2	4.2
per million, life sciences	(1.3)	(6.6)	(1.2)	(1.4)	(1.4)	(1.4)
S&E doctorates, graduates	9.0	4.6	1.2	1.2	1.2	1.2
per million, physical sciences	(1.2)	(1.5)	(0.4)	(0.4)	(0.4)	(0.4)
Master's, graduates	90.7	25.1	14.5	15.1	15.1	15.1
per million, engineering	(13.1)	(12.3)	(4.2)	(4.6)	(4.6)	(4.6)
N	27	27	25	27	27	27

Sources: USPTO, Cook (2007a); see Appendix.
Notes: 1) African American Inventors samples: (1) is from Cook (2007a); (2) is from commercial encoding; (3) is samples (1) and (2) merged, excluding common patents; and (4) is sample (3) with African-origin names.
2) S&E fields include engineering, geosciences, life sciences, mathematics and physical sciences.
3) The Survey of Doctorate Recipients is a biennial survey, and missing data are linear interpolated.
4) Standard deviations appear in parentheses below the mean.
5) Data for U.S., U.S. women, African American (2), (3), and (4) inventors are patents granted between 1976 and 2008, for which applications were made between 1976 and 2004. Data for African American (1) inventors are patents granted between 1976-2008, for which applications were made between 1976 and 2002.

Table 3: Time-Series Estimation

Dependent Variable: Log of Patents per Million

	OLS				2SLS			
	U.S. Inventors	U.S. Women Inventors	U.S. Women Inventors (discounting)	African American Inventors	U.S. Inventors	U.S. Women Inventors	U.S. Women Inventors (discounting)	African American Inventors
R&D expenditure	-0.260	0.330	0.340	1.915***	-0.202	0.252	0.453	0.757
per capita, lagged, deflated	(0.661)	(1.225)	(1.152)	(0.725)	(0.835)	(1.554)	(1.375)	(1.762)
Employed S&E	0.480	-0.799	-0.352	-1.494	0.270	-0.209	0.204	-1.402
doctorates per million	(0.948)	(1.648)	(1.597)	(1.127)	(0.869)	(0.967)	(0.987)	(1.268)
Engineering Ph.D.'s	0.742***	0.064	-0.528	-0.084	0.709***	0.142	0.103	-0.086
granted, per million	(0.244)	(0.192)	(0.604)	(0.071)	(0.248)	(0.247)	(0.229)	(0.074)
Life sciences Ph.D.'s	-0.004	0.441	0.032	0.384	-0.183	0.192	0.223	0.453
granted, per million	(0.495)	(0.653)	(0.175)	(0.318)	(0.542)	(0.570)	(0.545)	(0.325)
Physical science Ph.D.'s	-0.469	-0.277	0.427	0.046	-0.546	-0.505	-0.440	0.030
granted, per million	(0.523)	(0.499)	(0.621)	(0.094)	(0.597)	(0.593)	(0.530)	(0.107)
Engineering Master's	-0.705	-0.451	-0.219	0.177	-0.657	-0.385	-0.455	-0.068
granted, per million	(0.647)	(0.626)	(0.439)	(0.546)	(0.682)	(0.619)	(0.600)	(0.673)
Constant	0.031	0.283	0.233	0.024	0.048	0.282	0.222	0.086
	(0.055)	(0.203)	(0.193)	(0.180)	(0.069)	(0.176)	(0.161)	(0.209)
Time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dummies for patent reform	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	27.846	16.317	13.713	3.700	32.057	19.374	15.030	3.553
N	26	26	26	26	26	26	26	26

Notes: 1) Patent data are patents granted between 1976 and 2008, for which applications were made between 1976 and 2004.
2) U.S. women inventor (discounting) data are discounted by multiple inventors (see text).
3) The African American sample is sum of Cook (2007a) and commercial encoding.
4) Ph.D.'s granted are separated into fields: engineering, life sciences, and physical sciences.
5) Log of patents per million data are by application year and are first-differenced in estimation.
6) Log of R&D expenditure per capita, deflated, Employed S&E Doctorates, Ph.D.'s granted, and Master's in engineering are first-differenced and lagged one year in estimation.
7) Industrial R&D expenditure per capita is deflated by GDP deflator from the Bureau of Economic Analysis (2009).
8) Models are estimated as OLS and 2SLS models. Instruments for R& D spending in the IV regressions are lag of log GDP per capita, high-school enrollment rates, and degree-institution enrollment rates.
9) A time trend is included in each model.
10) Newey-West robust standard errors for heteroskedasticity and autocorrelation are in parentheses.
11) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 4: Time-Series Estimation

Dependent Variable: Log of Difference in Patents per Million

	OLS		2SLS	
	U.S. Women Inventors	African American Inventors	U.S. Women Inventors	African American Inventors
R&D expenditure	0.054	-0.124	0.255	-0.317
per capita, lagged, deflated	(0.754)	(0.465)	(1.043)	(0.566)
Employed S&E	-0.680	-1.380**	-0.526	-1.444**
doctorates per million	(1.203)	(0.640)	(0.849)	(0.632)
Engineering Ph.D.'s	0.073	0.036	0.103	0.038
granted, per million	(0.120)	(0.040)	(0.149)	(0.043)
Life sciences Ph.D.'s	0.219	0.074	0.150	0.074
granted, per million	(0.428)	(0.195)	(0.408)	(0.188)
Physical science Ph.D.'s	-0.277	0.072	-0.377	0.069
granted, per million	(0.307)	(0.063)	(0.382)	(0.058)
Engineering Master's	-0.540	-0.335	-0.492	-0.356
granted, per million	(0.461)	(0.286)	(0.451)	(0.292)
Constant	0.169	0.187**	0.163	0.197**
	(0.156)	(0.094)	(0.145)	(0.093)
Time trend	Yes	Yes	Yes	Yes
Dummies for patent reform	Yes	Yes	Yes	Yes
F	11.605	43.850	13.856	45.338
N	26	26	26	26

Notes: 1) Patent data are patents granted between 1976 and 2008, for which applications were made between 1976 and 2004.
2) The African American sample is sum of Cook (2007a) and commercial encoding.
3) Ph.D.'s granted are separated into fields: engineering, life sciences, and physical sciences.
4) Log of difference in patents per million = log (U.S. inventors patents per million - each group's patents per million). Data are by application year and first-differenced.
5) Log of R&D expenditure per capita, deflated, Employed S&E Doctorates, Ph.D.'s granted, and Master's in engineering are first-differenced and lagged one year in estimation.
6) Industrial R&D expenditure per capita is deflated by GDP deflator from the Bureau of Economic Analysis (2009).
7) Models are estimated as OLS and 2SLS models. Instruments for R& D spending in the IV regressions are lag of log GDP per capita, high-school enrollment rates, and degree-institution enrollment rates.
8) A time trend is included in each model.
9) Newey-West robust standard errors for heteroskedasticity and autocorrelation are in parentheses.
10) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 5: Time-Series Estimation

Dependent variable: Log of Percentage of Patents Assigned to Firms

	OLS			2SLS		
	U.S. Inventors Patents	U.S. Women Patents	African American Patents	U.S. Inventor Patents	U.S. Women Patents	African American Patents
Industrial R&D expenditure	0.065**	0.137	1.146***	-0.051	-0.068	-0.026
per capita, lagged, deflated	(0.031)	(0.164)	(0.420)	(0.094)	(0.197)	(1.119)
Employed S&E	-0.060	-0.190	0.964	-0.009	-0.059	0.876
doctorates per million	(0.099)	(0.274)	(0.860)	(0.108)	(0.312)	(1.042)
Engineering Ph.D.'s	-0.047	0.147*	0.032	-0.030	0.163*	0.033
granted, per million	(0.031)	(0.083)	(0.072)	(0.036)	(0.093)	(0.108)
Life sciences Ph.D.'s	0.182**	0.120	-0.504*	0.218**	0.095	-0.419
granted, per million	(0.081)	(0.171)	(0.262)	(0.087)	(0.150)	(0.284)
Physical science Ph.D.'s	-0.008	-0.151**	0.191**	-0.019	-0.182**	0.166**
granted, per million	(0.059)	(0.065)	(0.078)	(0.065)	(0.079)	(0.084)
Engineering Master's	-0.055	0.181	0.951**	-0.091*	0.148	0.510
granted, per million	(0.047)	(0.152)	(0.379)	(0.048)	(0.162)	(0.457)
Constant	-0.005	-0.029	-0.132	-0.001	-0.018	-0.034
	(0.006)	(0.037)	(0.109)	(0.009)	(0.041)	(0.133)
Time trend	Yes	Yes	Yes	Yes	Yes	Yes
Dummies for patent reform	Yes	Yes	Yes	Yes	Yes	Yes
F	33.063	5.385	8.086	48.961	4.516	1.576
N	26	26	26	26	26	26

Notes: 1) Patent data are patents granted between 1976 and 2008, for which applications were made between 1976 and 2004.
2) The African American sample is sum of Cook (2007a) and commercial encoding.
3) Ph.D.'s granted are separated into fields: engineering, life sciences, and physical sciences.
4) Log of percentage of patents assigned data are by application year and are first-differenced in estimation.
5) Log of industrial R&D expenditure per capita, deflated, Employed S&E Doctorates, Ph.D.'s granted, and Master's in engineering are first-differenced and lagged one year in estimation.
6) Industrial R&D expenditure per capita is deflated by GDP deflator from the Bureau of Economic Analysis (2009).
7) Models are estimated as OLS and 2SLS models. Instruments for R&D spending in the IV regressions are lag of log GDP per capita, high-school enrollment rates, and degree-institution enrollment rates.
8) A time trend is included in each model.
9) Newey-West robust standard errors for heteroskedasticity and autocorrelation are in parentheses.
10) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 6: Time-Series Estimation

Dependent variable: Log of Percentage of Patents Assigned to COMPUSTAT Firms

	OLS			2SLS		
	U.S. Inventors	U.S. Women Inventors	African American Inventors	U.S. Inventors	U.S. Women Inventors	African American Inventors
Industrial R&D expenditure	0.013	0.110	0.737	-0.007	0.015	-0.377
per capita, lagged, deflated	(0.061)	(0.201)	(0.567)	(0.190)	(0.302)	(1.124)
Employed S&E	-0.208	-0.661	1.054	-0.204	-0.556	0.829
doctorates per million	(0.183)	(0.437)	(1.327)	(0.179)	(0.431)	(1.205)
Engineering Ph.D.'s	-0.048	0.136	0.141**	-0.039	0.153	0.151*
granted, per million	(0.063)	(0.108)	(0.066)	(0.076)	(0.114)	(0.088)
Life sciences Ph.D.'s	0.299**	0.179	-0.821***	0.330**	0.157	-0.750***
granted, per million	(0.135)	(0.200)	(0.277)	(0.168)	(0.181)	(0.282)
Physical science Ph.D.'s	-0.117	-0.190*	0.135	-0.113	-0.236**	0.109
granted, per million	(0.133)	(0.102)	(0.105)	(0.143)	(0.115)	(0.088)
Engineering Master's	-0.094	0.229	1.131**	-0.098	0.222	0.781*
granted, per million	(0.076)	(0.168)	(0.468)	(0.075)	(0.194)	(0.460)
Constant	-0.005	0.006	-0.081	-0.007	0.011	0.016
	(0.011)	(0.048)	(0.128)	(0.015)	(0.051)	(0.140)
Time trend	Yes	Yes	Yes	Yes	Yes	Yes
Dummies for patent reform	Yes	Yes	Yes	Yes	Yes	Yes
F	26.603	8.006	10.057	43.706	8.158	8.455
N	27	27	26	26	26	26

Notes: 1) Patent data are patents granted between 1976 and 2008, for which applications were made between 1976 and 2004.
2) The African American sample is sum of Cook (2007a) and commercial encoding.
3) Ph.D.'s granted are separated into fields: engineering, life sciences, and physical sciences.
4) Log of percentage of patents assigned to COMPUSTAT firms data are by application year and are first-differenced in estimation.
5) Log of industrial R&D expenditure per capita, deflated, Employed S&E Doctorates, Ph.D.'s granted, and Master's in engineering are first-differenced and lagged one year in estimation.
6) Industrial R&D expenditure per capita is deflated by GDP deflator from the Bureau of Economic Analysis (2009).
7) Models are estimated as OLS and 2SLS models. Instruments for R&D spending in the IV regressions are lag of log GDP per capita, high-school enrollment rates, and degree-institution enrollment rates.
8) A time trend is included in each model.
9) Newey-West robust standard errors for heteroskedasticity and autocorrelation are in parentheses.
10) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 7: Time-Series Estimation

Dependent Variable: Difference in Percentage of Patents Assigned to Firms

	OLS		2SLS	
	U.S. Women Inventors	African American Inventors	U.S. Women Inventors	African American Inventors
Industrial R&D expenditure	-2.150	-69.930**	1.021	-8.674
per capita, lagged, deflated	(7.630)	(28.815)	(10.751)	(72.376)
Employed S&E	7.059	-42.683	3.281	-42.180
doctorates per million	(10.447)	(51.398)	(11.436)	(65.498)
Engineering Ph.D.'s	-7.619*	-2.303	-8.297*	-2.103
granted, per million	(4.317)	(4.764)	(4.576)	(6.959)
Life sciences Ph.D.'s	-0.759	34.156**	0.950	29.464*
granted, per million	(8.589)	(16.519)	(7.615)	(17.571)
Physical science Ph.D.'s	3.257	-11.933***	4.929	-10.703**
granted, per million	(3.733)	(4.611)	(4.278)	(5.060)
Engineering Master's	-7.283	-61.965**	-7.254	-36.947
granted, per million	(7.901)	(24.215)	(8.510)	(28.335)
Constant	0.658	6.225	0.412	1.171
	(1.732)	(6.666)	(1.760)	(8.415)
Time trend	Yes	Yes	Yes	Yes
Dummies for patent reform	Yes	Yes	Yes	Yes
F	1.535	6.657	1.178	1.992
N	26	26	26	26

Notes: 1) Patent data are patents granted between 1976 and 2008, for which applications were made between 1976 and 2004.
2) The African American sample is sum of Cook (2007a) and commercial encoding.
3) Ph.D.'s granted are separated into fields: engineering, life sciences, and physical sciences.
4) Difference in percentage of patents assigned to firms = percentage of U.S. inventors' patents assigned to firms - percentage of each group's patents assigned to firms. Data are by application year and first-differenced.
5) Log of industrial R&D expenditure per capita, deflated, Employed S&E Doctorates, Ph.D.'s granted, and Master's in engineering are first-differenced and lagged one year in estimation.
6) Industrial R&D expenditure per capita is deflated by GDP deflator from the Bureau of Economic Analysis (2009).
7) Models are estimated as OLS and 2SLS models. Instruments for R&D spending in the IV regressions are lag of log GDP per capita, high-school enrollment rates, and degree-institution enrollment rates.
8) A time trend is included in each model.
9) Newey-West robust standard errors for heteroskedasticity and autocorrelation are in parentheses.
10) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 8: Time-Series Estimation

Dependent Variable: Difference in Percentage of Patents Assigned to COMPUSTAT Firms

	OLS		2SLS	
	U.S. Women Inventors	African American Inventors	U.S. Women Inventors	African American Inventors
Industrial R&D expenditure	-1.591	-32.712	3.540	10.807
per capita, lagged, deflated	(8.257)	(31.226)	(12.569)	(58.247)
Employed S&E	20.577	-34.757	15.779	-27.516
doctorates per million	(21.322)	(62.964)	(20.834)	(58.604)
Engineering Ph.D.'s	-5.281	-7.418**	-6.088	-7.710*
granted, per million	(4.560)	(3.447)	(4.549)	(4.483)
Life sciences Ph.D.'s	-0.175	42.313***	2.514	39.444***
granted, per million	(9.020)	(13.957)	(7.966)	(13.788)
Physical science Ph.D.'s	0.076	-6.140	1.849	-5.128
granted, per million	(5.581)	(5.848)	(5.827)	(5.015)
Engineering Master's	-5.649	-56.455**	-5.401	-42.015*
granted, per million	(7.598)	(24.661)	(8.610)	(22.433)
Constant	-1.160	1.417	-1.577	-2.324
	(2.251)	(6.204)	(2.383)	(7.039)
Time trend	Yes	Yes	Yes	Yes
Dummies for patent reform	Yes	Yes	Yes	Yes
F	2.871	10.991	1.429	7.431
N	27	26	26	26

Notes: 1) Patent data are patents granted between 1976 and 2008, for which applications were made between 1976 and 2004.
2) The African American sample is sum of Cook (2007a) and commercial encoding.
3) Ph.D.'s granted are separated into fields: engineering, life sciences, and physical sciences.
4) Difference in percentage of patents assigned to firms = percentage of U.S. inventors' patents assigned to firms - percentage of each group's patents assigned to firms. Data are by application year and first-differenced.
5) Log of industrial R&D expenditure per capita, deflated, Employed S&E Doctorates, Ph.D.'s granted, and Master's in engineering are first-differenced and lagged one year in estimation.
6) Industrial R&D expenditure per capita is deflated by GDP deflator from the Bureau of Economic Analysis (2009).
7) Models are estimated as OLS and 2SLS models. Instruments for R&D spending in the IV regressions are lag of log GDP per capita, high-school enrollment rates, and degree-institution enrollment rates.
8) A time trend is included in each model.
9) Newey-West robust standard errors for heteroskedasticity and autocorrelation are in parentheses.
10) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 9A: Probit Estimation

Dependent Variable: Dummy of Assignment to a Firm

Explanatory Variables	(1)	(2)	(3)
Female inventor	-0.1107***	-0.2160***	-0.0786***
	(0.0030)	(0.0109)	(0.0040)
African American inventor	-0.0676***	-0.0919*	-0.0061
	(0.0167)	(0.0446)	(0.0227)
Number of inventors in team	0.0833***	0.1094***	0.0610***
	(0.0009)	(0.0047)	(0.0010)
Citations received	0.0011***	0.0011***	0.0012***
	(0.0000)	(0.0001)	(0.0001)
Chemical	0.1597***	0.2145***	0.0914***
	(0.0018)	(0.0038)	(0.0028)
Computer	0.2119***	0.1628***	0.1967***
	(0.0017)	(0.0044)	(0.0026)
Drugs	0.0232***	0.0595***	0.0233***
	(0.0031)	(0.0072)	(0.0041)
Electrical	0.1714***	0.1541***	0.1512***
	(0.0017)	(0.0036)	(0.0025)
Mechanical	0.0763***	0.0773***	0.0672***
	(0.0017)	(0.0035)	(0.0027)
Grant Year dummy	Yes	Yes	Yes
State dummy	Yes	Yes	Yes
Pseudo R^2	0.1393	0.1318	0.1526
N	1,747,848	193,236	421,327

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006 for column (1), between 1976 and 1980 for column (2), and between 2001 and 2005 for column (3).
2) All models are estimated as probit models.
3) Coefficients in each columns are marginal effects (discrete change). Robust standard errors of marginal effects are clustered on the identity of the prolific inventor and are in parentheses.
4) The omitted technology category is Other.
5) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 9B: Probit Estimation

Dependent Variable: Dummy of Assignment to a Firm

Explanatory Variables	(1)	(2)	(3)
Female inventor	-0.1047***	-0.2787***	-0.0530***
	(0.0060)	(0.0255)	(0.0082)
African American	-0.0622	-0.0226	0.0507
inventor	(0.0366)	(0.0664)	(0.0435)
Number of inventors in team	0.0890***	0.1102***	0.0662***
	(0.0010)	(0.0048)	(0.0012)
Citations received	0.0010***	0.0011***	0.0011***
	(0.0000)	(0.0001)	(0.0001)
Female x Team	-0.0307***	-0.0157	-0.0213***
	(0.0018)	(0.0102)	(0.0020)
Female x Citation received	0.0005***	0.0001	0.0003
	(0.0001)	(0.0006)	(0.0002)
African American x Team	-0.0138	-0.0662*	-0.0063
	(0.0095)	(0.0272)	(0.0100)
African American x Citations	0.0011*	-0.0026	0.0004
received	(0.0005)	(0.0020)	(0.0010)
Chemical	0.1555***	0.2102***	0.0884***
	(0.0019)	(0.0039)	(0.0030)
Computer	0.2072***	0.1610***	0.1933***
	(0.0017)	(0.0044)	(0.0027)
Drugs	0.0126***	0.0529***	0.0187***
	(0.0033)	(0.0076)	(0.0045)
Electrical	0.1674***	0.1521***	0.1483***
	(0.0018)	(0.0037)	(0.0026)
Mechanical	0.0726***	0.0750***	0.0639***
	(0.0017)	(0.0035)	(0.0029)
Female x Chemical	0.0684***	0.1373***	0.0351***
	(0.0047)	(0.0148)	(0.0072)
Female x Computer	0.0977***	0.1259***	0.0505***
	(0.0047)	(0.0296)	(0.0070)
Female x Drugs	0.0912***	0.1283***	0.0395***
	(0.0050)	(0.0180)	(0.0077)
Female x Electrical	0.0764***	0.0783**	0.0445***
	(0.0055)	(0.0271)	(0.0078)
Female x Mechanical	0.0558***	0.0645**	0.0436***
	(0.0051)	(0.0227)	(0.0073)
African American x Chemical	0.0509	0.1124	-0.0250
	(0.0339)	(0.0636)	(0.0570)
African American x Computer	-0.0343	-0.2249	-0.1402
	(0.0418)	(0.1395)	(0.0827)
African American x Drugs	0.0685*	0.1349*	-0.0123
	(0.0318)	(0.0671)	(0.0605)
African American x Electrical	-0.0378	0.0578	-0.1892*
	(0.0402)	(0.0780)	(0.0857)
African American x Mechanical	0.0109	0.0713	-0.0320
	(0.0308)	(0.0636)	(0.0542)
Grant Year dummy	Yes	Yes	Yes
State dummy	Yes	Yes	Yes
Pseudo R^2	0.1404	0.1324	0.1537
N	1,747,849	193,236	421,327

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006 for column (1), between 1976 and 1980 for column (2), and between 2001 and 2005 for column (3).
2) All models are estimated as probit models.
3) Coefficients in each columns are marginal effects (discrete change). Robust standard errors of marginal effects are clustered on the identity of the prolific inventor and are in parentheses.
4) The omitted technology category is Other.
5) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 10A: Probit Estimation

Dependent Variable: Dummy of Assignment to a Firm

Explanatory Variables	Chemical	Computer	Drugs	Electrical	Mechanical	Other
Female inventor	-0.0366***	-0.0232***	-0.0456***	-0.0574***	-0.1821***	-0.2594***
	(0.0044)	(0.0036)	(0.0071)	(0.0059)	(0.0079)	(0.0052)
African American	-0.0229	-0.0631**	0.0154	-0.0686*	-0.1016**	-0.1417***
inventor	(0.0245)	(0.0220)	(0.0348)	(0.0290)	(0.0341)	(0.0398)
Number of inventors	0.0401***	0.0325***	0.0610***	0.0427***	0.1489***	0.2061***
in team	(0.0015)	(0.0009)	(0.0021)	(0.0014)	(0.0021)	(0.0029)
Citations received	0.0004***	0.0002***	0.0008***	0.0008***	0.0022***	0.0033***
	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Grant Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
State dummy	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.0909	0.0894	0.0896	0.0804	0.1308	0.1444
N	288,662	287,230	189,342	304,917	304,462	373,213

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006.
2) All models are estimated as probit models.
3) Coefficients in each column are marginal effects (discrete change). Robust standard errors of marginal effects are clustered on the identity of the prolific inventor and are in parentheses.
4) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 10B: Probit Estimation

Dependent Variable: Dummy of Assignment to a Firm

Explanatory Variables	Chemical	Computer	Drugs	Electrical	Mechanical	Other
Female inventor	0.0266***	0.0035	0.0186	-0.0330**	-0.0963***	-0.2528***
	(0.0070)	(0.0072)	(0.0113)	(0.0117)	(0.0198)	(0.0133)
African American	-0.0283	-0.2066**	0.0442	-0.0795	-0.0227	0.0490
inventor	(0.0493)	(0.0674)	(0.0542)	(0.0518)	(0.0572)	(0.0732)
Number of inventors	0.0456***	0.0340***	0.0713***	0.0436***	0.1526***	0.2076***
in team	(0.0017)	(0.0010)	(0.0025)	(0.0015)	(0.0021)	(0.0032)
Citations received	0.0003***	0.0002***	0.0007***	0.0008***	0.0022***	0.0033***
	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Female x Team	-0.0230***	-0.0103***	-0.0281***	-0.0072*	-0.0379***	-0.0038
	(0.0024)	(0.0024)	(0.0032)	(0.0032)	(0.0069)	(0.0068)
Female x Citations received	0.0003	0.0002	0.0013***	-0.0001	0.0011*	0.0001
	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0005)	(0.0005)
African American x Team	0.0025	0.0227*	-0.0041	-0.0060	-0.0362	-0.1194***
	(0.0115)	(0.0112)	(0.0178)	(0.0122)	(0.0232)	(0.0352)
African American x Citations	-0.0002	0.0016**	-0.0014	0.0018	-0.0004	0.0042*
received	(0.0012)	(0.0006)	(0.0010)	(0.0010)	(0.0016)	(0.0020)
Grant Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
State dummy	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.0920	0.0898	0.0910	0.0805	0.1311	0.1443
N	288,663	287,230	189,342	304,917	304,462	373,213

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006.
2) All models are estimated as probit models.
3) Coefficients in each column are marginal effects (discrete change). Robust standard errors of marginal effects are clustered on the identity of the prolific inventor and are in parentheses.
4) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 11A: Probit Estimation

Dependent Variable: Dummy of Assignment to a COMPUSTAT Firm

Explanatory Variables	(1)	(2)	(3)
Female inventor	-0.0015	-0.1331***	0.0159**
	(0.0036)	(0.0111)	(0.0052)
African American inventor	-0.0103	-0.0513	0.0486
	(0.0187)	(0.0521)	(0.0292)
Number of inventors in team	0.0670***	0.1022***	0.0542***
	(0.0009)	(0.0036)	(0.0012)
Citations received	0.0005***	0.0008***	0.0003***
	(0.0000)	(0.0002)	(0.0001)
Chemical	0.2729***	0.3095***	0.1868***
	(0.0032)	(0.0058)	(0.0059)
Computer	0.3856***	0.2905***	0.3900***
	(0.0029)	(0.0064)	(0.0048)
Drugs	0.1163***	0.1457***	0.1120***
	(0.0047)	(0.0104)	(0.0072)
Electrical	0.3052***	0.2522***	0.3104***
	(0.0030)	(0.0054)	(0.0054)
Mechanical	0.1158***	0.0948***	0.1236***
	(0.0028)	(0.0050)	(0.0055)
Grant Year dummy	Yes	Yes	Yes
State dummy	Yes	Yes	Yes
Pseudo R^2	0.1161	0.122	0.1263
N	1,747,828	193,236	421,327

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006 for column (1), between 1976 and 1980 for column (2), and between 2001 and 2005 for column (3).
2) All models are estimated as probit models.
3) Coefficients in each columns are marginal effects (discrete change). Robust standard errors of marginal effects are clustered on the identity of the prolific inventor and are in parentheses.
4) The omitted technology category is Other.
5) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 11B: Probit Estimation

Dependent Variable: Dummy of Assignment to a COMPUSTAT Firm

Explanatory Variables	(1)	(2)	(3)
Female inventor	0.0032	-0.2704***	0.0371***
	(0.0067)	(0.0220)	(0.0111)
African American	-0.0433	-0.0223	0.0664
inventor	(0.0342)	(0.0782)	(0.0662)
Number of inventors	0.0714***	0.1019***	0.0585***
in team	(0.0009)	(0.0036)	(0.0013)
Citations received	0.0005***	0.0008***	0.0003***
	(0.0000)	(0.0002)	(0.0001)
Female x Team	-0.0232***	0.0145	-0.0176***
	(0.0017)	(0.0119)	(0.0022)
Female x Citations received	0.0001	0.0011	0.0001
	(0.0001)	(0.0007)	(0.0003)
African American x Team	0.0008	-0.0975**	0.0098
	(0.0087)	(0.0317)	(0.0112)
African American x Citations	0.0007	-0.0013	-0.0001
received	(0.0007)	(0.0025)	(0.0011)
Chemical	0.2677***	0.3033***	0.1793***
	(0.0033)	(0.0060)	(0.0062)
Computer	0.3828***	0.2881***	0.3901***
	(0.0029)	(0.0065)	(0.0050)
Drugs	0.1034***	0.1370***	0.1021***
	(0.0049)	(0.0109)	(0.0078)
Electrical	0.3007***	0.2491***	0.3060***
	(0.0031)	(0.0054)	(0.0055)
Mechanical	0.1114***	0.0918***	0.1194***
	(0.0028)	(0.0050)	(0.0057)
Female x Chemical	0.0674***	0.1985***	0.0556***
	(0.0083)	(0.0261)	(0.0139)
Female x Computer	0.0474***	0.1453**	-0.0061
	(0.0091)	(0.0501)	(0.0144)
Female x Drugs	0.1061***	0.1979***	0.0628***
	(0.0101)	(0.0312)	(0.0151)
Female x Electrical	0.0783***	0.1289**	0.0572***
	(0.0102)	(0.0395)	(0.0161)
Female x Mechanical	0.0697***	0.0733*	0.0501**
	(0.0089)	(0.0319)	(0.0154)
African American x Chemical	0.1073*	0.2722***	0.0418
	(0.0445)	(0.0807)	(0.0708)
African American x Computer	-0.0208	-0.2324*	-0.0749
	(0.0454)	(0.1145)	(0.0738)
African American x Drugs	0.1161*	0.2387*	-0.0175
	(0.0516)	(0.0929)	(0.1011)
African American x Electrical	-0.0574	0.0507	-0.1571*
	(0.0440)	(0.0975)	(0.0759)
African American x Mechanical	-0.0209	0.1461	-0.0830
	(0.0424)	(0.0961)	(0.0720)
Grant Year dummy	Yes	Yes	Yes
State dummy	Yes	Yes	Yes
Pseudo R^2	0.1167	0.1228	0.1269
N	1,747,829	193,236	421,327

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006 for column (1), between 1976 and 1980 for column (2), and between 2001 and 2005 for column (3).
2) All models are estimated as probit models.
3) Coefficients in each columns are marginal effects (discrete change). Robust standard errors of marginal effects are clustered on the identity of the prolific inventor and are in parentheses.
4) The omitted technology category is Other.
5) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 12A: Probit Estimation

Dependent Variable: Dummy of Assignment to a COMPUSTAT Firm

Explanatory Variables	Chemical	Computer	Drugs	Electrical	Mechanical	Other
Female inventor	0.0426***	0.0168**	0.0439***	0.0216**	-0.0225**	-0.0701***
	(0.0061)	(0.0062)	(0.0084)	(0.0082)	(0.0074)	(0.0040)
African American	0.0541	-0.0183	0.0789	-0.0584	-0.0708*	-0.0525*
inventor	(0.0333)	(0.0332)	(0.0455)	(0.0362)	(0.0324)	(0.0211)
Number of inventors	0.0528***	0.0303***	0.0547***	0.0480***	0.0885***	0.1009***
in team	(0.0017)	(0.0013)	(0.0020)	(0.0016)	(0.0018)	(0.0016)
Citations received	0.0001	-0.0003***	0.0001	0.0007***	0.0018***	0.0017***
	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Grant Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
State dummy	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.1053	0.0554	0.0934	0.0649	0.082	0.105
N	288,662	287,230	189,342	304,915	304,449	373,213

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006.
2) All models are estimated as probit models.
3) Coefficients in each column are marginal effects (discrete change). Robust standard errors of marginal effects are clustered on the identity of the prolific inventor and are in parentheses.
4) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 12B: Probit Estimation

Dependent Variable: Dummy of Assignment to a COMPUSTAT Firm

Explanatory Variables	Chemical	Computer	Drugs	Electrical	Mechanical	Other
Female inventor	0.1163***	0.0785***	0.1144***	0.0558***	0.0484**	-0.0859***
	(0.0102)	(0.0097)	(0.0132)	(0.0152)	(0.0151)	(0.0080)
African American	0.0624	-0.0794	0.0360	-0.0631	-0.0199	-0.0323
inventor	(0.0659)	(0.0625)	(0.0718)	(0.0599)	(0.0557)	(0.0658)
Number of inventors	0.0590***	0.0341***	0.0643***	0.0493***	0.0914***	0.1004***
in team	(0.0019)	(0.0015)	(0.0023)	(0.0017)	(0.0018)	(0.0017)
Citations received	0.0001	-0.0004***	0.0000	0.0007***	0.0018***	0.0016***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Female x Team	-0.0257***	-0.0205***	-0.0247***	-0.0104*	-0.0272***	0.0039
	(0.0031)	(0.0027)	(0.0031)	(0.0041)	(0.0047)	(0.0038)
Female x Citations received	0.0001	0.0001	0.0004*	-0.0002	0.0006	0.0008**
	(0.0002)	(0.0001)	(0.0002)	(0.0003)	(0.0004)	(0.0003)
African American x Team	-0.0004	0.0101	0.0112	-0.0009	-0.0135	-0.0257
	(0.0168)	(0.0164)	(0.0153)	(0.0181)	(0.0175)	(0.0300)
African American x Citations	-0.0009	0.0012	0.0002	0.0005	-0.0018	0.0034*
received	(0.0018)	(0.0009)	(0.0013)	(0.0013)	(0.0016)	(0.0014)
Grant Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
State dummy	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.1058	0.0559	0.0945	0.0649	0.0823	0.1051
N	288,663	287,230	189,342	304,915	304,449	373,213

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006.
2) All models are estimated as probit models.
3) Coefficients in each column are marginal effects (discrete change). Robust standard errors of marginal effects are clustered on the identity of the prolific inventor and are in parentheses.
4) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 13A: Multinomial Logit Estimation

	(1)			(2)			
	Dependent variable: Assignment to			Dependent variable: Assignment to			
Explanatory Variables	All firms	Government	University	COMPUSTAT firm	Non-listed firm	Government	University
Female inventor	-0.1061***	0.0027***	0.0048***	-0.0095***	-0.0944***	0.0030***	0.0048***
	(0.0014)	(0.0004)	(0.0004)	(0.0016)	(0.0012)	(0.0004)	(0.0004)
African American inventor	-0.0665***	0.0165***	-0.0071***	-0.0067	-0.0606***	0.0173***	-0.0072***
	(0.0060)	(0.0022)	(0.0014)	(0.0074)	(0.0063)	(0.0023)	(0.0015)
Number of inventors in team	0.1126***	0.0029***	0.0032***	0.1014***	0.0139***	0.0032***	0.0036***
	(0.0003)	(0.0001)	(0.0001)	(0.0004)	(0.0003)	(0.0001)	(0.0001)
Citations received	0.0011***	-0.0005***	-0.0000	0.0007***	0.0005***	-0.0005***	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Chemical	0.0650***	0.0138***	0.0465***	0.2076***	-0.1296***	0.0123***	0.0420***
	(0.0011)	(0.0005)	(0.0009)	(0.0013)	(0.0010)	(0.0005)	(0.0009)
Computer	0.1129***	0.0233***	-0.0014**	0.3114***	-0.1842***	0.0203***	-0.0045***
	(0.0010)	(0.0007)	(0.0005)	(0.0012)	(0.0009)	(0.0007)	(0.0005)
Drugs	-0.0883***	0.0181***	0.1408***	0.0340***	-0.1096***	0.0171***	0.1357***
	(0.0019)	(0.0007)	(0.0019)	(0.0019)	(0.0012)	(0.0007)	(0.0019)
Electrical	0.0732***	0.0290***	0.0215***	0.2395***	-0.1520***	0.0265***	0.0177***
	(0.0010)	(0.0007)	(0.0007)	(0.0013)	(0.0009)	(0.0007)	(0.0007)
Mechanical	0.0434***	0.0112***	-0.0027***	0.0994***	-0.0487***	0.0106***	-0.0038***
	(0.0009)	(0.0005)	(0.0005)	(0.0014)	(0.0011)	(0.0005)	(0.0005)
Grant year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2		0.1589				0.1171	
N		1,747,881				1,747,881	

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006.
2) All models are estimated as multinomial logit models. In model (1), there are 4 choices of assignment that are firm, government, university, and individual. In model (2), there are 5 choices of assignment that are COMPUSTAT firm, non-listed firm, government, university, and individual.
3) Coefficients in each column are marginal effects (discrete changes). Heteroscedasticity-robust standard errors of are in parentheses.
4) The base case is none or individual assignment. The omitted technology category is Other.
5) The "university" assignee category includes universities, foundations, research institutions, and hospitals.
6) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 13B: Multinomial Logit Estimation

	(1)			(2)			
	Dependent variable: Assignment to			Dependent variable: Assignment to			
Explanatory Variables	All firms	Government	University	COMPUSTAT firm	Non-listed firm	Government	University
Female inventor	-0.1620***	0.0040***	0.0175***	-0.0076	-0.1358***	0.0031*	0.0151***
	(0.0055)	(0.0015)	(0.0020)	(0.0051)	(0.0031)	(0.0015)	(0.0020)
African American inventor	-0.1126***	0.0098	0.0179*	-0.0676*	-0.0400*	0.0090	0.0155
	(0.0282)	(0.0083)	(0.0103)	(0.0269)	(0.0196)	(0.0083)	(0.0102)
Number of inventors in team	0.1130***	0.0031***	0.0043***	0.1042***	0.0119***	0.0035***	0.0047***
	(0.0004)	(0.0001)	(0.0001)	(0.0004)	(0.0004)	(0.0001)	(0.0001)
Citations received	0.0011***	-0.0004***	0.0000	0.0007***	0.0005***	-0.0005***	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Female x Team	-0.0108***	-0.0012***	-0.0035***	-0.0207***	0.0089***	-0.0013***	-0.0036***
	(0.0015)	(0.0002)	(0.0001)	(0.0012)	(0.0009)	(0.0002)	(0.0001)
Female x Citations received	0.0005***	0.0000	-0.0001***	0.0003***	0.0002***	0.0000	-0.0001***
	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
African American x Team	-0.0013	-0.0008	-0.0001	0.0048	-0.0071	-0.0007	0.0003
	(0.0099)	(0.0005)	(0.0009)	(0.0083)	(0.0049)	(0.0006)	(0.0009)
African American x Citations received	0.0004	-0.0004***	0.0000	0.0004	-0.0000	-0.0004**	-0.0000
	(0.0004)	(0.0002)	(0.0001)	(0.0004)	(0.0004)	(0.0001)	(0.0001)
Chemical	0.0641***	0.0133***	0.0443***	0.2070***	-0.1292***	0.0117***	0.0396***
	(0.0012)	(0.0006)	(0.0010)	(0.0014)	(0.0010)	(0.0005)	(0.0009)
Computer	0.1096***	0.0241***	-0.0012**	0.3115***	-0.1866***	0.0208***	-0.0045***
	(0.0010)	(0.0008)	(0.0005)	(0.0012)	(0.0009)	(0.0007)	(0.0005)
Drugs	-0.0940***	0.0161***	0.1408***	0.0256***	-0.1075***	0.0152***	0.1361***
	(0.0021)	(0.0008)	(0.0021)	(0.0020)	(0.0012)	(0.0008)	(0.0020)
Electrical	0.0717***	0.0287***	0.0212***	0.2386***	-0.1520***	0.0261***	0.0172***
	(0.0011)	(0.0007)	(0.0007)	(0.0013)	(0.0010)	(0.0007)	(0.0007)
Mechanical	0.0419***	0.0109***	-0.0032***	0.0978***	-0.0483***	0.0102***	-0.0044***
	(0.0009)	(0.0006)	(0.0005)	(0.0014)	(0.0012)	(0.0005)	(0.0005)
Female x Chemical	0.0637***	0.0034**	0.0046***	0.0343***	0.0221***	0.0051**	0.0072***
	(0.0027)	(0.0016)	(0.0016)	(0.0051)	(0.0049)	(0.0017)	(0.0018)
Female x Computer	0.0642***	-0.0069***	-0.0035**	-0.0142*	0.0735***	-0.0066***	-0.0022
	(0.0030)	(0.0010)	(0.0015)	(0.0056)	(0.0057)	(0.0010)	(0.0017)
Female x Drugs	0.0746***	0.0067***	-0.0009	0.0666***	0.0056	0.0078***	0.0002
	(0.0025)	(0.0018)	(0.0013)	(0.0051)	(0.0048)	(0.0019)	(0.0014)
Female x Electrical	0.0487***	-0.0002	0.0002	0.0264***	0.0133*	0.0011	0.0024
	(0.0032)	(0.0014)	(0.0016)	(0.0059)	(0.0058)	(0.0016)	(0.0018)
Female x Mechanical	0.0134***	0.0045**	0.0099***	0.0221***	-0.0131*	0.0053*	0.0113***
	(0.0041)	(0.0021)	(0.0028)	(0.0065)	(0.0059)	(0.0022)	(0.0029)
African American x Chemical	0.0619***	0.0104	-0.0175***	0.1326***	-0.0776***	0.0130	-0.0174***
	(0.0136)	(0.0093)	(0.0023)	(0.0248)	(0.0215)	(0.0103)	(0.0025)
African American x Computer	0.0027	0.0311*	-0.0110**	-0.0090	0.0070	0.0331*	-0.0107*
	(0.0208)	(0.0161)	(0.0050)	(0.0286)	(0.0267)	(0.0168)	(0.0053)
African American x Drugs	0.0682***	-0.0100***	-0.0156***	0.1342***	-0.0657**	-0.0100**	-0.0158***
	(0.0111)	(0.0032)	(0.0024)	(0.0255)	(0.0230)	(0.0034)	(0.0026)
African American x Electrical	0.0154	0.0239*	-0.0114***	-0.0332	0.0475	0.0247	-0.0115**
	(0.0183)	(0.0134)	(0.0042)	(0.0279)	(0.0273)	(0.0138)	(0.0044)
African American x Mechanical	0.0308**	0.0027	-0.0193***	-0.0181	0.0471	0.0030	-0.0198***
	(0.0139)	(0.0075)	(0.0032)	(0.0279)	(0.0263)	(0.0078)	(0.0033)
Grant year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.1603			0.1180			
N	1,747,881			1,747,881			

Notes: 1) Patent data are patents granted to U.S. inventors between 1976 and 2006.
2) All models are estimated as multinomial logit models. In model (1), there are 4 choices of assignment that are firm, government, university, and individual. In model (2), there are 5 choices of assignment that are COMPUSTAT firm, non-listed firm, government, university, and individual.
3) Coefficients in each column are marginal effects (discrete changes). Heteroscedasticity-robust standard errors of are in parentheses.
4) The base case is none or individual assignment. The omitted technology category is Other.
5) The "university" assignee category includes universities, foundations, research institutions, and hospitals.
6) Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table Appendix.1: Distribution of Patents Granted, Women, and, U.S. inventors, by Ownership and Technological Category, 1975 - 2008

A. All women on team

	Chemical	Comp.& Comm.	Drugs& Medical	Elec.	Mech.	Other	Total
No assign	0.21	0.18	0.38	0.27	0.59	0.80	0.53
Firm	0.71	0.80	0.48	0.68	0.39	0.19	0.42
Individual	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government	0.03	0.02	0.01	0.02	0.01	0.00	0.01
University	0.05	0.01	0.12	0.02	0.01	0.00	0.03

B.Women as a part of team

	Chemical	Comp.& Comm.	Drugs& Medical	Elec.	Mech.	Other	Total
No assign	0.04	0.04	0.06	0.05	0.18	0.31	0.09
Firm	0.84	0.93	0.73	0.87	0.77	0.66	0.80
Individual	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government	0.03	0.01	0.03	0.03	0.02	0.01	0.02
University	0.09	0.02	0.19	0.05	0.03	0.02	0.08

C.No women on team

	Chemical	Comp.& Comm.	Drugs& Medical	Elec.	Mech.	Other	Total
No assign	0.11	0.08	0.20	0.11	0.28	0.40	0.20
Firm	0.82	0.89	0.65	0.83	0.69	0.58	0.74
Individual	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government	0.02	0.02	0.02	0.03	0.02	0.01	0.02
University	0.04	0.02	0.13	0.03	0.01	0.01	0.03

Source: Authors' calculations; USPTO(2009), Cook and Kongcharoen (2009), and Hall et al. (2001, updated 2009).
Notes: 1) Technological categories are from Hall et al. (2001, updated 2009).
2) The "university" assignee category includes universities, foundations, research institutions, and hospitals.