

War, Innovation, and Gender

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Did increased women's participation in the labor market during World War II affect the level of female innovation during the war and in its aftermath? During the five years of World War II, women's labor force participation in the US rose by almost half in the economy overall and even more in some industries such as durable manufacturing which produced many goods – e.g. airplanes – that were necessary for the war effort (Rose, 2018). Wages for women also increased significantly as they accessed jobs traditionally reserved for union men (Schweitzer, 1980). Over that period, women learned new skills and were exposed to different production technologies in industries previously closed to them. Goldin and Olivetti (2013) find that the increase in labor supply particularly affected the top half of the education distribution, which tends to be more innovative. World War II represented a highpoint for women's participation in the labor market, and while factories laid off workers after the war as they reverted their activity back to peacetime production, a substantial share of women remained in the labor force after the return of men (Goldin, 1991). The evidence points to lasting effects of the war on the labor supply of women (Clark and Summers, 1982) and thus we could expect lasting effects on innovation as well.

We argue that the World War II increase in women's labor force participation could have affected post-war innovation in ways that are both direct – a rise in innovation by women – and indirect – increased innovation by men. In terms of the direct pathways,

gains in the labor force by women were most pronounced after war in skilled positions that often require tertiary degrees (Goldin and Olivetti 2013) and in the manufacturing of durable goods (Rose 2018). Wartime demands for expertise in science and technology created new opportunities for women's education and women gained knowledge about such things as chemistry, mechanics, and engineering. Because women were more likely to stay in these positions after war and had gained knowledge and expertise pertinent to patentable technologies, they were more likely to file patents after war. One interesting example is the case of Mary Sherman Morgan who was studying chemistry in college when World War II broke out. Due to a shortage of male chemists, a munitions factory recruited her to manufacture explosives. Continuing her employment after the war, she is known for her 1957 invention of a liquid fuel which powers satellite rockets.¹

Indirectly, women's labor force participation increases contact with men as their peers. This can boost innovation by males in a variety of ways. Research shows that an increase in employee diversity advances innovation (Ostergaard et al., 2011) so the introduction of women in the workforce should have that effect. Moreover, there is a body of work on how peer effects contribute to the diffusion of innovation (Munshi, 2004; Bandier and Rasul, 2006). Finally, this peer-to-peer contact could enhance men's knowledge about the challenges and needs of women. As a result, it is possible that patent filings by men after the war could increase for technologies that disproportionately benefit women (such as appliances relating to household chores).

Following Acemoglu, Autor, and Lyle (2004), we exploit male mobilization rates across US states to identify female labor supply changes and examine their effect on patent filings by women. The data is drawn from the published tables of the Selective Service System (1956). The male mobilization rate varies across US states due to exemptions for men employed in farming, the age and racial composition of the state population, and differences in local draft rules notably related to the frequency of the draft. As a

¹ https://en.wikipedia.org/wiki/Mary_Sherman_Morgan. For other examples see <https://news.yale.edu/2017/02/10/grace-murray-hopper-1906-1992-legacy-innovation-and-service>

result, some states observed a male mobilization rate of 54 percent while in others it reached only 40 percent. We combine the mobilization data with patent data from the PATSTAT dataset, which includes the names and addresses of all inventors. The address and zip codes allow us to allocate patents by state to match the mobilization rates. We also use a dataset called Gender by Name (2020) based on data from the Social Security Administration to attribute a gender to each inventor. We use the US census to obtain data on controls for state population composition such as race, education, age, and marital status.

The PATSTAT data allows us to identify the person or team responsible for filing new patents. We can differentiate patents where inventors are exclusively women from patents where women are co-inventors with men. We can also determine the end-use of the patent by industry to examine whether the industries known for having had a larger shock in terms of female participation were more likely to see an increase in filings by female inventors. Moreover, some keywords in the patent title can shed light on whether patent filings by women target technologies used primarily by women, possibly household items that reduce unpaid home labor. Importantly, using the citations data of the patent helps us observe whether the rise in patent filings might be building increasingly on patents that also have female inventors.

This paper makes a number of contributions. War often has transformative effects on society as those who sacrificed for one's country during war make greater demands on the state afterward. World War II is no different, with both Civil Rights and Women's Rights movements accelerating in its wake. This paper offers one additional pathway through which wartime conditions—in this case, labor force opportunities for women—can transform society by increasing innovations by women and innovations often affecting women. Indeed, innovations like the washing machine were often critical to securing greater economic freedom for women (Coen-Pirani, León, and Lugauer 2010). Second, the relationship between economics and war typically focuses on trade, domestic economic strife, conquest for resources, and hegemony. In this paper, we

investigate how wars can challenge a different dimension of economics – domestic economic inequalities – by contributing to the rise of a female innovative force.

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