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ABSTRACT

Why Don't Women Patent?*

We investigate women's underrepresentation among holders of commercialized patents: only 5.5% of holders of such patents are female. Using the National Survey of College Graduates 2003, we find only 7% of the gap in patenting rates is accounted for by women's lower probability of holding any science or engineering degree, because women with such a degree are scarcely more likely to patent than women without. Differences among those without a science or engineering degree account for 15%, while 78% is accounted for by differences among those with a science or engineering degree. For the latter group, we find that women's underrepresentation in engineering and in jobs involving development and design explain much of the gap.

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1 Introduction

The gender gap in patenting rates is much more pronounced than the gender gap in many other endeavors: American women patent at only 8% of the male rate, according to the National Survey of College Graduates 2003, while by comparison they earn 81% of male full–time weekly earnings (U.S. Bureau of Labor Statistics 2011). Other sources confirm the wide patenting gap. Only 10.3% of the 90,705 U.S. origin patents granted in 1998 are estimated by the United States Patent and Trademark Office (1999) to have had at least one female inventor.[1] Adjusting for co–authorship, Frietsch et al. (2009) estimate that women accounted for 8.2% of patents filed by Americans at the European Patent Office in 2005, a decrease from the 8.8% peak of 2001. The highest shares were for Spain and France (12.3% and 10.2% respectively), while the lowest shares were for Austria and Germany (3.2% and 4.7% respectively).[2] The magnitude of the gender gap in patenting raises the concern that, rather than reflecting comparative advantage or differing tastes by gender, the gap reflects gender inequity and an inefficient use of female innovative capacity.

Innovation, or equivalently, technological progress, is a driver of economic growth and key to future prosperity: more than half of U.S. economic growth since the Second World War is attributable to technogical progress (Boskin and Lau 2000). Clearly, growth will be highest if the innovative capacity of the whole workforce is exploited, and doing so is particularly important at a time of concern about growth and technological progress. By referring to the 2007–2009 recession as a "Sputnik moment", President Obama in 2010 called into doubt whether the United States was innovating at its full potential,[3] while an influential report by the National Academy of Sciences (2007) states "... the committee is deeply concerned that the scientific and technological building blocks critical to our

[1] The National Women's Business Council (2012) estimates a share of 14% for 1998 ostensibly based on the same data, rising to 18% in 2010, but neither the level nor trend of their aggregate patents granted corresponds to aggregate data published by the USPTO.

[2] See also Ashcraft and Breitzman (2007).

[3] www.whitehouse.gov/blog/2010/12/06/president-obama-north-carolina-our-generation-s-sputnik-moment-now, accessed 21 August 2012.

economic leadership are eroding...". Among many other recommendations, the report urges increasing the share of women in science and engineering.

Innovation is difficult to measure at the individual level, and scholars use patents as a proxy. While not all innovations are patented, patenting is likely to be correlated with unpatented innovation, including innovation embodied in tacit knowledge and disseminated by inter–firm worker mobility. In this paper, we examine the reasons for women's underperformance in patenting using a representative sample of U.S. college graduates, the 2003 National Survey of College Graduates. While there have been earlier quantitative studies of the question, they have been confined to samples of PhDs, generally academic scientists and engineers.[4] Such samples provide only limited information about patenting generally, since our data show that PhDs hold only 29% of patents, and academics only 7% of patents. Furthermore, the gender patenting gap appears to be much smaller in these samples than in the more general population we study in our paper. Although the studies generally do not report the unadjusted gender gap, we estimate based on information in the papers that women in these samples are between 40% and two–thirds as likely to patent as men, compared with 8% for the college graduates we study. Most of the gender patenting gap apparently arises because women do not get to the stage of being in the samples of earlier studies.

The earlier studies do not report how much of the raw gap is explained by the covariates, but since our estimated raw gaps are similar to the reported conditional gaps, the covariates apparently explain little.[5] Nevertheless, these papers do identify significant predictors of patenting (for both men and women). Patenting is higher in certain fields, for researchers with more publications, more co–authors per publication, and with company scientists as co–authors, for more experienced researchers and for researchers in industry or at universities that are highly ranked and have more patents. Whittington (2011) finds that female PhDs in academia do not enjoy the patenting bonus children

[4] Ding et al. (2006), Thursby and Thursby (2005), Whittington (2011), Whittington and Smith–Doerr (2005, 2008). See also Stephan et al. (2010) for a general analysis of patenting by PhDs.

[5] The exception is Whittington's (2011) academic sample, for which covariates explain 42% of the raw gap by our calculations.

provide men, though their counterparts in industry do. Qualitative analysis, including parts of the studies cited above and papers such as Murray and Graham (2007), highlight that academic women failed to make early contacts in industry and then fell behind men in developing the appropriate skills, that academic women have smaller networks with fewer industrial contacts and are more concerned that commercial science hurts academic advancement.

In our data, 7.5% of patents granted are granted to women (alternatively: women's patenting rate is 8% of men's), while only 5.5% of patents commercialized or licensed, presumably those more important for economic growth, are commercialized or licensed by women. A natural first hypothesis for the difference in patenting rates is women's underrepresentation in science and engineering: while 33.1% of males in the sample have a tertiary qualification in science or engineering, the figure is only 14.2% for women. However, we find that the patenting rate of women with science or engineering degrees is sufficiently low that increasing women's representation in science and engineering would have little effect absent other changes. For commercialized or licensed patents, only 7% of the gender patenting rate gap is accounted for by the lower share of women with any science or engineering degree, while 78% of the gap is explained by lower female patenting among holders of a science or engineering degree. The remaining 15% of the gender gap is explained by lower female patenting among those without a science or engineering degree.

For holders of science and engineering (S&E) degrees, two thirds of the gender patenting rate gap reflects a gap in the probability of holding any commercialized patent. We are able to explain 61% of this probability gap, with specific fields of study within S&E accounting for 31% of the gap, and the degree to which respondents' jobs involve particular tasks accounting for at least another 13%: women are underrepresented in electrical and mechanical engineering, the most patent–intensive fields, and in development and design, the most patent–intensive job tasks. Women's education, in particular their lower share of doctorates, accounts for another 10%. The gender gap in the number of commercialized patents conditional on holding any has slightly different determinants. We are able to explain almost half this gap, with job tasks, especially design and development, explaining 40% of the gap.

The results make clear that the first steps towards increasing female patenting rates must be to increase women's representation in electrical and mechanical engineering, relative to life sciences, and in jobs involving design and development. Whether this will have the desired effect of increasing female patenting rates naturally depends upon how the representation is increased. We discuss policies that will increase the average quality of the elite doing innovative design and development by increasing the pool of qualified women available at each step of the career path. These policies complement those stemming from studies of the existing elite: any newcomers will still have to grapple with the further gender issues identified by the existing literature. We stress that most of the policies we mention have not been rigorously evaluated, we recommend the use of randomized trials to do so, and we urge early intervention: women do not enter the career paths that lead men to be granted many patents in middle age.

2 Data

We use individual–level data from the 2003 National Survey of College Graduates (NSCG), collected by the U.S. Bureau of the Census under the auspices of the National Science Foundation. The data may be downloaded at sestat.nsf.gov/datadownload. These data are a stratified random sample of people reporting having a bachelor's degree or higher on the long form of the 2000 census. All respondents who had ever worked were asked whether they had applied for a U.S. patent since October 1998, whether they had been granted any U.S. patent since October 1998, and if so, how many, and how many had been commercialized or licensed. The survey will not capture patents by those with less than a college degree, but we assume that most patents are captured: education is not recorded in patent filings, so there is no way of quantifying the missing patents.

We choose these data for their combination of patent information and a rich set of variables describing respondents' education and job, including job tasks, and because they are representative of a population likely to include most inventors. The companion Survey of Doctoral Recipients, the only other large–scale survey with patent information of which we are aware, is more limited by design, while administrative patent records have almost no information on the inventors and are not linked to other data sets.[6] An additional advantage of the data is that the information on the licensing or commercialization of the patent can be used to identify patents more likely to contribute to economic growth. A disadvantage of the data is that they are several years old: the 2003 wave is the most recent available for the NSCG, while the next to be released will not contain patenting information.

We count as holders of S&E degrees respondents with bachelor's, master's or doctoral degrees in science (excluding social sciences) or in engineering, as well as those who minored in science or engineering in college.[7] We exclude from our sample respondents 65 or older (the youngest respondent is 24, but few are younger than 26) and respondents who live outside the United States or in U.S. territories. The sample of potential patentors we work with has 88,094 observations, representing 2070 patents granted and 1299 patents commercialized or licensed. Because the data result from an oversample of scientists and engineers, we use sample weights in all of our analysis to make it representative.

3 Method

We first perform a Oaxaca decomposition on the gender patenting rate gap so as to highlight the importance of women's lower representation among those with any degree in science or engineering. If N is the number of patents and $P(SE)$ is the probability of having a degree in science or engineering, the expected number of patents for a person is

$$E(N) = P(SE)E(N|SE) + [1 - P(SE)]E(N|non\ SE),$$

or, in terms of patents per person (the patenting rate) for a population,

$$\overline{N} = P^S\hat{N}^S + (1 - P^S)\hat{N}^O,$$

[6] German administrative patent data are now linked to information on inventors, but the information is much less rich than that in the NSCG. We are not aware of linked databases in other countries.

[7] Three quarters of those who minored in S&E also majored in S&E, so including those with minors expands the sample only slightly.

where the bar denotes the average, the hat denotes the average conditioning on science and engineering degree status, and O indexes non–S&E. The difference between male and female patenting rates is therefore

$$\overline{N}_m - \overline{N}_f = [P_m^S \hat{N}_m^S + (1 - P_m^S)\hat{N}_m^O] - [P_f^S \hat{N}_f^S + (1 - P_f^S)\hat{N}_f^O],$$

where m and f subscripts denote gender. This may be rewritten as

$$\overline{N}_m - \overline{N}_f = (P_m^S - P_f^S)(\hat{N}_f^S - \hat{N}_f^O) + P_m^S(\hat{N}_m^S - \hat{N}_f^S) + (1 - P_m^S)(\hat{N}_m^O - \hat{N}_f^O). \quad (1)$$

The first term on the right hand side represents the share of the patenting rate gap due to the gender gap in having a science or engineering degree; the second represents the share due to the gender patenting rate gap among those with a science or engineering degree; the third the share due to the gender patenting rate gap among those without a science or engineering degree.[8]

The same equation may be used to decompose the gender gap in the probability of patenting, P, by replacing $\hat{N}$ with $\hat{P}$, the probability of patenting conditional on science and engineering degree status, on the right hand side. The gender gap in the number of patents conditional on having any patent, $\widetilde{N}$, may be decomposed by replacing $\hat{N}$ with $\tilde{\widetilde{N}}$, the average number of patents conditional on having a patent and on science and engineering degree status, and P^S with $\widetilde{P}^S$, the probability of having a science or engineering degree conditional on having a patent.

In the same spirit, we investigate the degree to which the gender patenting gap is caused by the gender difference in the probability of having any patent, and the gender difference in the number of patents conditional on having any. If N is the number of patents, $E(N) = P(\mathit{Any\ patent}) \times E(N|\mathit{Any\ patent})$, or $\overline{N} = P\widetilde{N}$, where the tilde denotes the average conditioning on having a patent. The gender patenting rate gap is

[8] The decomposition is sensitive to the choice of this variant rather than its dual. We consider this one more appropriate in a context where the counterfactual of increasing the share of women in S&E is of interest: the additional women would presumably experience a patenting boost equal to the current female S&E/non–S&E differential, so the weight on the S&E representation gap (the first component in equation 1) should be the female S&E/non–S&E patenting differential, not the male as in the dual.

therefore

$$\overline{N}_m - \overline{N}_f = P_m \widetilde{N}_m - P_f \widetilde{N}_f.$$

This may be rewritten as

$$\overline{N}_m - \overline{N}_f = P_m(\widetilde{N}_m - \widetilde{N}_f) + \widetilde{N}_f(P_m - P_f), \tag{2}$$

with the first term on the right hand side reflecting the share of the gap due to the gender gap in the number of patents conditional on having any patent, and the second term reflecting the gap in the probability of having any patent.

Having performed these decompositions, we run regressions on separate samples of science and engineering degree holders and other degree holders, and we separately examine the probability of patenting and the number of patents conditional on having any, as the determinants may differ. We focus on patents commercialized or licensed, given their probable greater contribution to economic growth, but results for patents granted are similar. For the full samples of all those who have ever worked, we report linear probability coefficients (probit marginal effects are similar) from regressions of the form:

$$P(Any\ commercialized\ patent)_i = \alpha_0 + \alpha_1 F_i + \alpha_2 X_i + \epsilon_i, \tag{3}$$

where the coefficient of interest is α_1, the coefficient on the female dummy. For the samples of commercialized or licensed patent holders (whom we sometimes refer to as inventors) we report coefficients from least squares estimation of

$$log(Commercialized\ patents|any)_i = \beta_0 + \beta_1 F_i + \beta_2 X_i + \nu_i, \tag{4}$$

where β_1 is the coefficient of interest. Finally, for the samples of patent holders (commercialized or not), we report linear probability coefficients from regressions for the probability of commercializing a patent conditional on any patent being granted:

$$P(Patent\ commercialized|patent\ granted)_i = \gamma_0 + \gamma_1 F_i + \gamma_2 X_i + \eta_i. \tag{5}$$

All regressions are weighted with the survey weights, and robust standard errors are calculated in all cases. In all regressions, we gradually add covariates to assess how much of the gender gap is due to gender differences in particular characteristics. The controls include demographics, detailed fields of study, highest degree, employment and student status, whether a bachelor's degree level knowledge of science or engineering was necessary for the job, the degree to which the work on the job is related to the field of highest degree, and controls for whether at least 10% of time on the job is spent in activities we judged likely to be associated with patenting: basic research, applied research, development, design, computer tasks and management. Job–related covariates are interacted with a dummy for employed.

4 Descriptive statistics

Table 1, based on samples where an observation is a patent, shows that 7.5% of patents granted were reported by female inventors (column 1). This number is calculated in a way comparable to the numbers of Frietsch et al. (2009), who adjust for co–authorship, and indeed their 2005 female share for the United States is very similar at 8.2%. The smaller share compared to the U.S. Patent and Trademark Office (1998) estimates of the share of patents with at least one female inventor may indicate that women inventors file patents with more co–inventors. Only 5.5% of commercialized or licensed patents, were reported by female inventors (column 4). The lower figure for commercialized patents is due to the fact that while overall 77% of patents granted were commercialized (column 1), only 62% of patents granted to female inventors were commercialized (column 3), compared to 79% for men (column 2).[9] 74% of patent holders hold S&E degrees (column 1), a share that is slightly higher for women than men and lower among holders of commercialized patents, especially men (68%, column 4).

Based on the full sample of respondents (those who have ever worked), Figure 1 gives a vivid illustration of the gender gap in the number of commercialized or licensed patents per capita for men and women (the graph for patents granted is qualitatively similar).[10]

[9] Cook and Kongcharoen (2010) study the gender gap in commercialization of patents.

[10] One outlier has been dropped. See below.

Male patents per capita peak in mid–career, while female patents per capita are uniformly low and always below male levels. Over all ages, women patent at 8% of the male rate. Using the same sample, Table 2 shows statistics split by gender and S&E degree status. S&E degree holders patent more than others, and within both degree categories men patent more than women. For example, 4.4% of men with S&E degrees report being granted a patent, and 2.9% report commercializing a patent (column 2), compared to 1.0% and 0.6% respectively for women (column 3). The male–female disparity is larger for the (unconditional) number of patents, indicating that male inventors have more patents than female inventors.

In Table 3, we take a first step towards investigating the reasons for higher patenting rates for men among S&E degree holders (panel A), and among non–S&E degree holders (panel B), by showing the distribution of fields of study by gender and the patenting intensity of each field. Columns 1 and 2 show the highest degrees of women with any S&E degree are concentrated in the life sciences: 27% of their highest degrees are in this field, compared to 14% for men. Consequently, women with S&E degrees are underrepresented in most other S&E fields, with the largest gaps in the relatively large (for men) fields of electrical and mechanical engineering.

The consequences of these different fields of study may be seen in columns 3–6: respondents reporting a highest degree in life sciences report only 0.06 patents on average (column 4), compared with 0.28 in electrical engineering, the most patent–intensive field, and 0.18 in mechanical engineering. Women with S&E degrees are also slightly underrepresented in the other patent–intensive fields of physical sciences and chemical engineering. The disparity between more female and more male fields is higher for commercialized or licensed patents (columns 5 and 6), since, as column 7 shows, only 39% of patents granted in life sciences are commercialized, compared to 62% in electrical engineering and mechanical engineering.

The lower panel examines the sample of respondents with no degree in S&E. We follow the NSF's classification of "technology" fields (which include computer programming, as distinct from computer science) as "S&E–related" rather than as S&E. For this sample, the most common S&E–related fields other than technology are science education fields. Women without an S&E degree are underrepresented in technology (compare columns 1 and 2), which not surprisingly is the most patent–intensive of these fields. However, with only 0.04 patents granted per person (column 4), technology is not very patent intensive compared to S&E fields, and it represents only a small fraction of non–S&E degrees. Most technology patents are commercialized (67% in column 7), yet technology's average number of commercialized patents is only half the S&E average of 0.06 (column 6).

In Tables 4 and 5, we similarly examine a set of job characteristics, for those working at the survey date. In Table 4, we consider the sample of respondents with an S&E degree. The first panel shows that men and women are equally likely to have a job closely related to the field of study of highest degree (columns 1 and 2), and that not surprisingly, those working in jobs closely related to science and engineering study have more patents than others (columns 3 and 4). Women are slightly more likely to be working in an unrelated field, which should tend to reduce their patenting. The second panel shows that men are much more likely to work in a job for which a knowledge of science and engineering at at least a bachelor's level is required: 72% of men do so, compared to 59% of women, and there is a sharp divide in patenting between respondents who have jobs requiring such knowledge (0.079 commercialized patents per person) and those who do not (0.009).

The third panel shows similar statistics according to whether respondents reported spending at least 10% of their time on various tasks likely to be related to patenting. Women are slightly underrepresented in basic and applied research, somewhat underrepresented in computer tasks, and very underrepresented in development and design, as well as management. At the same time, there are large patenting disparities between those that do and do not do applied research, development and design (columns 3 and 4).

Table 5 shows statistics for the sample of respondents without an S&E degree. The job characteristics which are most closely associated with patenting and in which women are most underrepresented are design and development, with a similar but much less marked pattern in management. Appendix Tables 1 and 2 show means of other variables used in estimation.

5 Results

We decompose the gender patenting gap before running regressions, focusing on commercialized patents, to establish the determinants of the gender gap among those with S&E degrees, and among those without. Finally, we estimate the probability of commercializing a patent for those who have been granted a patent.

5.1 Decomposition results

Table 6 presents results based on the decomposition of equation (1). The means underlying the decomposition are presented in Appendix Table 3. The first column shows that for commercialized or licensed patents, 5.6% of the gender patenting rate gap is owing to the smaller fraction of women with an S&E degree (14.2%, compared to 33.1% for men), 62% is owing to a gender patenting rate gap among holders of an S&E degree, and 32% is owing to a gender patenting rate gap among holders of other degrees.

This decomposition is heavily influenced by one observation, however: a male with a degree in communications reporting having 70 commercialized patents, an outlier among those without an S&E degree (the next highest tally is 15), and second most prolific patenter in the sample. There does not seem to be an error: the respondent reports that his work is unrelated to the field of his highest degree, that his main task is development, and that his occupation is manager. Nevertheless, we feel more comfortable with the decomposition dropping this observation, and this is reported in column 2. Now the share of the gap within S&E degree holders dominates more clearly at 78%, compared to 7% due to the smaller fraction of women with an S&E degree, and 15% for the within non–S&E component. Columns 3 and 4 shows the decompositions of the probability of any patents and the number of patents per inventor are similar.

Simulations provide a different way of representing the components of the gender patenting rate gap. If the share of women in S&E were increased to that of men, commercialized or licensed patents per woman would rise by a factor of 1.9, holding constant patenting rates within S&E. This would increase women's share of commercialized patents to 10.0%, rather than 5.5% as currently, increasing the number of commercialized patents by 5.0%.[11] On the other hand, if female commercialized patenting in S&E were instead raised so as to eliminate the within–S&E patenting rate gap, patents per woman would rise by a factor of 5.3, resulting in women contributing 23.5% of commercialized patents. This would increase the number of commercialized patents by 23.6%.

It is useful in interpreting the regressions that follow to use equation (2) to assess how much of the gender patenting rate gap in commercialized patents is due to a gap in the probability of having any commercialized patent versus the gap in the number of commercialized patents conditional on having any. For holders of S&E degrees, 66% is attributable to the gap in the probability of patenting, and the figure of 63% for holders of non–S&E degrees (without the outlier) is very similar.

5.2 Determinants of the probability of patenting

We now estimate the regressions of equation (3) to explain the gender gap in the probability of patenting, the more important component of the patenting gap. In Table 7 panel A, for S&E degree holders, we examine the probability of commercializing or licensing a patent, beginning with only the female dummy in column 1: S&E women are 2.3 percentage points less likely to patent than S&E men. Adding dummies for race, ethnicity and nativity in column 2 changes little, but adding 142 dummies for field of study of highest degree and 29 dummies for field of study of bachelor's degree in column 3 reduces the coefficient to 1.5 percentage points, a decrease corresponding to 31% of the original effect in column 1.

The covariates added in columns 4–8 cumulatively explain more of the gap, with education controls explaining 10% of the gap (column 4), but the dummies for how closely related one's work is to one's highest degree, and whether one needs knowledge of a science or engineering bachelor's degree for the job (column 8) having little effect. The effect of the education controls reflects the lower share of women with doctoral degrees. Only

[11] The outlier's patents are included in this calculation.

when the dummies for whether at least 10% of the respondent's time is spent in specific tasks does the coefficient fall again appreciably: from 1.2 percentage points in column 8 to 0.9 percentage points in column 9, or 13% of the original gap. This is likely to be an underestimate of the contribution of job tasks, since tasks are measured at the survey date, while patents are measured over a five year window. Unreported regressions reveal that while each task control individually reduces the gender gap, those with the strongest effects are design and development. Unreported regressions also show that neither adding a dummy for working at a university nor adding information about books and journal articles published and major conferences attended has any effect on the female coefficient. Altogether, the reported covariates explain 61% of the raw gender gap.

In panel B, we repeat the exercise for the sample of non–S&E degree holders. Women are 0.32 percentage points less likely to commercialize a patent than men. Only the controls for job tasks in column 8 make much of a difference to the coefficient, reducing it from 0.25 to 0.21 percentage points, or 16% of the raw gender gap. Altogether, the covariates explain only 34% of the raw gap.

5.3 Determinants of patents per inventor

We next turn to examining the number of commercialized patents, conditional on any having been commercialized, and present results of estimating equation (4) for the S&E sample in Table 8 panel A. Female inventors commercialize 17 log points fewer patents than men (column 1), and controlling for detailed field of study in column 3 increases the gap to 24 log points. Although this suggests women's choice of field is beneficial to patenting, the effect is outweighed by the opposite effect of field on the more important gap in the probability of patenting at all (Table 7 panel A).

Controls for age (rather than years since highest degree) are important for the gap in patents per inventor, reducing the conditional gender gap from 24 log points in column 5 to 18 log points in column 6, or by 29% of the raw gender gap. This is somewhat deceptive, however, as Figure 1 shows that the return to age exists only for men. Job tasks are again important in column 9, accounting for 40% of the raw gender gap. Unreported regressions indicate that design tasks influence the gender gap the most, followed by development and management. Basic research and computer tasks do not affect the gap. The covariates together explain 49% of the raw gender gap.

In panel B, we examine the gender gap in the number of patents per inventor among those without an S&E degree. We are unable to explain this gender gap, with most covariates only deepening the puzzle. The raw gap is a large 37 log points, statistically significant at the 10% level, while the conditional gap in column 8 is 61 log points, though statistically insignificant. Only job tasks (column 8) make a non–trivial contribution to understanding the raw gap, explaining 27% of it.

The panel B regressions are sensitive to the outlier mentioned above, so in panel C, we present the coefficients from regressions on a sample with the outlier dropped. The raw gap is smaller, at 21 log points (column 1), statistically significant at the 10% level. Fields of study deepen the puzzle, while doing work requiring science or engineering knowledge (column 7) and job tasks (column 8) appear to explain a lot of the gap, though the estimates are very imprecise.

5.4 Determinants of the probability of commercializing a granted patent

We have focused on commercialized or licensed patents, as these are likely to be those contributing more to economic growth. Table 1 indicated that conditional on being granted any patent, female inventors are less likely to commercialize a patent than male inventors. We examine this conditional probability explicitly in Table 9, by estimating equation (5). For S&E degree holders, in panel A, there is a 9.7 percentage point raw gender gap (column 1), statistically significant at the 10% level, which may be compared with the overall commercialization rate of 77%. 70% of this gap is explained by detailed field of study (column 3); age and years since highest degree explain another 24% (column 6), while other covariates either explain little or increase the puzzle. Together the covariates explain 86% of the gap.

Due to the small sample size of only 202 patents, we are less successful in understanding this outcome for those without an S&E degree (panel B). The raw gender gap is 8.8 percentage points, but it is statistically insignificant. The point estimates indicate that most covariates deepen the puzzle, while job tasks make a large contribution to explaining the raw gap, with an additional contribution of age and years since highest degree. The column 9 point estimate is the same as in column 1.

6 Conclusions and policy recommendations

Women are much less likely to be granted a patent than men, and are somewhat less likely to commercialize or license the patents they are granted. Because women with a degree in S&E patent little more than other women, increasing the share of women in S&E would not greatly increase female patenting rates, absent changes within S&E. Only 7% of the gender gap in commercialized patents is owing to women's underrepresentation in S&E, compared to 78% owing to the patenting rate gap among holders of S&E degrees. Results for all patents granted are similar.

The most important determinants of the gender patenting rate gap among S&E degree holders are women's underrepresentation in patent–intensive fields of study, especially electrical and mechanical engineering, and in patent–intensive job tasks, especially development and design. Women's lower share of doctoral degrees plays a minor role.

It is also useful to note factors found to be unimportant among S&E degree holders. Conditional on age and years since highest degree, current employment status and years since last employment do not affect the gender gap. Though women in the sample are closely attached to the labor force, the effect of actual experience may be larger than captured by these measures anchored on the survey date. Other variables with little effect on the conditional gender gap include the extent to which the respondent's job is related to the field of study of highest degree and whether the respondent's job requires science or engineering knowledge at the level of a bachelor's degree or higher. This is despite a large gender gap in the S&E knowledge requirement variable, and a large unconditional patenting differential between respondents in jobs requiring and not requiring S&E knowledge: these gaps reflect different choices of field of study.

There is little sign that large improvements in female patenting are likely to have occurred since the time of the survey. Bachelor's degrees in engineering awarded to women rose by 29.7% between 1990 and 2000, but only by 10.2% between 2000 and 2010. Some increase would be expected, given a rising population, so it is more significant that though women's share of bachelor's degrees in engineering rose from 15.4% to 20.6% between 1990 and 2000, it fell back to 18.2% by 2010.[12] Consistent with this, Figure 1 gives no indication that younger cohorts of women were patenting more in 2003 and might now have reached a middle age patenting peak like their male colleagues.[13]

The results point to the need to increase the share of women in engineering and in jobs involving development and design, to complement policies stemming from papers examining the smaller gender patenting rate gap existing among workers already in such jobs. To increase female representation in engineering, policies should address high female outflows from engineering as well as low female inflows into engineering: Hunt (2010) demonstrated that women trained as engineers disproportionately leave engineering jobs due to dissatisfaction with pay and promotion. To increase the share of women in design and development tasks, Figure 1 suggests that policies should target young women: women do not appear to get on the first step of escalator leading to large numbers of patents in middle age, as their patents are well below men's even at the youngest ages in the sample.

Small–scale remedies are already being applied by universities, companies, and professional organizations, but they lack rigorous evaluation.[14] Seeking to increase female and minority enrollments in engineering, the National Science Foundation–supported 4Δ initiative focuses on outreach to girls and minority youth to stimulate their interest in and better inform them about engineering. This collaboration of four engineering profes-

[12] Statistics from www.nsf.gov/statistics/wmpd/sex.cfm .

[13] In principle, one cannot distinguish cohort, age and time effects from the graph, however.

[14] E.g. The MIT Women's Initiative (web.mit.edu/wi/) and High–Tech High Heels (hightechhighheels.org), the latter supported by Texas Instruments; accessed 20 August 2012.

sional societies stresses the need for assessment to establish best practices, yet evaluation appears to consist of before and after comparison of participants.[15]

What is required are randomized trials of both outreach interventions and other potential remedies. A precedent has been established by the American Economic Association, which has randomized and evaluated its mentoring program for women, with grants and publications as the outcomes (Blau et al. 2010). In addition to these randomized trials, there is a need for non–experimental research on gender and the choice of S&E college majors to distinguish between science and engineering: Stinebrickner and Stinebrickner (2011) study the decision to major in science and math in a liberal arts college where engineering is not an option; Zafar (forthcoming) uses data from a university at which engineering school students must declare their engineering major on entering college, and therefore drops these students.

Successful policies are likely to include increasing high school girls' awareness of engineering as a viable career option and of the necessity of taking appropriate math in high school, university reforms to the widespread requirement that students commit to engineering before enrollment, and mentoring programs connecting design and development engineers in industry with female engineering students or early–career female engineers. The intriguing Mentoring Experiment might provide useful tools for matching mentors and mentees.[16] Aimed at information technology professionals using the SQL Server database, it matches less experienced workers with volunteer mentors online, advertising in SQL Server–related fora. Fewer obvious tools are available to combat any employer discrimination or incompatibility of work cultures that may play a role, though diversity training, possibly evaluated with implicit bias tests (implicit.harvard.edu/implicit/demo/), is one option.

[15] outreach4change.org/index.php?option=com_content&view=article&id=13&Itemid=16 and www.nsf.gov/awardsearch/showAward.do?AwardNumber=0937306, accessed 20 August 2012.

[16] thementoringexperiment.org, accessed 20 August 2012.

References

Ashcraft, Catherine and Anthony Breitzman. 2007. "Who Invents IT? An Analysis of Women's Participation in Information Technology Patenting". National Center for Women and Information Technology.

Blau, Francine D., Janet M. Currie, Rachel T. A. Croson and Donna K. Ginther. 2010. "Can Mentoring Help Female Assistant Professors? Interim Results from a Randomized Trial." *American Economic Review*, 100 (2) 348–352.

Boskin, Michael J. and Lawrence J. Lau. 2000. "Generalized Solow Neutral Technical Progress and Postwar Economic Growth". NBER Working Paper 8023.

Cook, Lisa and Chaleampong Kongcharoen. 2010. "The Idea Gap in Pink and Black". NBER Working Paper 16,331.

Ding, Waverly W., Fiona Murray and Toby E. Stuart. 2006. "Gender Differences in Patenting in the Academic Life Sciences". *Science*, 313 665–667.

Frietsch, Rainer, Inna Haller, Melanie Funken–Vrohlings, and Hariolf Grupp. 2009. "Gender–specific patterns in patenting and publishing". *Research Policy*, 38 590–599.

Hunt, Jennifer. 2010. "Why Do Women Leave Science and Engineering?". NBER Working Paper 15853.

Murray, Fiona and Leigh Graham. 2007. "Buying science and selling science: gender differences in the market for commercial science". *Industrial and Corporate Change*, 16 (4) 657–689.

National Academy of Sciences, National Academy of Engineering and Institute of Medicine. 2007. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future*, Washington, D.C.: The National Academies Press.

National Women's Business Council. 2012. "Intellectual Property and Women Entrepreneurs: Quantitative Analysis". nwbc.gov/research/intelletual-property-women-entrepreneurs, accessed 19 August 2012.

Stephan, Paula, Gurmu Shiferaw, A.J. Sumell and Grant Black. 2010. "Who's Patenting in the University? Evidence from the Survey of Doctorate Recipients". *Economics of Innovation and New Technology*, 19 (5) 481–503.

Stinebrickner, Todd and Ralph Stinebrickner. 2011. "Math or Science? Using Longitudinal Expectations Data to Examine the Process of Choosing a College Major". University of Western Ontario working paper.

Thursby, Jerry G. and Marie C. Thursby. 2005. "Gender Patterns of Research and Licensing Activity of Science and Engineering Faculty". *Journal of Technology Transfer*, 30 343–353.

U.S. Bureau of Labor Statistics. 2011. “Highlights of Womens Earnings in 2010”. www.bls.gov/cps/cpswom2010.pdf, accessed 22 August 2012.

U.S. Patent and Trademark Office. 1999. “Buttons to Biotech: 1996 Update Report with supplemental data through 1998”. www.uspto.gov/web/offices/ac/ido/oeip/taf/wom_98.pdf, accessed August 20, 2012.

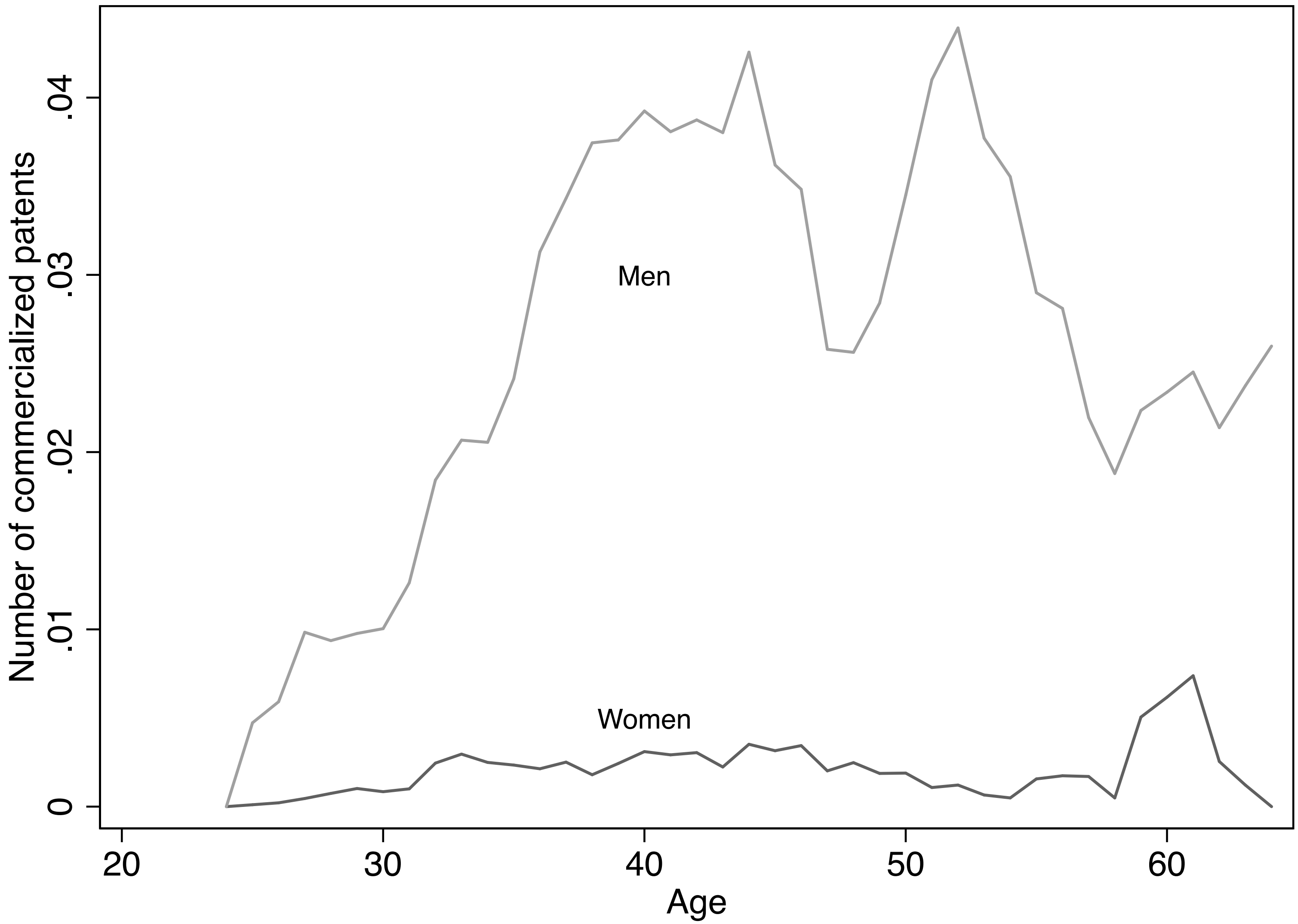
Whittington, Kjersten Bunker. 2011. “Mothers of Invention? Gender, Motherhood, and New Dimensions of Productivity in the Science Profession”. *Work and Occupations*, 38 (3) 417–456.

Whittington, Kjersten Bunker and Laurel Smith–Doerr. 2005. “Gender and Commercial Science: Women’s Patenting in the Life Sciences”. *Journal of Technology Transfer*, 30 355–370.

Whittington, Kjersten Bunker and Laurel Smith–Doerr. 2008. “Women Inventors in Context: Disparities in Patenting Across Academia and Industry”. *Gender and Society*, 22 194–218.

Zafar, Basit. Forthcoming. “College Major Choice and the Gender Gap”. *Journal of Human Resources*.

Figure 1: Commercialized or licensed patents per capita



Note: The sample is respondents who have ever worked, with one outlier dropped (see text). Weighted using survey weights. Age is measured in years and a moving average with one lag and one lead is applied to smooth the series.

Table 1: Statistics on sample of patents

	Patents granted			Patents commercialized		
	All	Male inventors	Female inventors	All	Male inventors	Female inventors
	(1)	(2)	(3)	(4)	(5)	(6)
Female inventor	0.075	0	1	0.055	0	1
Commercialized	0.773	0.785	0.617	1	1	1
S&E degree holder	0.738	0.737	0.761	0.684	0.681	0.730
Observations	2070	1833	237	1299	1173	126

Note: Weighted using survey weights. An observation corresponds to a patent. S&E denotes science and engineering.

Table 2: Patenting rates by gender among holders of science and engineering degrees

	All	S&E degree holders		Non-S&E degree holders	
		Male	Female	Male	Female
	(1)	(2)	(3)	(4)	(5)
A. Patents granted					
Number	0.032	0.131	0.025	0.023	0.001
Any (%)	1.0	4.4	1.0	0.6	0.1
B. Patents commercialized					
Number	0.019	0.074	0.011	0.017	0.001
Any (%)	0.7	2.9	0.6	0.4	0.1
Observations	88,094	25,568	9607	23,754	29,165

Note: Weighted using survey weights. Samples are drawn from respondents who have ever worked. S&E denotes science and engineering.

Table 3: Respondent fields of study and associated patenting statistics

	Highest degree		Patents granted		Patents commercialized		
	Men (%)	Women (%)	Any (%)	Number	Any (%)	Number	As % patents granted
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. S&E degree holders							
Computer Science	11.0	12.7	1.9	0.04	1.3	0.03	64.4
Mathematics	5.2	8.5	1.2	0.02	0.8	0.01	65.2
Life Sciences	14.2	26.5	2.2	0.06	1.1	0.02	39.3
Physical sciences	8.5	7.4	6.5	0.22	3.7	0.10	45.3
Civil engineering/ architecture	5.5	1.6	1.1	0.03	0.7	0.02	62.4
Electrical engineering	11.3	3.5	8.1	0.28	5.7	0.18	62.3
Chemical engineering	3.5	2.3	6.4	0.20	4.6	0.12	59.4
Mechanical/industrial engineering	13.8	4.0	6.2	0.18	4.2	0.11	61.7
S&E-related fields	10.1	15.0	1.2	0.03	0.7	0.01	42.6
Social sciences	1.8	2.7	2.1	0.03	1.5	0.02	71.9
Other non-S&E	15.2	15.9	2.1	0.06	1.5	0.03	56.0
All	100.0	100.0	3.4	0.10	2.2	0.06	55.4
Observations	24,575	10,600		35,175			--
B. Non S&E degree holders							
Technology	2.2	0.3	2.5	0.04	1.9	0.03	67.2
Other S&E-related	7.7	14.3	0.3	0.01	0.2	0.00	61.9
Social science	13.8	13.1	0.3	0.01	0.2	0.00	19.4
Other non-S&E	76.2	72.4	0.3	0.01	0.2	0.01	83.2
All	100.0	100.0	0.3	0.01	0.2	0.01	70.5
Observations	23,754	29,165		52,919			--

Note: Weighted using survey weights. Samples are drawn from respondents who have ever worked. Column 7 is based on the ratio of columns 6 and 4. S&E denotes science and engineering.

Table 4: Job characteristics for workers with S&E degrees

	Men (%) (1)	Women (%) (2)	Patents granted (3)	Patents commercialized (4)
How related is job to high degree?				
Closely related	59.6	59.3	0.133	0.073
Somewhat related	26.7	23.9	0.076	0.041
Unrelated	13.6	16.8	0.024	0.018
	100.0	100.0	--	--
Need S&E bachelor's knowledge?				
Yes	72.1	58.6	0.141	0.079
No	27.9	41.4	0.018	0.009
	100.0	100.0	--	--
At least 10% time in job spent on:				
Basic research?				
Yes	23.2	20.7	0.181	0.085
No	76.8	79.3	0.079	0.049
Applied research?				
Yes	35.6	30.4	0.227	0.121
No	64.4	69.6	0.038	0.024
Development?				
Yes	36.5	25.5	0.241	0.145
No	63.5	74.5	0.032	0.013
Design?				
Yes	38.1	20.0	0.209	0.127
No	61.9	80.0	0.049	0.022
Computer tasks?				
Yes	43.3	38.7	0.108	0.067
No	56.7	61.3	0.098	0.049
Management tasks?				
Yes	66.3	45.1	0.126	0.070
No	33.7	54.9	0.062	0.034

Note: Weighted with survey weights. 31,404 observations on respondents with an S&E degree who were working at the survey date. The job tasks questions are in answer to "Which of the following work activities occupied at least 10% of your time during a typical work week on this [principal] job?": Basic research – study directed towards gaining scientific knowledge primarily for its own sake; Applied research – study directed toward gaining scientific knowledge to meet a recognized need; Development – using knowledge gained from research for the production of materials, devices; Design of equipment, processes, structures, models; Computer applications, programming, systems development; Managing or supervising people or projects. S&E denotes science and engineering.

Table 5: Job characteristics for workers with no S&E degree

	Men (1)	Women (2)	Patents granted (3)	Patents commercialized (4)
Need S&E bachelor's knowledge?				
Yes	18.0	14.3	0.015	0.010
No	82.0	85.7	0.012	0.009
At least 10% time in job spent on:				
Basic research?				
Yes	15.8	13.1	0.008	0.004
No	84.2	86.9	0.013	0.010
Applied research?				
Yes	20.0	19.0	0.016	0.010
No	80.0	81.0	0.012	0.009
Development?				
Yes	23.8	20.2	0.043	0.037
No	76.2	79.8	0.004	0.001
Design?				
Yes	18.0	11.1	0.066	0.057
No	82.0	88.9	0.003	0.001
Computer tasks?				
Yes	29.7	26.8	0.011	0.007
No	70.3	73.2	0.013	0.010
Management tasks?				
Yes	65.3	53.1	0.017	0.015
No	34.7	47.9	0.006	0.001

Note: Weighted with survey weights. 45,508 observations on respondents without an S&E degree who were working at the survey date. See Table 4 for the exact questions about job tasks. S&E denotes science and engineering.

Table 6: Decomposition of the gender gap in number of commercialized patents (%)

	Number of patents		Probability of any patent	Number of patents | any patent
	Full sample	Sample without one male non-S&E outlier		
	(1)	(2)	(3)	(4)
Between S&E, non-S&E degree holders	5.6	7.1	9.4	11.0
Within S&E degree holders	62.1	78.4	71.7	74.1
Within non-S&E degree holders	32.4	14.5	18.9	15.0
Total	100.0	100.0	100.0	100.0

Note: S&E denotes science and engineering.

Table 7: Probability of commercializing or licensing a patent

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. S&E degree holders									
Female	-0.0230***	-0.0224***	-0.0152***	-0.0130***	-0.0131***	-0.0129***	-0.0126***	-0.0120***	-0.0089***
	(0.0014)	(0.0014)	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0016)	(0.0015)	(0.0015)
R^2	0.01	0.01	0.03	0.04	0.04	0.04	0.04	0.04	0.05
B. Non S&E degree holders									
Female	-0.0032***	-0.0031***	-0.0029***	-0.0028***	--	-0.0028***	-0.0027***	-0.0025***	-0.0021***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)		(0.0005)	(0.0005)	(0.0005)	(0.0005)
R^2	0.00	0.00	0.01	0.01	--	0.01	0.01	0.01	0.01
Race, ethnicity, immigrant	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fields of study	--	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Highest degree	--	--	--	Yes	Yes	Yes	Yes	Yes	Yes
Level of S&E degree	--	--	--	--	Panel A	Panel A	Panel A	Panel A	Panel A
Potential experience	--	--	--	--	--	Yes	Yes	Yes	Yes
Labor force status	--	--	--	--	--	--	Yes	Yes	Yes
Need S&E knowledge,	--	--	--	--	--	--	--	Yes	Yes
Job tasks	--	--	--	--	--	--	--	--	Yes

Note: Coefficients from least squares regressions weighted with survey weights; robust standard errors. The panel A sample has 35,175 observations, the panel B sample 52,919. Race and ethnicity controls are dummies for Asian, black non-Hispanic, Hispanic any race and mixed race non-Hispanic. Immigrant controls are dummies for born abroad non-citizen, born abroad as U.S. citizen, born in U.S. territories. Fields of study controls are 142 (83 in panel B) dummies for field of study of highest degree, and 29 (14 in panel B) dummies for field of study of bachelor's degree. Highest degree controls are dummies for master's, doctoral and professional degrees. Level of S&E degree comprises four dummies for bachelor's, master's, doctoral and minor degrees in science or engineering. Potential experience is controlled with six age dummies and five dummies for years since highest degree. Labor force status comprises a dummy for employed, the number of years since last employment interacted with employment, and dummies for fulltime master's student, fulltime doctoral student, and other student. Need S&E knowledge is a dummy for whether the respondent reported that bachelor's degree level knowledge of science or engineering was necessary for the job. Study/job relatedness controls are two dummies for the current job is closely or fairly closely related to the field of study of highest degree. Jobs tasks are dummies for whether the respondent spends more than 10% of work time on basic research, applied research, development, design, computer tasks or management. Job covariates are interacted with an employment dummy. S&E denotes science and engineering.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 8: Determinants of number of commercialized patents, conditional on holding a commercialized patent

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. S&E degree holders									
Female	-0.174**	-0.177**	-0.239**	-0.228**	-0.236**	-0.185**	-0.167*	-0.165*	-0.095
	(0.078)	(0.079)	(0.083)	(0.084)	(0.086)	(0.089)	(0.088)	(0.088)	(0.090)
R^2	0.01	0.03	0.13	0.13	0.14	0.18	0.19	0.20	0.24
B. Non S&E degree holders									
Female	-0.365*	-0.388*	-0.376*	-0.382*	--	-0.592*	-0.635	-0.710	-0.611
	(0.196)	(0.209)	(0.191)	(0.201)		(0.346)	(0.415)	(0.496)	(0.486)
R^2	0.02	0.04	0.70	0.70	--	0.81	0.83	0.83	0.84
C. Non S&E degree holders, outlier dropped									
Female	-0.205*	-0.224*	-0.376*	-0.382*	--	-0.387	-0.370	-0.290	-0.120
	(0.120)	(0.130)	(0.192)	(0.202)		(0.245)	(0.276)	(0.304)	(0.336)
R^2	0.02	0.04	0.46	0.46	--	0.68	0.69	0.70	0.75
Race, ethnicity, immigrant	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fields of study	--	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Highest degree	--	--	--	Yes	Yes	Yes	Yes	Yes	Yes
Level of S&E degree	--	--	--	--	Panel A	Panel A	Panel A	Panel A	Panel A
Potential experience	--	--	--	--	--	Yes	Yes	Yes	Yes
Labor force status	--	--	--	--	--	--	Yes	Yes	Yes
Need S&E knowledge, study/job relatedness	--	--	--	--	--	--	--	Yes	Yes
Job tasks	--	--	--	--	--	--	--	--	Yes

Note: The dependent variable is the log of the number of licensed or commercialized patents. Coefficients from least squares regressions weighted with survey weights; robust standard errors. Each coefficient is from a different regression. The sample size in panel A is 1166 observations, in panel B is 133, in panel C is 132. In panel A, 85 fields of study of highest degree and 28 fields of study of bachelor's degree are represented in the sample; in panel B 46 fields of study of highest degree and 14 fields of study of bachelor's degree are represented in the sample; otherwise the covariates are described in the notes to Table 7. S&E denotes science and engineering.
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Probability of commercializing a patent, conditional on having been granted a patent

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. S&E degree holders									
Female	-0.097*	-0.092*	-0.024	-0.031	-0.031	-0.008	-0.004	-0.005	-0.014
	(0.049)	(0.050)	(0.047)	(0.047)	(0.047)	(0.046)	(0.046)	(0.046)	(0.047)
R^2	0.01	0.01	0.12	0.13	0.13	0.16	0.16	0.17	0.18
B. Non S&E degree holders									
Female	-0.088	-0.070	-0.184	-0.191	--	-0.195	-0.155	-0.192	-0.084
	(0.151)	(0.156)	(0.149)	(0.168)		(0.170)	(0.196)	(0.191)	(0.129)
R^2	0.00	0.07	0.51	0.54	--	0.65	0.66	0.69	0.74
Race, ethnicity, immigrant	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fields of study	--	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Highest degree	--	--	--	Yes	Yes	Yes	Yes	Yes	Yes
Level of S&E degree	--	--	--	--	Panel A	Panel A	Panel A	Panel A	Panel A
Potential experience	--	--	--	--	--	Yes	Yes	Yes	Yes
Labor force status	--	--	--	--	--	--	Yes	Yes	Yes
Need S&E knowledge, study/job relatedness	--	--	--	--	--	--	--	Yes	Yes
Job tasks	--	--	--	--	--	--	--	--	Yes

Note: Coefficients from least squares regressions weighted with survey weights; robust standard errors. The sample comprises respondents with a science or engineering degree who had been granted one or more patents. Panel A 1868 observations, panel B 202. In panel A, 84 fields of study of highest degree and 29 fields of study of bachelor's degree are represented in the sample; in panel B, 55 fields of study of highest degree and 14 fields of study of bachelor's degree are represented in the sample; otherwise the covariates are described in the notes to Table 7. S&E denotes science and engineering.

*** p<0.01, ** p<0.05, * p<0.1

Appendix Table 1: Weighted means of full samples

	S&E degree holders		Non-S&E degree holders	
	Men	Women	Men	Women
Asian, non-Hispanic	0.12	0.14	0.04	0.05
Black, non-Hispanic	0.04	0.07	0.06	0.08
Hispanic, any race	0.04	0.05	0.04	0.04
Mixed race, non-Hispanic	0.01	0.01	0.01	0.01
Foreign born	0.20	0.21	0.08	0.09
American born abroad	0.01	0.01	0.01	0.01
Born U.S. territories	0.00	0.00	0.00	0.00
Bachelor's highest degree	0.55	0.56	0.68	0.67
Master's highest degree	0.29	0.29	0.22	0.28
Doctorate highest degree	0.08	0.06	0.03	0.02
Professional highest degree	0.08	0.09	0.07	0.03
College minor in S&E?	0.18	0.22	--	--
Bachelor's in S&E?	0.89	0.83	--	--
Master's in S&E?	0.22	0.18	--	--
Doctorate in S&E?	0.07	0.05	--	--
Age	44.8	41.8	45.1	43.7
	(10.0)	(9.7)	(10.1)	(10.0)
Years since highest degree	17.5	14.8	18.3	16.4
	(10.3)	(9.8)	(10.2)	(10.0)
Student MA full time	0.01	0.01	0.01	0.01
Student PhD full time	0.01	0.01	0.00	0.00
Other student	0.05	0.01	0.04	0.06
Employed	0.91	0.82	0.91	0.80
Years since last worked ×	0.24	0.91	0.26	1.03
not employed	(1.47)	(3.37)	(1.60)	(3.51)
Observations	25,568	9607	23,754	29,165

Note: Weighted using survey weights. Standard deviations in parentheses. Samples are drawn from respondents who have ever worked. S&E denotes science and engineering.

Appendix Table 2: Weighted means of samples of inventors of commercialized patents

	S&E degree holders		Non-S&E degree holders		
	Men	Women	Men (a)	Men (b)	Women
Patents commercialized	2.6	1.8	4.7	1.9	1.2
	(3.5)	(1.5)	(13.8)	(2.1)	(0.4)
Patents granted	3.5	2.7	5.0	2.2	1.5
	(5.0)	(3.2)	(13.9)	(2.9)	(0.6)
Patents commercialized					
1	0.52	0.60	0.61	0.64	0.76
2	0.20	0.19	0.20	0.20	0.24
3-10	0.25	0.21	0.13	0.14	0
More than 10	0.02	0	0.06	0.02	0
Asian, non-Hispanic	0.14	0.20	0.07	0.07	0.00
Black, non-Hispanic	0.01	0.01	0.02	0.03	0.05
Hispanic, any race	0.01	0.06	0.03	0.03	0.01
Mixed race, non-Hispanic	0.01	0.05	0.02	0.02	0.11
Foreign born	0.24	0.30	0.12	0.13	0.07
American born abroad	0.02	0.01	0.02	0.02	0.00
Born U.S. territories	0.00	0.00	0.00	0.00	0.00
Bachelor's highest degree	0.42	0.30	0.77	0.76	0.59
Master's highest degree	0.32	0.43	0.17	0.17	0.23
Doctorate highest degree	0.24	0.26	0.04	0.04	0.10
Professional highest degree	0.03	0.01	0.03	0.03	0.09
College minor in S&E?	0.78	0.23	--	--	--
Bachelor's in S&E?	0.96	0.87	--	--	--
Master's in S&E?	0.37	0.48	--	--	--
Doctorate in S&E?	0.23	0.24	--	--	--
Age	45.5	43.5	44.9	44.9	43.4
	(9.01)	(9.4)	(8.3)	(8.4)	(9.6)
Years since highest degree	17.6	15.1	19.6	19.6	14.2
	(9.6)	(9.4)	(8.6)	(8.7)	(9.1)
Student MA full time	0.00	0.00	0.02	0.02	0.01
Student PhD full time	0.00	0.01	0.00	0.00	0.00
Other student	0.03	0.05	0.04	0.05	0.12
Employed	0.92	0.88	0.98	0.98	0.72
Years since last worked ×	0.13	0.24	0.01	0.01	0.18
not employed	(0.73)	(0.92)	(0.12)	(0.13)	(0.63)
Observations	1059	107	114	113	19

Note: Weighted using survey weights. Standard deviations in parentheses. Samples are for respondents who hold commercialized patents. A high outlier in terms of number of commercialized or licensed patents has been dropped from the fourth column of numbers: Men (b). S&E denotes science and engineering.

Appendix Table 3: Means used for decomposition of Table 6

	All		S&E degree		Non-S&E degree	
	Men	Women	Men	Women	Men	Women
A. Full samples						
$\overline{N}$ Number of patents	0.036	0.002	0.074	0.011	0.017	0.001
P Probability of patenting	0.012	0.001	0.029	0.006	0.004	0.001
$\widetilde{N}$ Number of patents | any patent	3.01	1.62	2.58	1.82	4.68	1.24
P^S Probability of S&E degree	0.331	0.142	1	1	0	0
B. Dropping one male non S&E outlier						
$\overline{N}$ Number of patents	0.029	--	--	--	0.007	--
P Probability of patenting	0.012	--	--	--	0.003	--
$\widetilde{N}$ Number of patents | any patent	2.43	--	--	--	1.86	--
P^S Probability of S&E degree	0.331	--	--	--	0	--

Note: Mean weighted with survey weights. "Patents" refers to patents commercialized or licensed. The number of observations is different in each cell, and is one smaller in each cell in panel B compared to the corresponding cell in panel A. S&E denotes science and engineering.