The Missing Men

World War I and Female Labor Force Participation

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ABSTRACT

Using spatial variation in World War I military fatalities in France, we show that the scarcity of men due to the war generated an upward shift in female labor force participation that persisted throughout the interwar period. Available data suggest that increased female labor supply accounts for this result. In particular, deteriorated marriage market conditions for single women and negative income shocks to war widows induced many of these women to enter the labor force after the war. In contrast, demand factors such as substitution toward female labor to compensate for the scarcity of male labor were of second-order importance.

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> The major fact will be a breakdown of the equilibrium between sexes. There will not be enough suitors for all young women searching for a husband. […] The prospect of remaining single will induce most young women to worry about getting an occupation to make their living and to be self-sufficient.
>
> —Girault (1915), p. 443–4

I. Introduction

The dramatic rise of female labor force participation has been one of the most significant changes to labor markets in the past century (Olivetti and Petrongolo 2016). This "quiet revolution" has been mostly interpreted as a consequence of long-run trends in technological change (Goldin 2006).[1] Less understood is the role of idiosyncratic historical events, such as shocks to the adult sex ratio, which can at times stall or propel the secular march toward gender equality by disrupting labor market conditions both in the short and the long run (Angrist 2002; Grosjean and Khattar 2019; Teso 2019). Indeed, implications of such imbalances and the mechanisms through which they materialize are often challenging to identify because they typically result from factors that gradually shape labor market structures as well (Qian 2008; Carranza 2014).

In this article, we provide evidence that jolts of history can generate rapid and long-lasting changes to women's involvement in the economy. We overcome identification issues by using World War I (WWI) in France as a severe exogenous shock to the adult sex ratio and show that it generated a persistent upward shift in female labor force participation during the interwar period. While WWI ravaged continental Europe between 1914 and 1918, France suffered an especially high death toll relative to other belligerent countries. Because of a universal conscription system, most French male citizens were drafted throughout the war. Out of ten million men aged 15–50 before the war, eight million were drafted in the army; 1.3 million died in combat—a military death rate of 16 percent. As a result, the sex ratio among adults aged 15–50 dropped from 98 men per 100 women at the onset the war to 88 by the end of the war. It was not until after World War II (WWII) that the sex ratio reverted back to balance (Figure 1).

Our empirical strategy exploits differential changes in female labor force participation rates before and after the war across départements that experienced different military death rates.[2] Key to our contribution, we collected the individual military records of these 1.3 million missing men to build a precise measure of military death rates at the département level. While the relationship between military death rates and changes in female labor force participation rates was flat between 1901 and 1911, it exhibits a positive slope of 0.4 between 1911 and 1921 (Figure 2). Difference-in-differences estimates confirm this relationship. In départements that experienced military death rates of 20 percent rather than 10 percent—equivalent to switching from the 25th to the

1. For instance, the increasing availability of household appliances liberated women's time for market work (Greenwood, Seshadri, and Yorukoglu 2005). Alternatively, the structural transformation increased the supply of service sector jobs, in which women have a comparative advantage (Ngai and Petrongolo 2017).

2. Départements constitute the second level of France's administrative subdivisions, between regions and arrondissements. They are broadly comparable to English and U.S. counties, German Landkreises, and Spanish provincias. There were 87 départements before the war.

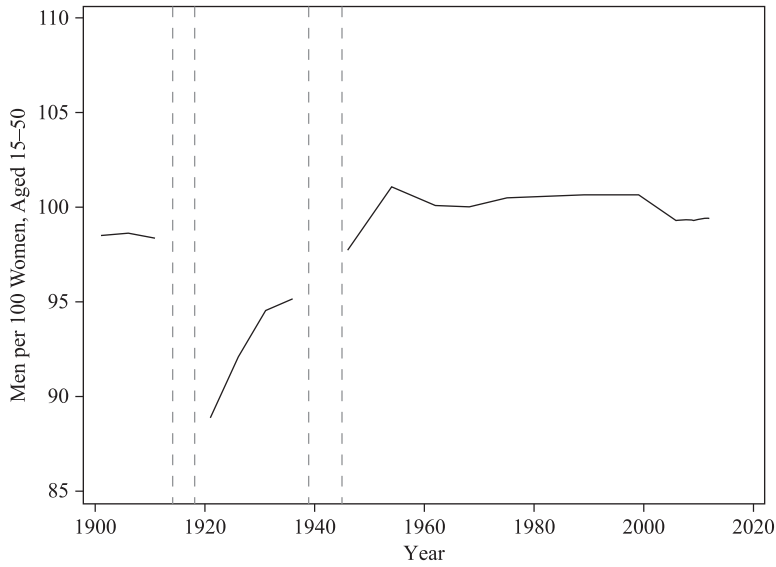

Figure 1

Adult Sex Ratio (1900–2012)

Notes: This figure displays the sex ratio among French adults aged 15–50. Data are from the censuses 1900–2012. Vertical lines indicate WWI (1914–1918) and WWII (1939–1945).

75th percentile of the distribution—female labor force participation rates were 3.5 percentage points higher throughout the interwar period, an increase of 11 percent relative to prewar levels. Eighty percent of the effect we identify stems from women entering the industrial sector, with a shift of the labor force toward blue-collar occupations and self-employment.

Next, we explore the validity of identifying assumptions. Military death rates were not randomly distributed; they were greater in rural départements due to the policies implemented by the Ministry of War to sustain the industrial war effort. Importantly, this does not invalidate our identification strategy, as military death rates were not correlated with pre-war trends in female labor force participation. Allowing for département-specific time trends, region-by-year fixed effects, or time-varying heterogeneity across départements (Bonhomme and Manresa 2015) generates results that are in line with the baseline estimate. Moreover, an instrumental variables strategy that exploits discontinuities in the timing of military service across cohorts yields similar results.

Data available for this time period suggest that supply factors related to changes in post-war marriage market conditions constitute a potentially important explanation for the patterns we identify. In particular, information on female labor force participation among widowed women indicates that these women were responsible for nearly half of the overall impact of WWI military fatalities on female labor force participation. We interpret this result as the consequence of increased labor supply due to negative income shocks experienced by war widows, whose pensions remained very low until the early

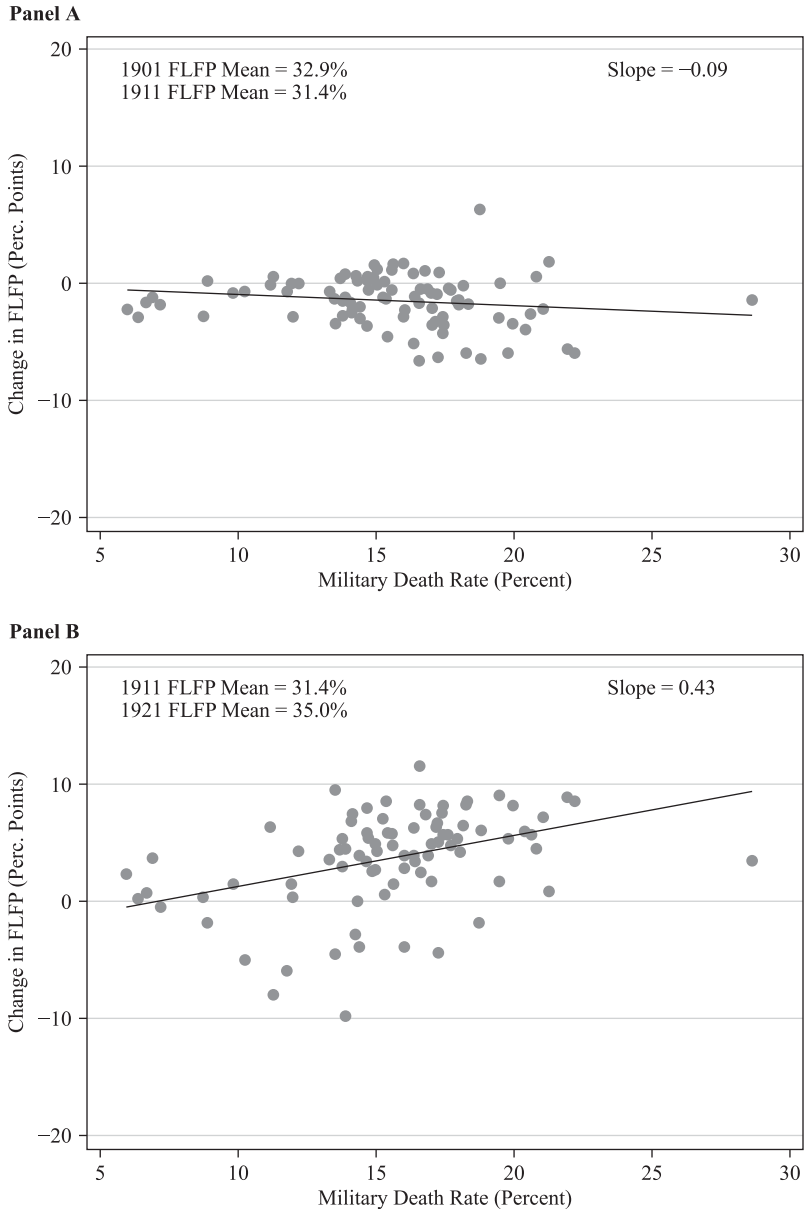

Figure 2

WWI Military Death Rates and Changes in FLFP

Notes: FLFP denotes female labor force participation rates in percent. Each dot represents one of 87 départements. The vertical axis represents changes in female labor force participation rates in percentage points between 1901 and 1911 in Panel A and between 1911 and 1921 in Panel B.

1930s. We also find that single women in départements more affected by the war delayed marriage, which likely induced them to enter the labor force while searching longer for a husband. In contrast, our analysis suggests that labor demand factors were of second-order importance. While post-war female employment rose, female wages declined in the manufacturing sector, as well as in the domestic services sector, across occupations in which men and women were closer substitutes. Therefore, substitution of firms from male labor to female labor was likely limited. To compensate for the scarcity of the male labor input, firms instead slightly increased their stock of physical capital. Finally, we find no evidence that female wartime employment was correlated with military death rates, nor that it generated a rise in female labor force participation after the war.

The remainder of the article is organized as follows. Section II discusses our contributions and the related literature, Section III describes the data and historical context, Section IV presents the main results, Section V explores the mechanisms, and Section VI concludes.

II. Contributions and Related Literature

We contribute to the literature that explores implications of war mobilization and fatalities on female labor force participation. Starting with Goldin (1991), this literature has extensively focused on the case of WWII in the United States, broadly suggesting that wartime mobilization generated an inflow of women into the labor force and that some of them kept working after the war (Acemoglu, Autor, and Lyle 2004**;** Goldin and Olivetti 2013; Doepke, Hazan, and Maoz 2015). Rose (2018) nuances these findings. Using direct measurement of female work during the war and of the drafting process, he shows that female wartime employment had little overall effect on female labor force participation after the war beyond a reallocation of female jobs from the nondurable manufacturing sector to the durable manufacturing sector. He further highlights that the correlation between female wartime employment and war mobilization is much weaker than previously thought. Finally, he finds no relationship between WWII military fatalities and post-war female labor force participation. Our study provides renewed evidence for the consequences of wars on female labor force participation, albeit in a different context. While, as Rose (2018), we find no evidence for a relationship between female wartime employment and post-war female labor, we show that the permanent loss of men due to the war generated a substantial inflow of women into the labor force after the war.

In that respect, our analysis helps clarify historical debates. Perhaps prompted by aggregate trends in female labor force participation that rapidly reverted to pre-war levels, contemporaneous historiography has emphasized that WWI in France was far from an engine of liberation for women (Thébaud 2013, p. 419–29).[3] The surge in female employment during the war was indeed short-lived. Nevertheless, by comparing relative changes in female labor force participation across départements that were

3. For instance, Françoise Thébaud concludes her seminal study by "[t]he war, which brought hundreds of thousands of women into factories and male sectors, appears as a parenthesis" (Thébaud 2013 [1986], p. 406). Her historical analyses, however, highlight that the consequences of the war varied across women depending on their social origin, residence location, and age (Thébaud 1992).

differentially affected by military fatalities, our study paints a nuanced picture: the war increased women's presence in the labor force, but only as a result of disruptions that mostly materialized after the war.

Implications of WWI in France for marriage and fertility outcomes have also been the subject of recent research. Most related to our article, Abramitzky, Delavande, and Vasconcelos (2011) show that women in regions that experienced greater military death rates faced deteriorated post-war marriage prospects.[4] To explain post-war patterns in fertility and female marriage choices, Vandenbroucke (2014) and Knowles and Vandenbroucke (2019) build and calibrate models of fertility choices and marital matching. All three studies rely on military fatalities data from Huber (1931, p. 426), which are only available across 22 regions and the accuracy of which has been challenged by historians (Prost 2008). Besides studying alternative consequences of the war over a longer time horizon, our analysis employs a measure of military death rates that builds upon the collection of 1.3 million individual military records (Gay and Boehnke 2020). Our measure is therefore more accurate than that in the literature as it varies across 87 units rather than just across 22. In fact, we show that variation in the Huber (1931) data is insufficient to precisely identify the effect of WWI military fatalities on female labor force participation.

Our study also contributes to our understanding of the consequences of permanent sex ratio imbalances on female labor force participation. Economic theories of marriage imply that the scarcity of one gender impacts women's working behaviors through its effects on marriage market conditions. For instance, in Grossbard's (2014) demand and supply model of marriage, a scarcity of men decreases the implicit market price of women's work in the household, which in turn increases women's supply of labor through an income effect. Collective models of household labor supply yield similar conclusions (Chiappori 1992). These theoretical predictions have been tested using various sources of variation in sex ratios, such as natural fluctuations in cohort sizes or migration shocks. For instance, exploiting sex ratio differences across cohorts in the United States between 1965 and 2005, Amuedo-Dorantes and Grossbard (2007) find a negative correlation between sex ratios and women's participation in the labor force. Alternatively, Angrist (2002) shows that changes in immigrants' sex ratios in the United States between 1910 and 1940 induced second-generation immigrant women to marry more often, contributing to a decline in their participation in the labor force.[5] These permanent disruptions to sex ratios usually materialize progressively, generating equilibrium responses over time. Furthermore, they are typically the product of factors that also shape labor market structures, making it challenging to identify the mechanisms through which they translate (Qian 2008; Carranza 2014). We overcome these identification issues by using a permanent source of variation in adult sex ratios that is sharp—military fatalities were concentrated within a period of four years—large in magnitude, and exogenous to the outcome under scrutiny.

4. The consequences of male scarcity due to WWII for family formation and fertility have also been studied in the contexts of Bavaria, the United States, and Russia (Bethmann and Kvasnicka 2013; Jaworski 2014; Brainerd 2017).

5. Another strand of literature relies on temporary variations in sex ratios. For instance, Charles and Luoh (2010) find that rising male incarceration rates in the United States affected women's working behaviors through an impact on marriage market conditions.

Imbalances in sex ratios can further have far-reaching consequences for women's involvement in the economy. For instance, the scarcity of men in Africa due to the transatlantic slave trade between the 15th and 19th centuries resulted in higher participation of women in the labor force today (Teso 2019). Conversely, the scarcity of women in Australia due to the arrival of predominantly male British convicts throughout the 19th century resulted in lower participation of women in the labor force today (Grosjean and Khattar 2019). Little is known about the mechanisms that induced these long-run relationships to emerge in the first place: the historical nature of these phenomena generally implies a substantial lack of data at the time of the initial imbalance, preventing a proper analysis of the short-run mechanisms at play around the historical shock. This lack of quantitative evidence might jeopardize the validity of such persistence studies and, in particular, the credibility of their exclusion restrictions (Cantoni and Yuchtman 2020). By uncovering the initial channels through which sex ratio imbalances due to the war affected women's working behaviors in interwar France, our analysis provides sound foundations for exploring the mechanisms of long-run persistence of this historical episode. Such is done in Gay (2021), which shows that this historical shock to female labor transmitted to subsequent generations until today, mainly through parental intergenerational transmission channels. Overall, our article constitutes an important foundation to studies focused on the medium- and long-run consequences of gender imbalances in that it provides quantitative evidence for the mechanisms through which the relationship between male scarcity due to the war and female labor force participation emerged in the first place.

III. Data and Historical Context

A. Female Labor Force Participation (1901–1936)

Female labor force participation data at the département level are from the seven censuses between 1901 and 1936.[6] While farmers' wives were to be classified as labor force participants, not all census enumerators did so in 1901 (Maruani and Meron 2012, p. 33–5). For consistency in measurement, the analysis focuses on female labor force participation net of farmers' wives. Because these women were systematically classified as farm owners whenever recorded, we avoid potential measurement error by removing them from the labor force, as nearly all female farm owners were farmers wives. Moreover, this transformation enables us to focus on paid work.

Female labor force participation is the share of women aged 15 and older in the labor force.[7] Table 1 reports average female labor force participation rates for 1901–1936. While many women entered the labor force after the war, at least as many had dropped out by the late 1920s. Table 1 further motivates our focus on female labor net of farm owners: while the corrected measure remains stable at 33 percent between 1901 and 1906, the uncorrected measure increases by seven percentage points between these two censuses. Since there was no major shock to labor market conditions during this period,

6. Census years are 1901, 1906, 1911, 1921, 1926, 1931, and 1936, the last census before WWII. Online Appendix J provides comprehensive details about the sources of data used in this article.

7. This includes employed and unemployed women. Few unemployment benefits existed so individuals seldom had incentives to register—female unemployment rates were below 1 percent.

Table 1
Average Female Labor Force Participation Rates (1901–1936)

	1901	1906	1911	1921	1926	1931	1936
FLFP (net of farm owners)	32.9	32.7	31.4	35.0	29.9	30.1	28.1
FLFP (uncorrected)	45.0	51.9	51.5	55.7	49.6	49.4	47.0
Difference	12.1	19.2	20.1	20.7	19.7	19.3	18.9

Notes: This table reports average female labor force participation (FLFP) rates in percent across 87 départements.

the discrepancy appears solely due to inconsistent measurement in 1901. After 1901, the difference between the two measures remains stable, around 20 percentage points, suggesting that the transformation we operate does not introduce systematic biases.

B. Military Death Rates

To build a precise measure of military death rates at the département level, we collected the individual military records for the 1.3 million French soldiers who died because of the war from the Mémoire des Hommes archive maintained by the Ministry of Defense.[8] We then extracted their dates and départements of birth. The military death rate in a département is calculated as the ratio of deceased soldiers born in that département to the size of its drafted population, which we approximate by the male population aged 15–44 in 1911. This approximation is reasonable because all French male citizens aged 20–48 were subject to conscription at the onset of the war.

In Figure 3, we map the distribution of military death rates.[9] Military death rates range from 6 percent in Belfort to 29 percent in Lozère, with an average of 15 percent. Throughout the article, we interpret regression coefficients by comparing differences in outcomes across départements that experienced high military death rates (20 percent) rather than low military death rates (10 percent). This roughly corresponds to switching from a median département in the low military death rates group (25th percentile) to a median département in the high military death rates group (75th percentile).

Two types of inaccuracies could potentially affect the measure of military death rates. First, we assign military fatalities to a département through soldiers' départements of birth. However, these might have differed from their départements of residence at the onset of the war, as 19 percent of men aged 15–44 resided outside their département of birth in 1911. This could be problematic if pre-war migration flows were correlated with

8. This archive is accessible at http://www.memoiredeshommes.sga.defense.gouv.fr (accessed November 30, 2021). Online Appendix I provides more details about this database and discusses its advantage over Huber (1931, p. 426). The number of soldiers who ultimately died as a result of the war remains uncertain as some passed several years after the war due to injuries or illnesses contracted during the conflict, but the figure of 1.3 million is the consensus (Prost 2008). It is similarly difficult to assess the number of civilian fatalities; they are usually evaluated at 40,000 (Huber 1931, p. 310–4).

9. Data are missing for the three départements that belonged to Germany before the war—Bas-Rhin, Haut-Rhin, and Moselle. They are excluded throughout the analysis.

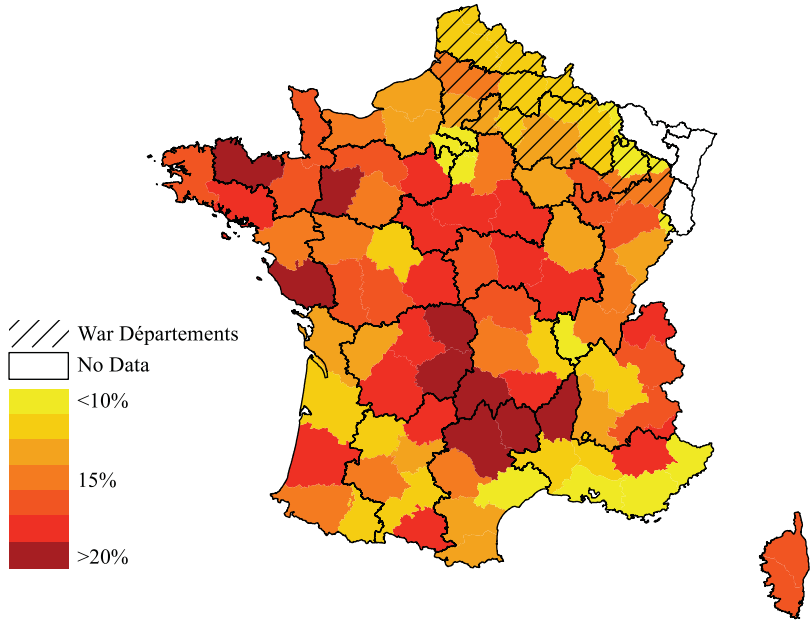

Figure 3

Distribution of Military Death Rates across 87 Départements

Notes: Data are missing for Bas-Rhin, Haut-Rhin, and Moselle. Shaded areas in the Northeast experienced war combats on their soil. Darker lines delineate military regions.

trends in female labor force participation. To alleviate this concern, we build a measure of military death rates that corrects for these patterns. Estimates with this corrected measure are similar to the baseline.

A second potential issue concerns the approximation of the pool of drafted men. We assume that men subject to conscription were drafted at similar rates across départements. However, 21 percent of them were initially exempted, mainly due to poor health (Huber 1931, p. 93).[10] Using military recruitment data by cohort together with health information, we show that differential recruitment rates across départements do not affect the results.

C. Sources of Variation in Military Death Rates

The distribution of military death rates was determined by the territorial organization of military recruitment and by demographic and economic factors. Rural départements

10. Recruitment rates nevertheless increased throughout the conflict as many conscripts previously deemed "unfit" were eventually recalled to compensate for heavy military casualties. For instance, 92 percent of the cohort aged 20 in 1914 was eventually drafted (Boulanger 2001, p. 118–28). Another potential concern might be that men younger than 20 and older than 48 voluntarily enlisted. These were relatively rare cases. While 26,000 men out of 188,000 conscripts voluntarily enlisted in 1914, only 11,000 out of 211,000 did so in 1915 (Boulanger 2001, p. 128–36).

experienced greater military death rates, a correlation generated by the policies implemented by the Ministry of War to sustain the industrial war effort. Nevertheless, the distribution of military death rates was not correlated with pre-war trends in female labor force participation.

1. The territorial organization of military recruitment

The territorial organization of the military structured both the recruitment and composition of military units. These were initially composed with soldiers residing in the same military region, so that soldiers from the same region were initially sent to the same battlefields. As a result, départements in different military regions experienced disparate military death rates. However, as casualties accumulated, the military command changed this policy: after only five months into the war, soldiers were allocated based on each unit's needs, so troops from different regions were increasingly mixed together (Boulanger 2001, p. 253). The resulting intraregional correlation in military death rates is therefore low at 0.12.

2. Economic and demographic factors

The systematic part of the variation in military death rates can be explained by demographic and economic factors. To see that, we regress military death rates on pre-war characteristics and report estimates in Table 2.[11] Départements that experienced greater military death rates had lower female labor force participation rates before the war (Column 1) and were more rural (Column 2). Rurality is captured through two measures: the share of rural population and the share of population born in the département.[12] Together, these two measures explain 74 percent of the variation in military death rates across départements. Pre-war differences in female labor force participation that are correlated with military death rates are fully captured by differences in rurality; the coefficient on female labor force participation is nonsignificant and close to zero once rurality is controlled for (Column 3). When 17 additional pre-war characteristics are further included, only rurality exhibits statistical significance, and corresponding coefficients barely change (Column 4). Finally, including 21 military-region fixed effects to compare neighboring départements generates similar estimates (Column 5).

The policies implemented by the Ministry of War to sustain the industrial war effort explain the correlation between military death rates and rurality. As the war lingered, the military command realized that its plan for supplying troops with weapons and machinery was dramatically insufficient (Porte 2005, p. 73–82). For instance, the plan of military mobilization did not mention the production of new military equipment, providing only for 50,000 workers allocated across 30 factories (Porte 2006, p. 26). To cope with the shortage of civilian labor and the German occupation of the industrial Northeast,

11. The full results for Table 2, Column 4, are available in Online Appendix Table A1.

12. Censuses define as "rural" the population that resides in municipalities with less than 2,000 inhabitants. The share of population born in the département is tied to fundamental aspects of French rurality as a measure of the intensity of the rural exodus during the late 19th century (White 2002). Average personal wealth, the share of active population in agriculture, and the share of cultivated land also capture some aspects of rurality, but all the variation in these variables is subsumed in variations in the two measures we propose.

Table 2
Military Death Rates and Pre-War Characteristics

	Dependent Variable: Military Death Rate				
	(1)	(2)	(3)	(4)	(5)
FLFP	–0.15***		0.03	–0.06	–0.01
	[0.05]		[0.03]	[0.07]	[0.07]
Rural		0.12***	0.12***	0.11***	0.16***
		[0.01]	[0.01]	[0.03]	[0.04]
Born in dép.		0.12***	0.13***	0.15***	0.11*
		[0.03]	[0.03]	[0.04]	[0.06]
Other characteristics	No	No	No	Yes	Yes
Military region FE	No	No	No	No	Yes
Départements	87	87	87	87	87
Adj. R^2	0.120	0.739	0.739	0.790	0.838

Notes: This table reports OLS estimates from regressing military death rates on pre-war département characteristics measured in 1911, otherwise noted. FLFP denotes female labor force participation in percent; Rural, the share of rural population in percent; Born in dép, the share of population born in the département in percent. Other characteristics consist of population in thousands, population density per km^2, average age, average height of 1911 conscripts in cm, the share of active population in industry in percent, km of roads and km of rails per km^2 in 1913, the share of cultivated land in 1912 in percent, personal wealth in 1908, banking deposits, and direct taxes in francs per inhabitant, the share of 1911 conscripts that could read and write and with primary education in percent, the minimum distance to the war in km, the share of students in religious schools in 1906 in percent, and turnout in 1914 in percent. Robust standard errors are in brackets. Significance: *$p < 0.10$, ***$p < 0.01$.

as early as August 1915, the Ministry of War began to withdraw soldiers with manufacturing skills from the front and sent up to 560,000 of them into war factories and mines.[13] Moreover, administrative jobs were mostly occupied by soldiers with higher formal education, who are from urban areas (Ridel 2007). Because of these policies, soldiers from industrial and urban départements were less likely to be on the battlefield and thus had lower chances of dying in combat.

Such correlation in levels need not threaten the identification as long as the distribution of military death rates is not correlated with trends in female labor force participation. Figure 4 displays absolute and relative trends in female labor force

13. The Dalbiez law of August 17, 1915, stipulates: "The Ministry of War is authorized to allocate to corporations, factories, and mines working for the national defense men belonging to a mobilized or mobilizable age class, industrial managers, engineers, production managers, foremen, workers, and who will justify to have practiced their job for at least a year in those corporations, firms and mines, or in comparable corporations, firms, and mines" (art. 6, *Journal Officiel de la République Française, Lois et Décrets*, 47(223), p. 5785–7, dated August 19, 1915). Online Appendix Table A2 provides a detailed account of the number of mobilized soldiers outside of armed services throughout the war.

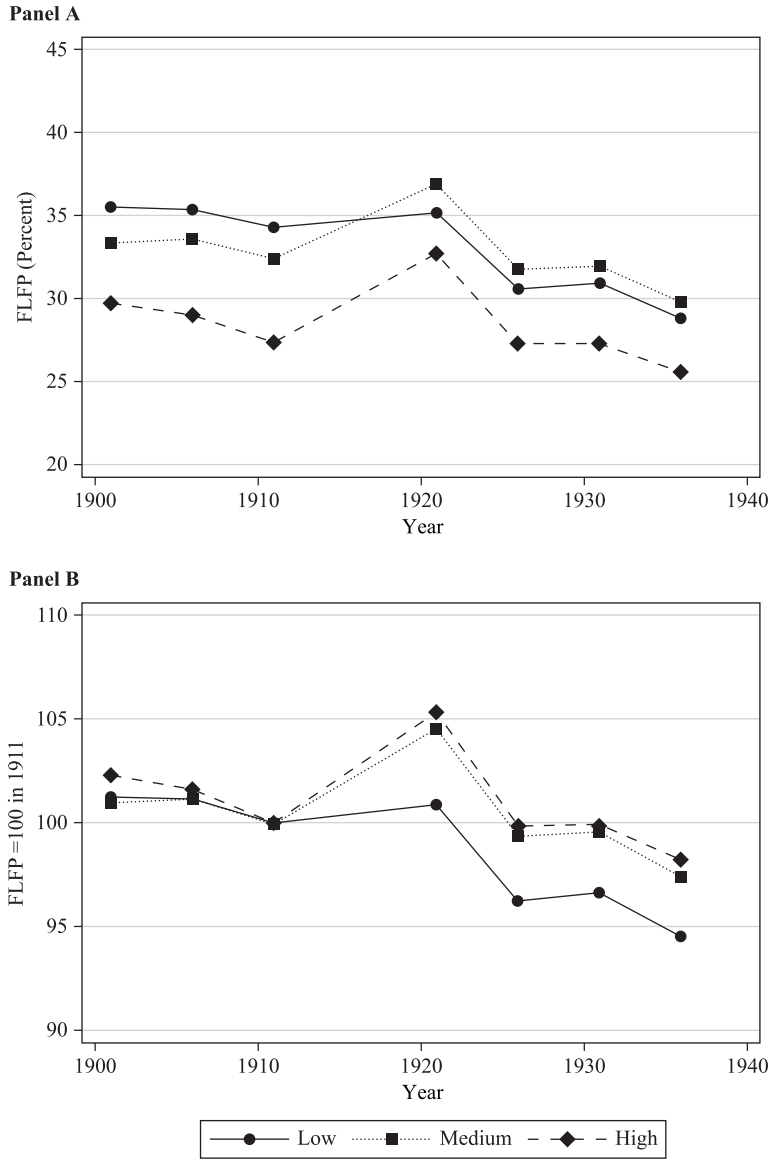

Figure 4

Trends in Female Labor Force Participation

Notes: This figure displays absolute and relative trends in female labor force participation rates between 1901 and 1936 across groups of 29 départements with high, medium, and low military death rates. In Panel B female labor force participation rates are normalized to 100 in 1911.

participation rates across three groups, each composed of 29 départements that experienced high, medium, and low military death rates. Départements with different military death rates had different levels of female labor force participation rates (Panel A), but they had little differential trends in female labor force participation in the pre-war period (Panel B).

IV. The Missing Men and Female Labor Force Participation

To analyze the effect of military fatalities on female labor force participation, we use a difference-in-differences strategy and estimate the following baseline specification:

$$(1)\quad \text{FLFP}_{d,t} = \beta \text{death\_rate}_d \times \text{post}_t + \boldsymbol{\theta}' \boldsymbol{X}_{d,t} + \boldsymbol{\gamma}_d + \boldsymbol{\delta}_t + \varepsilon_{d,t},$$

where $\text{FLFP}_{d,t}$ denotes the female labor force participation rate in département d and year t in percent, and post_t, an indicator variable for $t > 1918$. We cluster standard errors at the département level throughout the analysis. Département fixed effects $\boldsymbol{\gamma}_d$ control for département-specific unobservable characteristics that are fixed over time and might generate systematic differences in levels of female labor force participation. For instance, some départements might hold more traditional views about gender roles than others and exhibit systematically lower female labor force participation rates. Time fixed effects $\boldsymbol{\delta}_t$ control for year-specific shocks that are common to all départements. $\boldsymbol{X}_{d,t}$ is a vector containing the two time-varying measures of rurality.

Identification stems from relative changes in female labor force participation rates across départements with different military death rates. The baseline estimate is reported in Table 3, Column 1. In départements that experienced military death rates of 20 percent rather than 10 percent, female labor force participation was 3.5 percentage points higher after the war, an increase of 11 percent relative to pre-war levels. Removing time-varying controls does not affect this estimate (Column 2).

Next, we relax the assumption that the effect was constant over time and estimate year-specific coefficients:

$$(2)\quad \text{FLFP}_{d,t} = \sum_{\substack{\tau=1901 \\ \tau \neq 1911}}^{1936} \beta_\tau \text{death\_rate}_d \times \text{year}_\tau + \boldsymbol{\theta}' \boldsymbol{X}_{d,t} + \boldsymbol{\gamma}_d + \boldsymbol{\delta}_t + \varepsilon_{d,t},$$

where we exclude the year 1911, and where year_τ is set of indicator variables for each year between 1901 and 1936. Estimates are displayed in Figure 5. They are stable throughout the interwar period. Coefficients on pre-war years are close to zero and non-significant, suggesting that differential pre-war trends in female labor force participation do not drive the results. They are nonetheless slightly positive. For instance, the coefficient on the lead of 1906 is 0.03 (standard error of 0.05). This implies that départements that experienced greater military death rates had a slight relative downward trend in female labor force participation before the war, which could bias post-war estimates

Table 3
Impact of WWI Military Fatalities on FLFP

	Dependent Variable: FLFP										MLFP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Death rate × post	0.35***	0.37***	0.40**	0.21***	0.23**	0.38***	0.45***	0.28***	0.55***	0.48***	–0.01
	[0.07]	[0.08]	[0.16]	[0.08]	[0.09]	[0.07]	[0.10]	[0.07]	[0.13]	[0.07]	[0.06]
Controls	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specification	Baseline	No controls	Dép.-specific trends	Region × year FE	Residual measure	Empl.	Female farm owner	No war dép.	Corr. measure	Pop. weights	Male placebo
Difference from baseline	0.00	0.02	0.05	–0.15	–0.13	0.03	0.10	–0.07	0.20	0.13	–0.36***
		[0.10]	[0.17]	[0.10]	[0.11]	[0.10]	[0.12]	[0.10]	[0.15]	[0.10]	[0.09]
Observations	609	609	609	609	609	609	522	532	609	609	609
Départements	87	87	87	87	87	87	87	76	87	87	87
Within R^2	0.581	0.578	0.824	0.798	0.550	0.584	0.606	0.633	0.569	0.636	0.675
1911 mean	31.4	31.4	31.4	31.4	31.4	31.1	51.5	30.5	31.4	35.7	93.2

Notes: This table reports OLS coefficients from estimating Specification 1. The dependent variable is female labor force participation rate (FLFP) in percent except in Column 6, where it is female employment rate in percent, and in Column 11, where it is male labor force participation rate (MLFP) in percent. All regressions include département and year fixed effects. Controls include the share of rural population in percent and the share of population born in the département in percent. Census years are 1901, 1906, 1911, 1921, 1926, 1931, and 1936. Column 3 includes département-specific linear time trends, and Column 4 includes region-by-year fixed effects. In Column 5, military death rates are purged from pre-war trends between 1901 and 1911 in FLFP and rurality. In Column 7, female labor force participation includes female farm owners and excludes census year 1901. In Column 8, all 11 départements that experienced war combats on their territory are excluded. In Column 9, military death rates are corrected for pre-war migration patterns (see Online Appendix E). In Column 10, départements' relative population sizes in 1911 are used as weights. Standard errors are in brackets and are clustered at the département level. Significance: $^{**}p<0.05$, $^{***}p<0.01$.

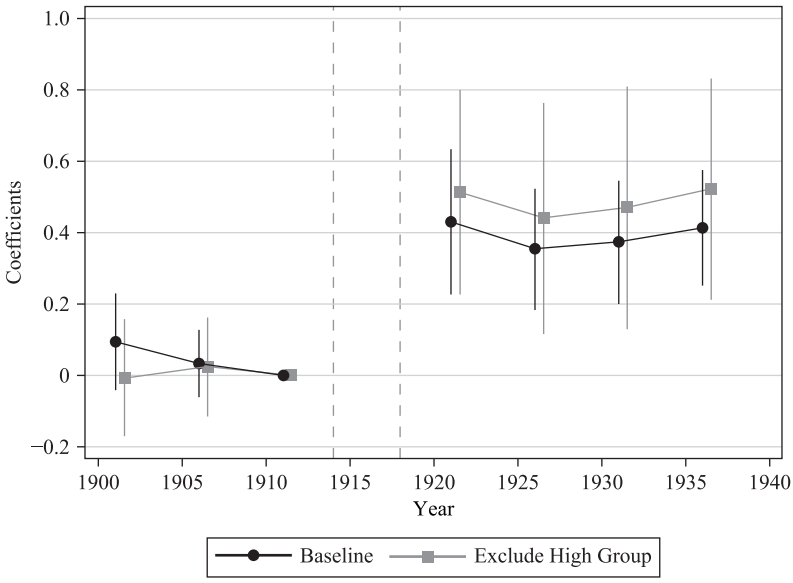

Figure 5

Impact of WWI Military Fatalities on FLFP

Notes: This figure reports year-specific OLS coefficients from estimating Specification 2. The dependent variable is female labor force participation (FLFP) in percent. Controls include the share of rural population in percent and the share of population born in the département in percent. Vertical lines represent 95 percent confidence intervals. "Exclude high group" corresponds to estimates when excluding the 29 départements with highest military death rates (among 87 départements).

downward. In Section IV.A, we show that the parallel-trends assumption is nonetheless justified in this context.

1. Decomposition by age

Female labor force participation rates for decennial age groups 20–29, 30–39, and 40–49 are available in the census of 1901 and in all post-war censuses. We reestimate the baseline specification on the sample of women aged 20–49 and obtain a coefficient of 0.40, close to the baseline (Online Appendix Table A3, Column 1). Although older women responded relatively more intensively to military fatalities than younger women did (Columns 2–4), base rates in labor force participation across groups imply that all ages contributed equally to the overall effect (Columns 5–7).

2. Decomposition by sector and occupation

In Online Appendix B, we decompose the overall effect by sector and occupation. Eighty percent stems from women entering the industrial sector, while the remainder essentially stems from women entering the domestic services sector. Moreover, we

observe a displacement of the female labor force toward blue-collar occupations and self-employment in départements that experienced greater military death rates, especially in the industrial sector. These results suggest that women mostly entered low-skilled jobs after the war.[14]

A. Robustness

We perform a wide range robustness checks that are summarized in Table 3, Columns 3–11. These checks, as well as additional ones provided in the Online Appendix, are described below.

1. Parallel-trends assumption

We provide evidence that the parallel-trends assumption is reasonable in this context. The baseline point estimate does not change significantly when we control for département-specific linear time trends or region-by-year fixed effects, nor when we purge military death rates from pre-war trends in female labor force participation and rurality (Columns 3–5).[15] Excluding départements in the higher group of military death rates results in pre-war trends that are flat at zero and in estimates that are only slightly larger than the baseline (Figure 5). In Online Appendix C, we further show that our results are robust to relaxing explicitly the assumption that time fixed effects are common to all départements. Herein, we allow for time-varying heterogeneity across départements using the Bonhomme and Manresa (2015) grouped fixed effects strategy, which imposes no a priori structure on group membership.

2. Measurement of female labor force participation

Using alternative measurements of female labor force participation does not alter the results. Estimates are similar to the baseline when we exclude unemployed women and when we include female farm owners (Columns 6–7).

3. War départements

Consequences of the war might have been different in départements that experienced war combats directly if military death rates were correlated with the intensity of war destruction or the reconstruction. Excluding these 11 départements from the analysis decreases the point estimate to 0.28 (Column 8). This is because these départements were predominantly industrial, and female labor was mostly responsive to military fatalities in the industrial sector. It nevertheless suggests that war départements are not driving the results. Using data from Michel (1932), we further show that the distribution of war destruction and of the reconstruction effort across these départements was not correlated with military death rates (Online Appendix D).

14. In Online Appendix H, we use individual-level data on the cohorts 1899–1908 from the census of 1968 to show that this did not affect these women's educational attainment.

15. Controlling for département-specific quadratic, cubic, or quartic time trends yields identical point estimates at 0.47, with standard errors of 0.16.

4. Pre-war migration patterns

We assign military fatalities to a département through soldiers' départements of birth, which might differ from their départements of residence on the eve of the war. This could introduce bias in the baseline estimate if military death rates and pre-war migration patterns were correlated. To alleviate this concern, we construct a measure that takes into account bilateral migration flows between départements in 1911 (Online Appendix E). Using this corrected measure generates a point estimate close to the baseline (Column 9).[16] We also show that a measure based on départements of military recruitment rather than départements of birth is contaminated with substantial measurement error because the geography of military recruitment did not overlap département boundaries.

5. Additional robustness checks

In Online Appendix F, we show that differences in enlistment rates due to pre-war differences in health conditions were uncorrelated with military death rates and changes in female labor force participation. Herein, we further provide evidence that the distribution of death rates due to the Spanish Flu of 1918–1919 was uncorrelated with military death rates and did not affect changes in female labor force participation. We also show in Online Appendix Table A4 that our results are robust to alternative specifications of standard errors: two-way clustering on départements and years (Cameron and Miller 2015), region-level clustering, and spatial autocorrelation (Conley 1999). Furthermore, Column 10 of Table 3 reports a population-weighted regression estimate. It is slightly larger than baseline at 0.48 as more populated départements were relatively more industrial. Finally, a placebo test shows that military death rates did not affect male labor force participation rates (Column 11).

B. Instrumental Variables Strategy

To further support the validity of the baseline ordinary least squares (OLS) point estimate, we use an instrumental variables (IV) strategy that exploits discontinuities in the timing of military service across cohorts. At the onset of the war, the active army was composed of four age cohorts: men aged 20–23, born between 1891 and 1894. We label an age cohort by the year in which they first drafted—the year they reached age 20. For instance, the class 1914 denotes the cohort of 1894. Hence, in 1914, the active army was composed of classes 1911–1914. While the class 1914 had just been recruited, the class 1911 had gone through three years of military training and was about to be transferred to the reserve of the active army. As a result, men of classes 1911–1914 had different levels of military training at the onset of the war. They nevertheless belonged to the same military units and were initially sent to the same battlefields. Intuitively, men with more

16. Trends in female migration patterns were not altered by the war (Online Appendix Figure A1). Reestimating the baseline specification with the share of women born in their département of residence as the dependent variable results in a weak and nonsignificant estimate of 0.08 (standard error of 0.11). This alleviates the concern that post-war labor mobility might confound the results.

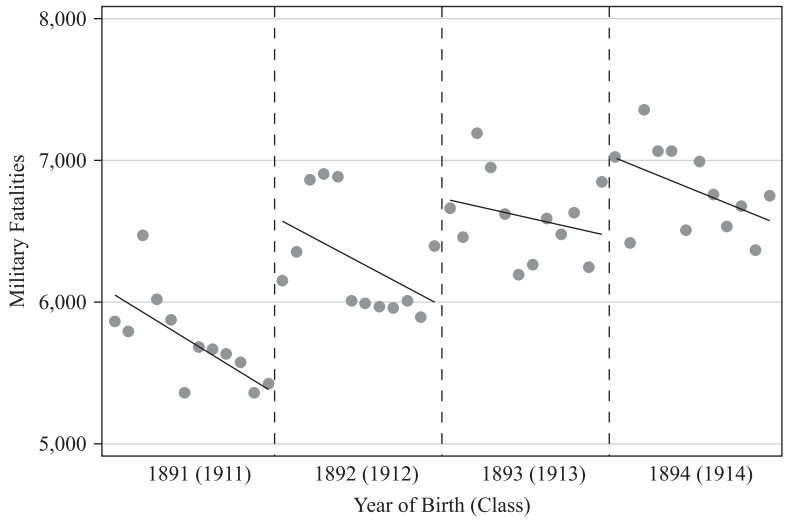

Figure 6

Military Fatalities by Month of Birth, Classes 1911–1914

Notes: Each dot represents the number of military fatalities relative to soldiers born during the same month of the same year. Black lines are regression lines for each class.

military training should be more "efficient" on the battlefield and die at lower rates.[17] Consistent with this idea, discontinuities in the number of military fatalities across cohorts are apparent in Figure 6.[18] We argue that these discontinuities are due to differences in military training.

Other reasons could potentially explain these differences. First, members of each class could have different initial physical or intellectual abilities. To examine this possibility, we collected height and education data from yearly recruitment reports of the army. Summary statistics, reported in Online Appendix Table A5, clearly reject this possibility. Second, older soldiers might have died at lower rates than younger ones because of better physical abilities or some form of seniority.[19] Averaging military death rates over an entire class in this case might yield the patterns we observe in the data. However, differences in military fatalities across classes are not driven by an averaging effect, as cohort-specific regression lines in Figure 6 do not display positive slopes.

We build on these discontinuities and create three instruments, each representing the size of a cohort relative to the next in 1911. In Online Appendix G we show that these

17. The contribution of each class to military fatalities is indeed monotonically increasing from the class 1911 to the class 1914: the class 1911 contributed 5.7 percent to overall military fatalities; the class 1912, 6.2 percent; the class 1913, 6.5 percent; the class 1914, 6.7 percent.

18. This is not driven by cyclical birth patterns, as the same pattern holds when we weight military fatalities by the number of births in each month.

19. Guillot and Parent (2018, p. 428) show that soldiers in higher ranks had a longer life expectancy during the war, although this advantage remains quantitatively limited.

Table 4
Instrumental Variables Estimates

	Dependent Variable: Military Death Rate × Post			
	(1)	(2)	(3)	(4)
Panel A: First Stage				
Ratio class 1911–1912 × post	–0.28*** [0.05]			–0.17*** [0.03]
Ratio class 1912–1913 × post		–0.39*** [0.05]		–0.31*** [0.06]
Ratio class 1913–1914 × post			–0.31*** [0.10]	–0.20*** [0.05]
Controls	Yes	Yes	Yes	Yes
Observations	609	609	609	609
Départements	87	87	87	87

	Dependent Variable: FLFP				
	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
Panel B: Second Stage					
Death rate × post	0.35*** [0.07]	0.80*** [0.22]	0.48*** [0.14]	0.37** [0.18]	0.54*** [0.13]
Instruments	No	1	2	3	1–3
Controls	Yes	Yes	Yes	Yes	Yes
Difference with OLS	0.00	0.44* [0.23]	0.13 [0.16]	0.02 [0.19]	0.19 [0.15]
Observations	609	609	609	609	609
Départements	87	87	87	87	87
Within R^2	0.581	0.507	0.575	0.581	0.567
KPW F-statistic		29.159	55.847	10.638	27.350

Notes: This table reports first-stage coefficients in Panel A, and IV coefficients from estimating Specification 1 with class ratios as instruments in Panel B. Instrument 1 is the ratio of the class 1911 to the class 1912; Instrument 2, the ratio of the class 1912 to the class 1913; Instrument 3, the ratio of the class 1913 to the class 1914. All regressions include département and year fixed effects and controls for the share of rural population in percent and the share of population born in the département in percent. FLFP denotes female labor force participation in percent. All regressions contain 87 départements. Census years are 1901, 1906, 1911, 1921, 1926, 1931, and 1936. The KPW F-statistic is the Kleibergen–Paap Wald rk F-statistic. Standard errors are in brackets and are clustered at the département level. Significance: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

instruments are nearly randomly distributed and are not correlated with pre-war levels in female labor force participation and rurality. They are, however, strongly correlated with military death rates: first-stage estimates reported in Panel A of Table 4 imply that the larger the size of a class relative to the next, the smaller the military death rate. Moreover, they exhibit Kleibergen–Paap *F*-statistics between 11 and 56, suggesting little bias at the second stage. Using all three instruments together implies that in départements that experienced military death rates of 20 percent rather than 10 percent, female labor force participation was 5.4 percentage points higher after the war (Table 4, Panel B, Column 4). This is larger than the baseline OLS estimate—though not statistically different—for potentially three reasons: downward bias in the OLS estimate due to the slight relative downward trend in female labor force participation in départements that experienced greater military death rates, measurement error in military death rates, or the larger responsiveness of female labor force participation to the death of younger soldiers if the main mechanism operates through the marriage market.

In Online Appendix G, we further show through a series of placebo tests that only the class ratios we consider generate meaningful results. We also show herein that IV estimates are robust to the same robustness checks as those reported in Table 3 and to alternative specifications of the instruments.

V. Mechanisms

We now investigate the mechanisms that could explain the impact of WWI military fatalities on female labor force participation. Both changes in the supply and demand for female labor could account for the pattern we identify. On the one hand, the scarcity of men might have induced firms to increase their demand for female labor, especially in sectors in which women and men were close substitutes. On the other hand, shocks to the marriage market might have induced women to increase their overall supply of labor through two mechanisms. The first consists of differential base rates in labor force participation across marital statuses. As apparent on Online Appendix Figure A2, at the national level, single and widowed women had much larger propensities to work than married women. Therefore, a decline in the proportion of married women due to the war should have mechanically increased overall female labor supply. The second consists of changes in the relative intensity of female labor supply within each marital group due to negative income shocks. For instance, some war widows might have entered the labor force to compensate for the loss of their husbands' incomes as their pensions remained low until the early 1930s (Bette 2017). This negative income shock might also have induced their daughters to enter the labor force as secondary earners in their families.

We explore whether supply (Section V.A) or demand channels (Section V.B) help explain the pattern we identify. Empirical evidence points towards a supply-side explanation, although the absence of systematic information on female labor force participation by marital status at the département level prevents us from providing definitive evidence. In Section V.C, we also show that female wartime employment cannot explain post-war changes in female labor force participation.

A. Supply Factors: A Marriage Market Channel?

1. Military fatalities and the post-war marriage market

We first document the consequences of military fatalities for the post-war marriage market.[20] The primary channel through which the war affected the marriage market is changes in sex ratios. To illustrate the impact of military death rates on adult sex ratios, we estimate the following specification:

$$(3)\quad \text{sex\_ratio}_{a,d,t} = \sum_{\substack{\tau=1901 \\ \tau\neq 1911}}^{1946} \beta_\tau \text{death\_rate}_{a,d} \times \text{year}_\tau + \boldsymbol{\gamma}_d + \boldsymbol{\delta}_t + \boldsymbol{\mu}_a + \varepsilon_{a,d,t},$$

where $\text{sex\_ratio}_{a,d,t}$ denotes the sex ratio among age group a in département d and year t in percentage points, and year_τ, a set of indicator variables for each year between 1901 and 1946. To improve the precision of estimates, we compute decennial-cohort-specific sex ratios and military death rates for age groups 20–29, 30–39, and 40–49, and we include age-group fixed effects $\boldsymbol{\mu}_a$. Moreover, we include the year 1946 to assess the long-run consequences of the war. Estimates are displayed in Figure 7. Coefficients on pre-war years are flat at zero but strongly negative after the war. In particular, in départements that experienced military death rates of 20 percent rather than 10 percent, the sex ratio among adults aged 20–49 decreased by 6.2 percentage points between 1911 and 1921. Coefficients then revert to balance over time, reaching zero in 1946. This suggests that the marriage market remained disrupted throughout the interwar period, but that these disruptions had dissipated by the end of WWII.

Consistent with these sex-ratio effects, the share of married women aged 20–49 declined from 71 percent in 1911 to 66 percent in 1921. At the same time, the share of single women among this age group increased from 22 percent to 24 percent, while the share of widowed women increased from 6 percent to 9 percent (Online Appendix Figure A3).

To analyze the impact of WWI military fatalities on the interwar marriage market, we estimate the following specification:

$$(4)\quad Y_{m,d,t} = \beta \text{death\_rate}_d \times \text{post}_t + \boldsymbol{\theta}' \boldsymbol{X}_{d,t} + \boldsymbol{\gamma}_d + \boldsymbol{\delta}_t + \varepsilon_{m,d,t},$$

where $Y_{m,d,t}$ denotes the share of women aged 20–49 of marital status m, in département d, and year t in percent.[21] We report results in Panel A of Table 5. Estimates imply that in départements that experienced military death rates of 20 percent rather than 10 percent, the share of single women was 2.3 percentage points higher after the war, an increase of 10 percent relative to pre-war levels (Column 1). In these départements, the share of

20. We are not the first to document this phenomenon. Using a more aggregated source of data for military death rates (Huber 1931, p. 426), Abramitzky, Delavande, and Vasconcelos (2011) show that women were less likely to marry after the war in regions that experienced greater military death rates. We replicate their main result (Table 2, p. 136) using our measure of military death rates in Online Appendix Table A6.

21. We focus on this sample because age groups outside these bounds are not consistently defined across censuses. Marital statuses "widowed" and "divorced" are generally not available separately in the censuses, so we group widowed and divorced women into the same category. Moreover, because age groups within the 20–49 bounds were defined differently in the census of 1906, this year is excluded from the sample.

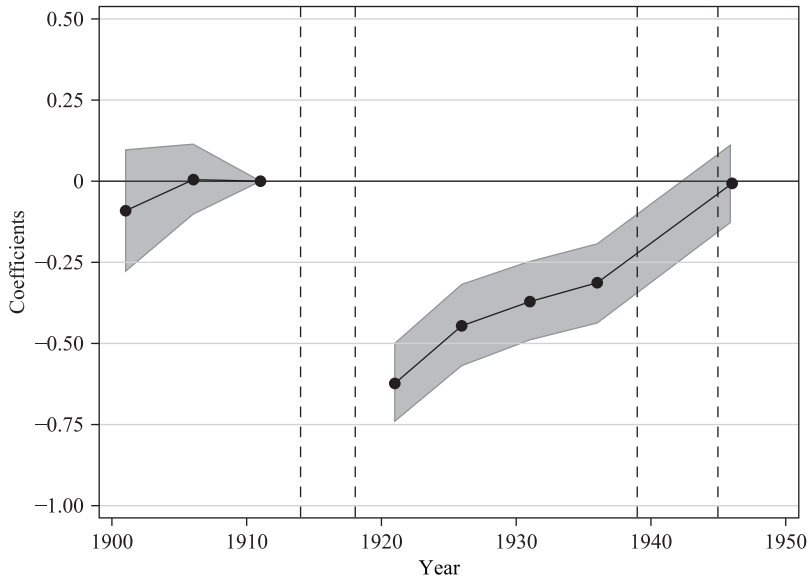

Figure 7

Impact of WWI Military Fatalities on Adult Sex Ratios

Notes: This figure reports year-specific OLS coefficients from estimating Specification 3. The dependent variable is the sex ratio among adults aged 20–49 in percentage points. Shaded areas represent 95 percent confidence intervals.

widowed women was 0.7 percentage point higher after the war, an increase of 13 percent (Column 2). Mirroring these trends, the share of married women in these départements was 3.1 percentage point lower after the war, a decline of 4 percent (Column 3). Our analysis suggests that three-quarters of these "missing married women" were single women who did not marry, while the rest were married women who became widows.

Estimates generally do not change significantly when we control for département-specific linear time trends or region-by-year fixed effects, or when we purge military death rates from pre-war trends in female labor force participation and rurality (Online Appendix Table A7). Moreover, year-specific coefficients reveal no pre-war differential trends in marriage market outcomes, suggesting that the parallel-trends assumption is again reasonable (Online Appendix Figure A4).

To explore which age groups quantitatively contribute the most to these estimates, we repeat the analysis by decennial age group, keeping the denominator equal to the female population aged 20–49. We find that the increase in the share of single women was mostly driven by younger women, aged 20–29, while the increase in the share of widowed women was driven by older women, aged 40–49 (Online Appendix Table A8).

Marriage market conditions remained disrupted throughout the interwar period, with rates of singlehood still increasing in the 1930s in départements relatively more affected by the war. In Online Appendix H, we explore the consequences of the war for family

Table 5
The Marriage Market Channel

	Panel A: Marital Status			Panel B: Labor Force Participation		
Dependent Variable:	Single Women/ All Women (1)	Widowed Women/ All Women (2)	Married Women/ All Women (3)	Active Women/ All Women (4)	Active Widows/ All Women (5)	Active Widows/ Widows (6)
Death rate × post	0.23***	0.07***	–0.31***	0.26***	0.12***	0.54***
	[0.04]	[0.02]	[0.05]	[0.07]	[0.03]	[0.11]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	522	522	522	261	261	261
Départements	87	87	87	87	87	87
Within R^2	0.693	0.864	0.763	0.604	0.325	0.609
Pre-war mean	22.3	5.6	71.4	32.9	5.7	34.5

Notes: This table reports OLS coefficients from estimating Specification 4 in Panel A and Specification 1 in Panel B. All regressions include département and year fixed effects, and controls for the share of rural population in percent and the share of population born in the département in percent. Shares are in percent and are defined with respect to the female population aged 20–49 in Panel A and the female population aged 15 and older in Panel B. Census years are 1901, 1911, 1921, 1926, 1931, and 1936 in Panel A, and 1901, 1926, and 1936 in Panel B. Standard errors are in brackets and are clustered at the département level. Significance: ***$p<0.01$.

formation in more details by using individual-level data from the family survey of 1954 and the census of 1968. We focus on the cohorts most directly affected by the war, the cohorts 1899–1908. Confirming findings in Abramitzky, Delavande, and Vasconcelos (2011, p. 147–8), we show that women in départements relatively more affected by the war delayed marriage and child bearing. These marriage market effects were not permanent, however, as rates of permanent singlehood among these women were not affected. This suggests that marriage market disruptions due to the war remained confined to the interwar period.

2. The marriage market as a transmission channel

Data to directly identify labor supply channels through changes in marriage market conditions are limited as censuses do not provide information on female labor force participation by marital status at the département level. The family surveys of 1901, 1926, and 1936 nevertheless provide information on employment status of widows at this level of aggregation.[22] This enables us to assess the role of war widows in the overall effect of WWI military fatalities on female labor force participation.

We first reestimate the baseline effect when using only censuses of 1901, 1926, and 1936, and obtain an estimate of 0.26 (Table 5, Column 4). Repeating the analysis with the share of active widows among all women as the dependent variable generates an estimate of 0.12, which implies that widowed women accounted for nearly half of the overall effect of WWI military fatalities on female labor force participation (Column 5). This can be explained not only by the increase in the share of widowed women in the population, which are structurally more likely to work than married women, but also by the increase in labor force participation rates among these women. Indeed, we find that in départements that experienced military death rates of 20 percent rather than 10 percent, labor force participation rates among widowed women increased by 5.4 percentage points, an increase of 16 percent relative to pre-war levels (Column 6).

We interpret these results as the consequence of increased labor supply due to negative income shocks experienced by war widows, whose pensions remained low until the early 1930s (Bette 2017). Tracking social security laws promulgated throughout the interwar period, we estimate that pensions to a war widow amounted to a quarter of the average labor income of a working woman during the 1920s (Online Appendix Figure A5). This suggests that a substantial number of war widows had to enter the labor force to compensate for the loss of their husbands' incomes.

Although département-level information on labor force participation rates of single women do not exist, our analysis in Online Appendix H highlights that they delayed marriage, potentially spending more time searching for a husband. This might have induced some of them to enter the labor force as well, at least temporarily.[23]

22. Family surveys provide information on widows but not on married or single women because they focus on family heads, and widows constitute the only category of women who were considered as such by official statistics.

23. Historical accounts support the idea that the marketplace was a platform to meet a husband. For instance, a female factory superintendent recounts the following in the 1930s: "[…] the young [female workers] prefer working at the factory than in their homes. Young women consider [the factory] as an occasion to get married" (Delagrange 1934, p. 39).

B. Demand Factors: A Substitution Channel?

The increase in female labor force participation during the interwar period might also be explained by firms substituting male labor with female labor to cope with the scarcity of men. In a partial equilibrium framework, an increase in female wages could uncover this phenomenon. However, we documented that women increased their overall supply of labor after the war because of changes in marriage market conditions. As a result, changes in wages can only provide a partial view: on the one hand, rising female wages would imply that the increase in the demand for female labor was strong enough to overcompensate the depressing effect of increased female labor supply on wages, and, on the other hand, declining female wages would imply that the potential increase in the demand for female labor was not large enough to compensate for the depressing effect of increased female labor supply on wages.

To overcome general equilibrium effects, we analyze changes in female wages across occupations with different degrees of substitutability between male and female labor. We first consider occupations in the textile manufacturing sector that were almost exclusively occupied by women: ironers, seamstresses, and milliners.[24] Hourly wage rates for these occupations are available at the city level between 1901 and 1926.[25] Focusing on these occupations enables us to fix the demand curve for female labor: because male and female labor were not substitutes in these occupations, the scarcity of men is unlikely to have affected the demand for female labor differentially across departments. As a result, only shifts in the female labor supply curve should have influenced female wages in these occupations.

We aggregate city-level hourly wage rates at the département level and use a difference-in-differences strategy analogous to Specification 1. We report results in Panel A of Table 6. Consistent with our argument, female wages declined across all occupations in départements that experienced greater military death rates. Year-specific estimates reveal no differential pre-war trends in wage rates across départements, suggesting that the parallel-trends assumption is reasonable (Online Appendix Figure A6). While these occupations are not representative of all female occupations, they are representative of a large share of jobs women held throughout this time period, especially in the manufacturing sector. Given that the impact of the war was especially salient in that sector of activity, these results imply that labor supply factors alone might constitute a first-order explanation.

Next, we consider occupations in the domestic services sector in which male and female labor were closer substitutes: cooks and housekeepers. Annual wage rates for these occupations are available at the city level in 1913 and 1921. We transform these into hourly wage rates, assuming 2,808 annual working hours (Bayet 1997, p. 26). Focusing on these occupations provides an upper bound for the potential role of changes in labor demand through substitution. Similar to the analysis above, we aggregate city-level hourly wage rates at the département level and use a difference-in-differences strategy.

24. In 1911, there were about 260 women per man in these occupations (*Résultats Statistiques du Recensement Général de la Population 1911*, Tome I, Partie 3, p. 28).

25. In fact, these are the only female occupations for which wage rates are available throughout this time. Available years are 1901, 1906, 1911, 1921, and 1926. Wage information for other female occupations in the manufacturing sector (laundresses, lacemakers, embroiderers, and vest makers) is only available for the 1920s. Such wage information is not available for the 1930s.

Table 6
Impact of WWI Military Fatalities on Wages, Foreign Labor, and Capital

	Panel A: Manufacturing Log Wages			Panel B: Domestic Log Wages		Panel C: Foreign Labor		Panel D: Engine Power	
	Ironer (1)	Seamstress (2)	Milliner (3)	Cook (4)	Housekeeper (5)	LFP (6)	Share Pop. (7)	Log Total (8)	Per Worker (9)
Death rate × post	−0.011***	−0.011***	−0.007**	−0.006***	−0.002*	−0.11	−0.09	0.03**	6.58***
	[0.004]	[0.003]	[0.004]	[0.002]	[0.001]	[0.22]	[0.06]	[0.01]	[2.37]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	355	355	355	171	171	261	261	261	261
Départements	87	87	87	87	87	87	87	87	87
Within R^2	0.951	0.953	0.951	0.900	0.948	0.468	0.646	0.858	0.249
Pre-war levels	0.21	0.23	0.25	0.20	0.13	35.0	2.26	29,782	35.76

Notes: This table reports OLS coefficients from estimating Specification 1. All regressions include département and year fixed effects, and controls for the share of rural population in percent and the share of population born in the département in percent. The dependent variable is log hourly wage rate in Columns 1–5, labor force participation rates of foreigners in percent in Column 6, the share of foreigners in the population in percent in Column 7, the log total power of engines in kW in Column 8, and the power of engines per 100 workers in the industrial sector in kW in Column 9. Survey years are 1901, 1906, 1911, 1921, and 1926 in Columns 1–3; 1913 and 1921 in Columns 4 and 5; 1911, 1921, and 1926 in Columns 6 and 7; and 1901, 1906, and 1926 in Columns 8 and 9. Standard errors are in brackets and are clustered at the département level. Significance: *$p<0.10$, **$p<0.05$, ***$p<0.01$.

We report results in Panel B of Table 6. Again, female wages declined across all occupations in départements that experienced greater military death rates.

These results suggest that increased female labor supply might have been the driving force behind the post-war increase in female labor force participation. Nevertheless, increased labor demand through substitution appears to have played a (limited) role in the domestic services sector. Indeed, the net magnitude of the negative impact of military fatalities on female wages was smaller in this sector than in the textile manufacturing sector: while in départements that experienced military death rates of 20 percent rather than 10 percent, female wages declined by 7–11 percent in the textile manufacturing sector, they declined by 2–6 percent in the domestic services sector.

A concern might be that wage movements were driven by declining demand for goods and services due to a decline in income in départements more affected by military fatalities. If this were the case, then at least male labor force participation rates would have decreased. But they remained unchanged (Table 3, Column 9), while female labor force participation rates increased. Moreover, wages in sectors producing nontradable goods would have declined relatively more than in sectors producing tradable goods, but female wages in the domestic services sector declined relatively less than those in the manufacturing sector.

Finally, firms did not substitute toward foreign labor, as neither labor force participation rates of foreigners nor their share in the population changed across départements that experienced different military death rates (Table 6, Panel C). Available data suggest that firms instead compensated for the scarcity of male labor by increasing their stock of physical capital, as total engine power and engine power per worker in the industrial sector increased more after the war in départements that experienced greater military death rates (Table 6, Panel D). However, the magnitudes of these effects remained limited.

C. Female Wartime Employment

We now examine whether WWI military fatalities affected female labor force participation through female wartime employment. Belligerent nations anticipated a short war: since the middle of the 19th century, military strategies used strong initial attacks to defeat opponents rapidly (Van Evera 1984). Consistent with this doctrine, the French plan of military mobilization did not specify an industrial organization that would support a potentially long war, so that the industrial system nearly came to a halt in August 1914. Figure 8 displays trends in operating firms along with male and female employment in the industrial sector during the war.[26] Half of industrial firms ceased operating in August 1914, and male and female employment declined to 32 percent and 43 percent, respectively, of their levels of July 1914.

By the end of August 1914, 200,000 French soldiers had died in combat. The military command soon realized that the war would last longer than anticipated and that its industrial plan to support the ongoing war effort was dramatically insufficient. For instance, while 13,000 shells were produced daily at the beginning of the war, troops were using 150,000 shells per day by January 1915 (Porte 2005, p. 66–7). To manage the

26. Data are from five industrial surveys conducted in July 1917, January 1918, July 1918, January 1919, and July 1919.

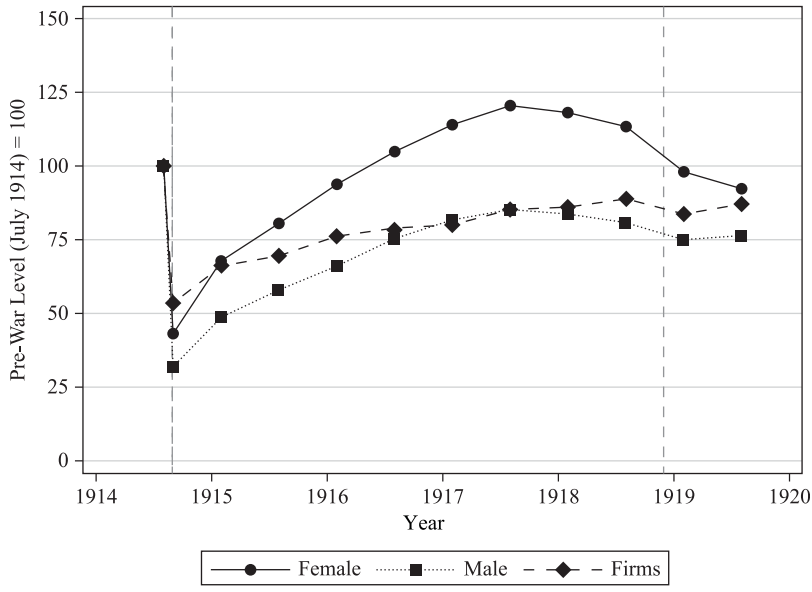

Figure 8

Labor during World War I (August 1914–July 1919)

Notes. Female denotes employed women; Male, employed men; Firms, operating firms. Data are relative to the industrial sector. Levels are normalized to 100 in July 1914.

extended needs of the army, the military command centralized the industrial war effort under the State Secretariat of Artillery and Ammunition in November 1915 and started to coordinate a vast network of public and private industrial firms (Bostrom 2016). Moreover, the government incentivized firms to employ alternative forms of labor, such as women, immigrants, and war prisoners. As a result, the number of women employed in the industrial sector exceeded its pre-war level by July 1916. This was especially salient in sectors that directly supplied weapons and machinery to the army. For instance, in the metallurgic sector, the number of employed women exceeded its pre-war level as early as January 1915 and was nearly 700 percent higher by July 1917.[27]

The need for new military equipment vanished at the end of the war. Moreover, the government issued laws to help soldiers return to their pre-war jobs, even offering monetary lump sums of a month's pay to women who would quit their jobs in war industries.[28] As a result, female employment in the industrial sector dropped below its pre-war level by January 1919.

27. Online Appendix Table A9 provides an overview of the evolution of the number of women employed across various industries during the war.

28. The law of November 22, 1918 ensured that soldiers could claim their pre-war job: "The administrations, offices, public, or private firms must guarantee to their mobilized personnel […] the occupation that all had at the moment of its mobilization" (*Journal Officiel de la République Française, Lois et Décrets*, 50(320), p. 10120–1, dated November 24, 1918). In November 1918, the Ministry of Armament was telling female workers: "[B]y

Table 7
Military Fatalities and Female Wartime Employment

	Panel A: Death Rate		**Panel B: FLFP**			
	(1)	(2)	(3)	(4)	(5)	(6)
Wartime employment	–0.00	–0.00				
	[0.01]	[0.01]				
Wartime employment × post			–0.00	–0.01	–0.00	–0.02
			[0.01]	[0.03]	[0.01]	[0.04]
Death rate × post			0.35***	0.35***	0.35***	0.36***
			[0.07]	[0.07]	[0.07]	[0.07]
Wartime employment × death rate × post				0.00		0.00
				[0.00]		[0.00]
Reference date	07–1917	07–1918	07–1917	07–1917	07–1918	07–1918
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87	87	609	609	609	609
Départements	87	87	87	87	87	87
Adj./Within R^2	0.745	0.746	0.582	0.582	0.581	0.582

Notes: Panel A reports OLS coefficients from regressing military death rates on changes in female employment in percent between July 1914 and July 1917 in Column 1 and between July 1914 and July 1918 in Column 2. Panel B reports OLS coefficients from estimating Specification 1. All regressions include controls for the share of the rural population in percent and the share of the population born in the département in percent. In Panel B, regressions include département and year fixed effects. FLFP denotes female labor force participation in percent. In Panel A, we report the adjusted R^2, and robust standard errors are in brackets. In Panel B, we report the within R^2, and standard errors are in brackets and are clustered at the département level. Significance: ***$p < 0.01$.

Women who entered the labor force during the war might have kept working after the war because they acquired valuable skills and experience, updated their beliefs about the benefits from working, or improved their information about labor market conditions. We capture the relative intensity of female wartime employment with the percentage change of women working in the industrial sector between July 1914 and July 1917, or June 1918. Départements that experienced greater increases in female employment during the war did not experience different military death rates (Table 7, Panel A). Hence, the potential impact of female wartime employment on subsequent female labor force participation is orthogonal to the mechanisms we highlight.

coming back to your previous occupations, you will be useful to your country as you have been by working in war industries in the past four years. […] Each [female] worker who expresses the will to quit one's firm before December 5, 1918, will receive the amount of thirty days of salary as a severance pay" (*Bulletin du Ministère du Travail*, 1919, p. 45*–6*).

Using a difference-in-differences strategy, we further find that départements with greater increases in female wartime employment did not experience a post-war rise in female labor force participation (Table 7, Panel B). Including an interaction term between military death rates and increases in female wartime employment does not affect the results. Similarly, we find no effect of female wartime employment on the distribution of occupations or sectors of activity (Online Appendix Table A10). These findings are consistent with contemporaneous reports of labor inspectors, which recount how managers systematically divided tasks of female workers.[29] Because of this division of labor, women could hardly acquire human capital transferable to other sectors after the war (Downs 1995).[30] These results parallel those of Rose (2018), who finds that female wartime employment during WWII in the United States was orthogonal to soldiers mobilization and did not affect post-war female labor.

VI. Conclusion

We show that the scarcity of men due to World War I in France induced many women to enter the labor force after the war. In départements that experienced military death rates of 20 percent rather than 10 percent, female labor force participation increased by 11 percent relative to pre-war levels. This effect is stable throughout the interwar period and robust to alternative empirical strategies. Available data for this time suggest that labor supply factors (changes in marriage market conditions) rather than labor demand factors (substitution from male to female labor) help explain the pattern we identify.

This study provides evidence that jolts of history can generate rapid and long-lasting changes to women's involvement in the economy. Yet, the response of female labor to sex ratio imbalances we identify was arguably amplified by the historical context in which it occurred—most women were not in the labor force at the time, and low-skilled jobs in the manufacturing sector were increasingly available because of the transition toward Taylorism during the interwar period (Downs 1995). As a result, changes in marriage market conditions profoundly affected the extensive margin of female labor. Analyzing the impact of WWI military fatalities on female labor across countries with different characteristics might be crucial to better understand dependencies between the mechanisms we highlight and the historical context and to gauge the external validity of our findings.

29. For instance, a labor inspector in a report of January 1918 describes: "[T]o make female labor possible and enable [women] to replace men, industrialists have, in many regions, modified and improved their managing methods. They divide labor to the extreme, organize production in series and assign female workers to very delimited tasks" (*Bulletin du Ministère du Travail et de la Prévoyance sociale*, 25(1), 1918, p. 11).

30. Historians have further pointed out that instead of an inflow of women into the labor force, women employed in war factories were already working before the war. For instance, Downs (1995, p. 48) writes: "In the popular imagination, working women had stepped from domestic obscurity to the center of production, and into the most traditionally male of industries. In truth, the war brought thousands of women from the obscurity of ill-paid and ill-regulated works as domestic servant, weavers and dressmakers into the brief limelight of weapons production" (cited in Vandenbroucke 2014, p. 118).

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