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Why are women underrepresented amongst patentees?

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ABSTRACT

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.

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 U.S. 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 technological 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 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

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[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] http://www.whitehouse.gov/blog/2010/12/06/president-obama-north-carolina-our-generation-s-sputnik-moment-now (accessed 21.08.12).

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explore 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 over a five-year window, PhDs are granted 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 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 suggest that increasing women's representation in electrical and mechanical engineering, relative to life sciences, and in jobs involving design and development, would increase female patenting. Whether this approach has the desired effect naturally depends upon how the representation is increased. We discuss policies that will increase the average quality of women 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 women: 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 patentees we work with has

[4] Ding et al. (2006), Thursby and Thursby (2005), Whittington (2011), and 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.

[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.