

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. Increased female labor supply accounts for this result: 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, available data suggests that 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, *La Revue d'Économie Politique*, 1915, 29(6), pp. 443–444.

1. 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 adult sex ratios, 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). Implications of such imbalances and the mechanisms through which they translate are challenging to identify because they typically result from gradual factors that also shape labor market structures (Qian, 2008; Carranza, 2014).

In this paper, 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 10 million men aged 15 to 50 before the war, 8 million were drafted in the army. 1.3 million died in combat; a military death rate of 16 percent. As a

¹For 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).

result, the sex ratio among adults aged 15 to 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 adult sex ratio reverted 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 all 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 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 75th percentile of the distribution—female labor force participation rates were 4 percentage points higher throughout the interwar period, an increase of 12 percent relative to pre-war levels. The effect we identify stems from women entering the industrial sector and the domestic services sector, especially in blue collar occupations.

Next, we explore the validity of the identifying assumption. Military death rates were not randomly distributed: they were greater in rural départements due to policies implemented by the Ministry of War to sustain the industrial war effort. Importantly, it does not invalidate identification as military death rates were not correlated with pre-war trends in female labor force participation. Allowing for département-specific time trends, for time-varying heterogeneity across départements (Bonhomme and Manresa, 2015), and using an instrumental variable approach that exploits discontinuities in the timing of military service across cohorts generate results that are in line with baseline estimates.

Supply factors related to changes in post-war marriage market conditions constitute a first-order explanation for the patterns we identify. Many single women entered the labor force while searching longer for a husband because of the tightness of the post-war marriage market. Similarly, many war widows

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

entered the labor force to compensate for the loss of their husbands' incomes. In contrast, available data for this time period suggest that 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 close substitutes. This suggests limited substitution of firms from male labor to female labor. Finally, we find no evidence that female wartime employment nor changes in men's beliefs about gender roles were correlated with post-war changes in female labor force participation.

The remainder of the paper is organized as follows. Section 2 discusses our contributions to the literature, Section 3 describes the data and historical context, Section 4 presents the main results, Section 5 explores the mechanisms, and Section 6 concludes.

2. Contributions and Related Literature

We first contribute to the literature that explores consequences of permanent sex ratio imbalances for 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 lead to 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 and migration shocks. For instance, exploiting sex ratio differences across cohorts in the U.S. between 1965 and 2005, Amuedo-Dorantes and Grossbard (2007) find a negative correlation between sex ratios and women's labor force participation. Alternatively, Angrist (2002) shows that changes in immigrants' sex ratios in the U.S. between 1910 and 1940 induced second-generation immigrant women to marry more often, decreas-

ing their participation in the labor force.³ Such permanent gender imbalances usually occur progressively, generating equilibrium responses over time. Further, 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 4 years—large in magnitude, and exogenous to the outcome under scrutiny.

Imbalances in sex ratios can 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 fifteenth and nineteenth century 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 nineteenth century resulted in lower participation of women in the labor force today (Grosjean and Khattar, 2019). Little is known about the mechanisms that induce these long-run relationships to emerge in the first place: the historical nature of these phenomena generally implies a lack of data at the time of the initial imbalance, preventing a proper analysis of short-run mechanisms. By uncovering the initial channels through which sex ratio imbalances affected women’s working behaviors in interwar France, this paper provides sound foundations for exploring the mechanisms of long-run persistence of this historical episode (Gay, 2019).

We also contribute to the analysis of the impact of war mobilization and fatalities on female labor force participation. Starting with Goldin (1991), this literature has mostly focused on the impact of WWII mobilization in the U.S., suggesting that wartime mobilization generated an increase in female labor supply after the war (Acemoglu, Autor and Lyle, 2004; Goldin and Olivetti, 2013; Doepke, Hazan and Maoz, 2015). Using more accurate measurement, Rose (2018) largely nuances these findings and shows that wartime female employment—but not manpower mobilization—only marginally affected the intensive margin of female

³Another strand of literature relies on temporary variations in sex ratios. For instance, Charles and Luoh (2010) find that rising male incarceration rates in the U.S. affected women’s working behaviors through their impact on marriage market conditions.

employment in 1950 in durable manufacturing. He further shows that WWII military fatalities did not affect post-war female labor. The French experience was dramatically different. While we similarly find no evidence for a relationship between female wartime employment, manpower mobilization, and post-war female labor, we show that the permanent loss of men due to the war generated a dramatic and persistent inflow of single and widowed women in the labor force after the war.

In that respect, our analysis helps clarify historical debates. Perhaps in part prompted by aggregate trends in female labor force participation, which had reverted to pre-war levels by 1926 (Table 1), recent historiography has emphasized that the war was not an engine of liberation (Thébaud, 2014).⁴ We find that the surge in female employment *during* the war was indeed short-lived. However, comparing relative changes in female labor force participation across départements differentially affected by military fatalities paints a nuanced picture: the war increased women’s presence in the labor force, but only as a result of marriage market disruptions that mostly materialized *after* the war.

Consequences of WWI in France on marriage and fertility outcomes have also been the subject of recent research in economics. Related to our analysis, Abramitzky, Delavande and Vasconcelos (2011) show that women in regions that experienced greater military death rates faced deteriorated post-war marriage prospects. Vandenbroucke (2014) further builds a model of fertility choices to explain the fall in fertility rates during the war. Similarly, Knowles and Vandenbroucke (2019) construct a model of matching to account for post-war changes in marriage probabilities of single women. 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 and henceforth is more precise and varies across 87 départements.

⁴For 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).

3. Data and Historical Context

3.1. Female Labor Force Participation (1901–1936)

We collected female labor force participation data at the département level from the seven censuses between 1901 and 1936.⁵ While farmers’ wives were to be classified as labor force participants throughout the period, not all census agents did so in 1901 (Maruani and Meron, 2012, pp. 33–35). For consistency, the analysis therefore 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 subtracting them, as nearly all female farm owners were farmers’ wives. Moreover, this transformation enables us to focus on paid work. We show in Appendix D that results are similar when female farm owners are included.

Female labor force participation is the share of women aged 15 and above in the labor force.⁶ Table 1 reports average female labor force participation rates from 1901 to 1936. While many women entered the labor force right after the war, at least as many had dropped out by the late 1920s.⁷ Table 1 further motivates our focus on female labor force participation net of female farm owners: while the corrected measure remains stable at 33 percent between 1901 and 1906, the uncorrected measure increases by 7 percentage points between these two censuses. Since there was no major shock to labor market conditions during the period, this discrepancy appears solely due to inconsistent measurement in 1901. After 1901, the difference between measures remains stable at 19–21 percentage points, suggesting that the transformation does not introduce systematic biases.

3.2. Military Death Rates

To build a precise measure of military death rates at the département level, we collected individual military records for all 1.3 million French soldiers who

⁵Census years are 1901, 1906, 1911, 1921, 1926, 1931, and 1936, the last census before WWII. Appendix K provides comprehensive details about sources of data used in the analysis.

⁶Results are similar when we use the share of women that are employed (Appendix D).

⁷Appendix Table A.1 reports summary statistics for male and female labor force participation rates by sector. Female trends mirror male trends, suggesting that labor market conditions across genders were driven by common national trends.

died because of the war from the *Mémoire des Hommes* archive maintained by the Ministry of Defense.⁸ For each deceased soldier, we recorded first name, last name, date of birth, and département of birth. The military death rate in a département is the ratio of deceased soldiers born in the département to the size of its drafted population, which we approximate by the male population aged 15 to 44 in 1911. This approximation is reasonable because all French male citizens aged 20 to 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 paper, we interpret regression results 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” death rate group (25th percentile) to a median département in the “high” death rate group (75th percentile).

Two types of inaccuracies could potentially affect this measure of military death rates. First, we assign military fatalities to a département through soldiers’ départements of birth, which might differ from their départements of residence—19 percent of men aged 15 to 44 resided outside their département of birth in 1911. This could be problematic if pre-war migration flows were correlated with trends in female labor force participation. In Appendix F, we build a measure of military death rates that corrects for pre-war migration patterns. Estimates with this corrected measure are similar to the baseline.¹⁰

⁸ The archive is accessible at <http://www.memoiredeshommes.sga.defense.gouv.fr>. Appendix J provides more details about this database. The number of soldiers who 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. The figure of 1.3 million remains the consensus among historians (Prost, 2008). It is similarly difficult to assess the number of civilian fatalities. Adding pension requests related to civilian fatalities, civilian victims from bombings of the commercial fleet, of Paris, and of cities near the front results in a figure close to 40,000 (Huber, 1931, pp. 310–314).

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

¹⁰ We also show that a measure based on soldiers’ départements of recruitment is contaminated with measurement error because the geography of military recruitment did not overlap département boundaries.

A second potential concern regards the approximation of the pool of drafted men. We assume that men subject to conscription were recruited by the army at similar rates across départements. However, some were exempted due to poor health conditions—79 percent of men subject to conscription were recruited at the onset of the war (Huber, 1931, p. 93).¹¹ Using military recruitment data by cohort together with health information, we show in Appendix G that differential recruitment rates across départements do not affect the results.

To illustrate the impact of military death rates on adult sex ratios, we estimate the following first-difference specification:

$$(1) \quad \Delta \text{sex_ratio}_{a,d} = \alpha + \beta \text{death_rate}_d + \varepsilon_{a,d},$$

where $\Delta \text{sex_ratio}_{a,d}$ denotes the change in sex ratio between 1911 and 1921 among age group a in département d in percentage points, and death_rate_d , the military death rate in département d in percent. Table 2 reports results. Age groups between 25 and 44 experienced strongest declines in sex ratios. For instance, in départements that experienced military death rates of 20 percent rather than 10 percent, the sex ratio in age group 30–34 declined by 6 percentage points.

3.3. 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. More rural départements experienced greater military death rates, a correlation generated by 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.

¹¹Recruitment 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 recruited (Boulanger, 2001, pp. 118–128). Another potential concern might be that men under 20 and over 48 voluntarily enlisted. These were relatively rare: 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, pp. 128–136).

3.3.1. The Territorial Organization of Military Recruitment

The territorial organization of the military structured both the recruitment and constitution of military units. Initially, units were constituted by soldiers from the same military region, so that soldiers from the same region were sent to the same battlefields.¹² As casualties accumulated, the military command changed this assignment policy: after only five months into the war, soldiers were allocated based on each unit's needs so that troops from different regions were increasingly mixed together.¹³ As a result, départements in different military regions had disparate military death rates as their troops were initially assigned to different battlefields. Analogously, départements within the same region had (in principle) similar military death rates. But because soldiers from different regions were rapidly mixed across units, the intra-regional correlation in military death rates remains low at 0.12.

3.3.2. Economic and Demographic Factors

Part of the variation in military death rates is explained by demographic and economic factors. We regress military death rates on pre-war characteristics and report estimates in Table 3.¹⁴ Départements that experienced greater military death rates had lower female labor force participation rates before the war (column 1) and were more rural (columns 2). Rurality is captured through two measures: the share of rural population and the share of population born in the département.¹⁵ They together explain 74 percent of the variation in military death rates. Pre-war differences in female labor force participation are fully captured by differences in rurality—the coefficient on female labor force

¹²There were 21 military regions and two recruitment bureaus for Paris and Lyon. The law of general organization of the army of July 24, 1873 provided the basis of this system. This territorial organization was seldom readjusted until WWI.

¹³This change in affectation policy was allowed by the *circulaire* of December 6, 1913, in the case of war time (Boulanger, 2001, p. 253).

¹⁴The full set of results is available in Appendix Table A.2.

¹⁵Censuses define the share of rural population as the share of population that resides in municipalities with less than 2,000 inhabitants. 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 share of rural population and the share of population born in the département.

participation is not significant and close to zero once rurality is controlled for (column 3). When we include 17 additional pre-war characteristics in column 4, only rurality exhibits statistical significance and corresponding coefficients barely change. Finally, including military region fixed effects to compare neighboring départements in column 5 generates similar estimates.

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, pp. 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 war factories (Porte, 2006, p. 26). To cope with the lack of civilian labor and the German occupation of industrial départements in the North-East, as early as August 1915, the Ministry of War started to withdraw soldiers with manufacturing skills from front lines and allocate them into war factories.¹⁶ Up to 560,000 soldiers who should have been on the battlefield were working in war factories during the conflict.¹⁷ In 1916, the military command also started to allocate soldiers into mines to increase steel production. Moreover, jobs in the military administration were mostly given to soldiers from urban areas because of their higher educational attainment (Ridel, 2007). As a result, soldiers from more industrial and urban départements—the less rural ones—had lower chances of dying in combats.

We interpret the residual variation in military death rates as non-systematic, related to the randomness at which soldiers encountered violence on the battlefield. Many war novels describe this phenomenon. Among others, Erich Maria Remarque writes: “It is just as much a matter of chance that I am still alive

¹⁶The 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), pp. 5785–5787, August 19, 1915).

¹⁷Appendix Table A.3 provides a detailed account of the number of mobilized soldiers outside of armed services throughout the war.

as that I might have been hit. In a bomb-proof dug-out I may be smashed to atoms and in the open may survive ten hours' bombardment unscathed" (Remarque, 2013 [1929]).¹⁸

3.4. Pre-War Trends in Female Labor Force Participation

Correlations in levels need not threaten identification as long as the distribution of military death rates is not correlated with pre-war trends in female labor force participation. Figure 4 displays relative trends in residual female labor force participation rates across three groups, each composed by 29 départements characterized by high, medium, and low military death rates.¹⁹ There were little differential trends in female labor force participation in the pre-war period, although départements with greater military death rates experienced a slight downward trend relative to other départements.

4. The Missing Men and Female Labor Force Participation

4.1. Baseline Estimates

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

$$(2) \quad \text{FLFP}_{d,t} = \beta \text{ death_rate}_d \times \text{post}_t + \gamma_d + \delta_t + \varepsilon_{d,t},$$

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 for $t > 1918$. Département fixed effects γ_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

¹⁸Cited in Guillot and Parent (2018, p. 413).

¹⁹Residuals are purged from variations in the share of rural population and the share of population born in the département. Relative trends are similar without this transformation (Appendix Figure A.1).

female labor force participation rates. Year fixed effects δ_t control for aggregate-level shocks that are common to all départements. Identification stems from relative changes in female labor force participation rates across départements with different military death rates. Baseline estimates are reported in Table 4. In départements that experienced military death rates of 20 percent rather than 10 percent, female labor force participation was 3.7 percentage points higher after the war, an increase of 12 percent relative to pre-war levels (column 1).²⁰ Controlling for rurality barely affects this estimate (columns 2–4).²¹

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

$$(3) \quad \text{FLFP}_{d,t} = \sum_{\substack{t=1901 \\ t \neq 1911}}^{1936} \beta_t \text{death_rate}_d \times \text{year}_t + \gamma_d + \delta_t + \varepsilon_{d,t},$$

where we exclude the year 1911, and where year_t is an indicator for each census-year between 1901 and 1936. Estimates are reported in Figure 5.²² They are stable throughout the interwar period and barely change once controls are included. Coefficients on pre-war years are close to zero and not significant, suggesting that differential pre-war trends in female labor force participation are not driving the results. They are nonetheless slightly positive: for instance, the coefficient on the lead of 1906 is 0.03 (standard error of 0.05).²³ 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 estimates downward.²⁴ In the next subsection, we show that the parallel

²⁰We also run a placebo test with male labor force participation rates as the outcome variable and find no correlation with military death rates (Appendix Table A.4).

²¹Other characteristics are presumably directly affected by military fatalities, such as changes in local labor market structures or changes in population levels. We do not include them as controls because they could confound the post-treatment relationship between military fatalities and female labor force participation. Measures of rurality could in principle also be affected by military fatalities but estimates barely change once they are included.

²²The complete set of results is available in Appendix Table A.5.

²³Male labor force participation rates exhibit no differential pre-war trends across départements (Appendix Figure A.2).

²⁴This could also be interpreted as an Ashenfelter dip, analogous to recent unemployed workers who enter a training program to improve their chances of employment, resulting in an upward bias. We alleviate this potential issue by matching départements with similar pre-war trends in

trends assumption is nonetheless justified in this context.

Most of the effect we identify stems from women entering the industrial sector and the domestic services sector: in départements that experienced military death rates of 20 percent rather than 10 percent, female labor force participation increased by about 20 percent in these sectors relative to pre-war levels (Appendix B). Moreover, we observe a displacement of wage earners from white collar occupations to blue collar occupations in départements that experienced greater military death rates, especially in the industrial sector. We further observe an increase in female self-employment. These results suggest that women mostly entered lower skilled jobs after the war.²⁵

4.2. Relaxing the Parallel Trends Assumption

We relax the parallel trends assumption in three ways. The full set of results is reported in Appendix C. These robustness checks imply that potential biases of baseline estimates remain limited.

4.2.1. Département-Specific Time Trends

First, we control for département-specific linear time trends (Appendix C.1). Point estimates are significant at the 1 percent level and are slightly larger than the baseline at 0.40 (relative to 0.35). Adding quadratic, cubic, or quartic time trends generates similar insights, with point estimates close to 0.47.²⁶

female labor force participation—excluding départements in the high group of military death rates (Figure 4). We then replicate specification 3 in Appendix Figure A.3. Resulting pre-war trends are flat at zero. Moreover, estimates are slightly larger than the baseline, which implies that départements with greater military death rates do generate a slight downward bias in baseline estimates.

²⁵In Appendix I, we use census micro data from 1962 to 1982 to show that, consistent with these results, women who reached adulthood right after the war exhibit less years of completed schooling. This effect however rapidly dissipates.

²⁶We also show that controlling for an interaction between rurality and a post-war indicator, as well as purging the military death rates treatment with pre-war trends in rurality and female labor force participation does not substantially alter the results.

4.2.2. Grouped Fixed Effects

Second, we relax the assumption that time fixed effects are common to all départements and allow for time-varying heterogeneity across départements using Bonhomme and Manresa’s (2015) grouped fixed effects strategy (Appendix C.2). Allowing for heterogeneity in the time pattern of female labor force participation across up to ten groups generates point estimates that are close to 0.3.

4.2.3. Instrumental Variable Strategy

Third, we use an instrumental variable strategy that exploits discontinuities in the timing of military service across cohorts (Appendix C.3). At the onset of the war, four age cohorts constituted the active army—men aged 20 to 23. We label an age cohort by the year in which it was first recruited by the army; the year it reached age 20. For instance, we label the cohort of 1894 as the *class 1914*. In 1914, the active army was constituted by classes 1911 to 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 to 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 military training should be more “efficient” on the battlefield and die at lower rates. The contribution of each class to military fatalities is indeed monotonically increasing from the class 1911 to the class 1914.²⁷ We argue that these differences in military death rates are essentially due to differences in military training. We build on these discontinuities and create three instruments, each representing the size of a cohort relative to the next at the onset of the war. These instruments are uncorrelated with pre-war trends in female labor force participation but strongly correlated with military death rates. Instrumenting military death rates in equation 2 with the relative size of consecutive cohorts results in point estimates that are slightly larger than the baseline at 0.54 (relative to 0.35).

²⁷The class 1911 contributed 5.7 percent to overall military fatalities; the class 1912, 6.2 percent; the class 1913, 6.5 percent, and the class 1914, 6.7 percent.

4.3. *Other Robustness Checks*

We perform additional robustness checks that support the credibility of baseline estimates: we use an alternative measure of female labor force participation that takes into account female farm owners (Appendix D); collect data on war destruction and the reconstruction to study the role of war départements (Appendix E); correct military death rates for pre-war migration patterns (Appendix F); analyze the role of pre-war health conditions, mobilization rates, and the Spanish flu epidemic (Appendix G); adjust standard errors for alternative forms of spatial correlation (Appendix H.1); run population-weighted regressions (Appendix H.2); and assess whether post-war migration patterns might account for part of the results (Appendix H.3).

5. Mechanisms

We now investigate the mechanisms that underlie 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 patterns we identify. Military fatalities could have induced women to increase their supply of labor for three reasons. First, single women were facing deteriorated marriage market prospects after the war due to the scarcity of men, decreasing the expected value of marriage (Abramitzky, Delavande and Vasconcelos, 2011). As a result, some women might have preferred to enter the labor force rather than to marry. Alternatively, they might have spent more time searching for a husband, thereby temporarily entering the labor force as secondary earners in their families.²⁸ Second, deteriorated marriage market conditions might have decreased the bargaining position of married women within the household, leaving them with a lower share of household income (Grossbard, 2014). This negative income shock could in turn have increased their supply of labor. Third, some war widows might have entered the labor force to compensate for the loss of their husbands' incomes as pensions

²⁸Historical accounts support the idea that the market place was a platform to meet a husband. For instance, a female factory superintendent recounts the following: “[...] 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).

to war widows were relatively small, at least until the early 1930s (Bette, 2017). For instance, in 1921, the pension to a war widow amounted to a quarter of the average labor income of a working woman (Appendix Figure A.4). This negative income shock might have induced daughters of war widows to enter the labor force as well. On the other hand, the scarcity of men could have induced firms to increase their demand for female labor, especially in sectors in which women and men were close substitutes.

We explore whether supply (Section 5.1) or demand channels (Section 5.2) explain the patterns we identify. Empirical evidence points towards a supply side explanation. In Section 5.3, we explore two alternative mechanisms: female wartime employment and changes in men’s beliefs about gender roles. Neither explains post-war changes in female labor force participation.

5.1. Supply Factors: The Marriage Market Channel

To uncover changes in female labor supply, we focus on transmission mechanisms through the marriage market. Summary statistics for the share of single, married, and widowed women before and after the war are reported in Appendix Table A.6. The share of single women increased after the war, especially among women aged 20 to 29: while 39 percent of women in this age group were single in 1911, 44 percent of them were single in 1921. The share of widows also increased after the war, especially among women aged 30 to 39: while 4 percent of women in this age group were widows in 1911, 10 percent of them were widows in 1921.

5.1.1. Military Fatalities and the Post-War Marriage Market

We first document that military fatalities tightened the post-war marriage market. Using a more aggregated source of data for military death rates (Huber, 1931, p. 426), Abramitzky, Delavande and Vasconcelos (2011) show that the war worsened the position of women in the marriage market as men became more scarce.²⁹ As a result, women were less likely to marry after the war in regions that experienced greater military death rates.

²⁹We replicate Table 2 of Abramitzky, Delavande and Vasconcelos (2011, p. 136) with our measure of military death rates and find similar results (Appendix Table A.7).

To analyze the impact of WWI military fatalities on the interwar marriage market, we estimate the following specification:³⁰

$$(4) \quad Y_{m,a,d,t} = \beta \text{death_rate}_d \times \text{post}_t + \gamma_d + \delta_t + \varepsilon_{m,a,d,t},$$

where $Y_{m,a,d,t}$ denotes the share of women of marital status m , in age group a , département d , and year t in percent. We report results in Table 5. Women in départements that experienced greater military death rates were more often single and widowed after the war. Estimates imply that in départements that experienced military death rates of 20 percent rather than 10 percent, the share of single women aged 20 to 29 was 2.7 percentage points higher after the war, an increase of 7 percent relative to pre-war levels (column 1). The effect was relatively larger for women aged 30 to 39 and 40 to 49, with corresponding increases of 16 and 13 percent relative to pre-war levels, respectively (columns 2 and 3). Women aged 30 to 49 were the most likely to lose their husbands during the war (columns 5 and 6).³¹

Year-specific estimates reveal no pre-war differential trends in marriage market outcomes, suggesting that the parallel trends assumption is reasonable (Appendix Table A.8). They further reveal that marriage market conditions remained perturbed throughout the interwar period. Two reasons account for this persistence. First, many men were affected by long-lasting diseases and wounds contracted during the conflict. As a result, the rate of widowhood of older women was still increasing in the 1930s in départements that experienced greater military death rates. Second, women of all ages delayed marriage during

³⁰Because marital statuses “widowed” and “divorced” are not available separately in the censuses except in the censuses of 1911 and 1921, we group widowed and divorced women into the same category. Moreover, because age groups were defined differently in the census of 1906, this year is excluded from the sample.

³¹Knowles and Vandenbroucke (2019) show that the flow of marriages increased for both men and women during the interwar period as many had delayed marriage during the war. Moreover, the men who died were those with lower propensity to marry, i.e., younger men. As a result, the pool of single men after the war had higher propensity to marry. This compositional change was strong enough to compensate the scarcity of single men and generate an increase in the flow of marriages in départements that experienced greater military death rates. Nevertheless, we find no correlation between changes in marriage flows and changes in female labor force participation rates.

the interwar period, explaining why the rate of singlehood was still high during the 1930s (Abramitzky, Delavande and Vasconcelos, 2011). In Appendix I, we use census micro data from 1962 to 1982 to show that rates of permanent singlehood of women who reached adulthood after the war were not affected, suggesting that marriage market perturbations due to the war remained circumscribed to the interwar period.

5.1.2. The Marriage Market as a Transmission Channel

Data to explore labor supply channels through changes in marriage market conditions directly are scarce—censuses do not provide information on female labor force participation by marital status at the département level. This impedes us from directly testing whether married women increased their supply of labor. Instead, we rely on information relative to changes in singlehood and widowhood. Nevertheless, the lack of data on labor force participation of married women is not that problematic as national trends suggest that single and widowed women were responsible for the increase in female labor force participation during the interwar period: while labor force participation rates of married women remained roughly constant at 22 percent between 1911 and 1921, those of single and widowed women increased from 67 percent to 70 percent and from 37 percent to 43 percent, respectively (Appendix Figure A.5).

To uncover the effect of military fatalities on female labor force participation through changes in marriage market conditions, we use tools from the causal mediation framework (Imai et al., 2011). For each age group, we estimate the following three equations:

$$(5) \quad \left\{ \begin{array}{lcl} \text{single}_{d,t} & = & \beta_s \text{ death_rate}_d \times \text{post}_t + \gamma_{s,d} + \delta_{s,t} + \varepsilon_{s,d,t} \\ \text{widow}_{d,t} & = & \beta_w \text{ death_rate}_d \times \text{post}_t + \gamma_{w,d} + \delta_{w,t} + \varepsilon_{w,d,t} \\ \text{FLFP}_{d,t} & = & \beta_1 \text{ death_rate}_d \times \text{post}_t + \\ & & \beta_2 \text{ single}_{d,t} + \beta_3 \text{ widowed}_{d,t} + \gamma_d + \delta_t + \varepsilon_{d,t}. \end{array} \right.$$

Département-level information on female labor force participation by age

group before the war is only available in the census of 1901. While dropping two pre-war years could be problematic, this information enables us to match labor and marriage market outcomes by age group. This is important as women at different points in their life-cycles might be differentially affected by the war. Moreover, removing 1906 and 1911 barely affects labor and marriage market results (Appendix Tables A.9 and A.10).

Quantities of interest are $\hat{\beta}_2 \times \hat{\beta}_s$ and $\hat{\beta}_3 \times \hat{\beta}_w$. They represent the effect of military fatalities on female labor force participation through singlehood and widowhood, respectively. These quantities have a causal interpretation under a set of parallel trends assumptions: there are no differential trends in labor and marriage market outcomes across départements with different military death rates and, conditionally on military death rates, there are no differential trends in labor market outcomes across départements with different marriage market outcomes. Previous analyses suggest that the parallel trends assumption is valid relative to labor and marriage market outcomes (Appendix Tables A.5 and A.8). To assess the validity of the third assumption, we compute year-specific coefficients relative to the third equation in specification 5. Because age-specific information on labor and marriage market outcomes before the war exists only for 1901, we pool all age groups to include 1911 and examine pre-war trends. We report results in Appendix Figure A.6. It reveals no differential pre-war trends in female labor force participation rates across départements with varying marriage market outcomes when conditioning on military death rates.

Table 6 reports estimates of the third equation in specification 5 separately for each age group.³² Odd columns report the unmediated impact of WWI military fatalities on female labor force participation. While women of all age groups were induced to enter the labor force during the interwar period, older women were twice as affected as younger women: in départements that experienced military death rates of 20 percent rather than 10 percent, labor force participation rates of women aged 30 to 39 and 40 to 49 increased by 16–17 percent relative to pre-war levels (4.8/30.1 and 4.7/27.7). In contrast, labor force participation rates of women aged 20 to 29 increased by 8 percent (2.7/34.7).

³²Appendix Table A.11 reports estimates when age groups are pooled and 1911 is included.

Even columns report two quantities of interest: they show how the coefficient on military death rates ($\hat{\beta}_1$) changes once marriage market outcomes are included and the effect of changes in marriage market conditions on female labor market outcomes ($\hat{\beta}_2$ and $\hat{\beta}_3$). In départements that experienced military death rates of 20 percent rather than 10 percent, labor force participation rates of women aged 30 to 39 were 1.6 percentage point higher because of the rise in singlehood (2.5×0.64) and 0.5 percentage point higher because of the rise of widowhood (0.8×0.62).³³ These two channels together account for 46 percent of the total effect of military fatalities on labor force participation of women aged 30 to 39 ($1 - 0.26/0.48$), 36 percent of the total effect on women aged 40 to 49 ($1 - 0.30/0.47$), and 22 percent of the total effect on women aged 20 to 29 ($1 - 0.21/0.27$). Women aged 30 to 39 were most impacted by the war because they were affected through two margins: increased singlehood and increased widowhood. Younger women were mostly affected through one margin (singlehood) and older women, through another margin (widowhood).

5.2. 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 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 the depressing effect of increased female labor supply on wages.

To overcome this general equilibrium issue, we analyze changes in female

³³For consistency, we use estimates from Appendix Table A.10 instead of those from Table 5, as its sample does not contain year 1906.

wages across occupations with different degrees of substitutability between male and female labor. We first consider a set of occupations in the textile manufacturing sector that were almost exclusively occupied by women: ironers, seamstresses, and milliners.³⁴ Hourly wage rates for these occupations are available at the city level from 1901 to 1926.³⁵ 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 supply curve should have influenced female wages and labor force participation rates in these occupations.³⁶

We aggregate city-level hourly wage rates at the département level and use a difference-in-differences strategy analogous to specification 2. We report results in panel A of Table 7. Consistent with our argument, female wages declined across all three occupations in départements that experienced greater military death rates. Moreover, year-specific estimates reveal no differential pre-war trends in wage rates across départements, suggesting that the parallel trends assumption is reasonable (Appendix Figure A.7). 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 constitute a first-order explanation.

Next, we consider occupations in which male and female labor are close substitutes: domestic services. Two surveys from 1913 and 1921 provide city-level

³⁴In 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).

³⁵In fact, these are the only female occupations for which wage rates are available throughout this time period. 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. Wage information at the female occupation level is not available for the 1930s.

³⁶This reasoning implicitly assumes that income shocks due to the war did not affect labor demand differentially across départements. We explain below how results in this section suggest that declining demand for labor due to negative income shocks is unlikely to constitute a first-order mechanism.

female wage information in the domestic services sector.³⁷ 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. We report results in panel B of Table 7. Again, female wages declined across both occupations in départements that experienced greater military death rates.

These results suggest that increased female labor supply was 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. 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 8–12 percent in the textile manufacturing sector, they declined by 2–6 percent in the domestic services sector.

A related concern might be that these 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 should have decreased. But male labor force participation rates remained unchanged (Appendix Table A.4), and female labor force participation rates increased. Second, wages in sectors producing non-tradable goods should have declined more strongly than in sectors producing tradable goods. But female wages in the domestic services sector declined relatively less than 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 in départements that experienced different military death rates (Appendix Table A.12, panel A). Available data suggests that firms instead compensated for the scarcity of male labor by increasing their stock of physical capital; in the industrial sector, total engine power and engine power per worker increased more after

³⁷These surveys provide yearly wage rates, which we transform into hourly wage rates assuming that women worked 2,808 hours per year in 1913 (Bayet, 1997, p. 26).

the war in départements that experienced greater military death rates (Appendix Table A.12, panel B).

5.3. Alternative Mechanisms

We now examine whether WWI military fatalities affected female labor force participation through two alternative mechanisms: female wartime employment and changes in men’s beliefs about gender roles.

5.3.1. Female Wartime Employment

Belligerent nations anticipated a short war: since the middle of the nineteenth century, military strategies used strong initial attacks to rapidly defeat opponents (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 came close to paralysis in August 1914. Figure 6 displays trends in operating firms along with male and female employment in the industrial sector during the war.³⁸ Half of industrial firms ceased operating in August 1914, and male and female employment declined to 32 percent and 43 percent of their levels in July 1914, respectively.

By the end of August 1914, 200,000 French soldiers had died in combats. 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 highly 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, pp. 66–67). To manage 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).³⁹ Moreover, the government incentivized firms to employ alternative forms of labor such as women, immi-

³⁸Data are from five industrial surveys conducted in July 1917, January 1918, July 1918, January 1919, and July 1919.

³⁹This Secretariat was created by the Order of November 3, 1915. See the *Journal Officiel de la République Française, Lois et Décrets*, 47(306), pp. 8108–8109, November 11, 1915.

grants, and war prisoners.⁴⁰ 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 1917.⁴¹

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 pay to women who would quit their jobs in war industries.⁴² As a result, female employment in the industrial sector dropped below its pre-war level by January 1919.

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 payoffs 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. Départements that experienced greater increases in female employment during the war did not experience different military death rates (Appendix Table A.14, panels A and B). Hence, the potential impact of female wartime employment on subsequent female labor force participation is orthogonal to the mechanisms we highlight.

Using a difference-in-differences strategy, we further find that départements with greater increases in female wartime employment did not experience a post-

⁴⁰These incentives are detailed in the *circulaire* of the Ministry of War of November 10, 1915. See the *Journal Officiel de la République Française, Lois et Décrets*, 47(306), p. 8110, November 11, 1915.

⁴¹Appendix Table A.13 provides an overview of the evolution of the number of women employed across various industries during the war.

⁴²The 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), pp. 10120–10121, November 24, 1918). In November 1918, the Ministry of Armement was telling female workers: “[b]y coming back to you 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, pp. 45*–46*).

war rise in female labor force participation (Appendix Table A.15, panels A and B). These findings are consistent with contemporaneous reports of labor inspectors, which describe that managers systematically divided tasks of female workers.⁴³ Because of this division of labor, women could hardly acquire human capital transferable to other sectors after the war (Downs, 1995).⁴⁴ These results parallel those in Rose (2018), who finds that female wartime employment during WWII in the U.S. was orthogonal to soldiers’ mobilization and did not affect post-war female labor.

5.3.2. *Changes in Men’s Beliefs about Gender Roles*

The war might also have affected female labor in the post-war period by changing men’s beliefs about gender roles and thereby their demand for female labor. For instance, men might have updated their beliefs about women’s abilities as workers because of their role during the war.

We measure changes in men’s beliefs about gender roles through changes in *députés*’ support to the extension of the suffrage to women.⁴⁵ We build on the fact that the bill extending the suffrage to women was debated before and after the war at the Assemblée Nationale. We collected data on public support of députés to the bill before the war from an open letter written by several women’s rights organizations in June 1914. The bill was voted on in May 1919. While 32 percent of députés supported female suffrage in 1914, 79 percent did so in 1919. The bill was eventually rejected by the Sénat in 1922, France’s upper house.

To better understand what this measure captures, we build two complemen-

⁴³For 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).

⁴⁴Historians have further pointed out that instead of an inflow of women in 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).

⁴⁵Députés are the members of the Assemblée Nationale, France’s lower house.

tary measures. The first one consists of support to the extension of suffrage and eligibility to women in labor courts (*conseils de prud'hommes*), which was adopted in 1901.⁴⁶ It captures pre-war beliefs about women's abilities as workers more directly, as parliamentary debates specifically focused on this issue (Willemez, 2015). The second measure consists of support to the separation of the Church from the State, which was adopted in 1905. It captures pre-war religious conservatism, which should be correlated with other dimensions of beliefs about gender roles. In Appendix Table A.16, we show that départements in which députés supported the extension of suffrage and eligibility to women in labor courts also supported more often the extension of political suffrage to women before the war. This positive correlation holds even after accounting for religious conservatism and pre-war characteristics, including female labor force participation and rurality. The correlation is still positive but weaker after the war, implying that local attitudes changed. These findings suggest that support to the extension of political suffrage to women does capture some aspect of men's beliefs about gender roles and women's abilities as workers.

Départements that experienced changes in the support to female suffrage also experienced slightly greater military death rates, suggesting that both processes might be related (Appendix Table A.14, panel C). However, a difference-in-differences strategy reveals that changes in the support to the extension of the suffrage to women were uncorrelated with changes in female labor force participation (Appendix Table A.15, panel C).

These results do not totally rule out the possibility that cultural mechanisms might partially account for the patterns we identify. Our measure of beliefs about gender roles is limited to changes that occurred between June 1914 and May 1919. But the more visible presence of women in the labor force after the war might have triggered shifts in cultural norms, which might in turn have influenced women's working behaviors toward the end of the interwar period.

⁴⁶We focus on votes on article 5, paragraph 5 of the law instituting labor courts, which specifically extends the franchise and eligibility to women.

6. Conclusion

In this paper, we show that the scarcity of men due to World War I 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 12 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 period suggest that labor supply factors (changes in marriage market conditions) rather than labor demand factors (substitution from male to female labor) explain the patterns 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 was arguably amplified by the historical context in which it occurred: most women were not in the labor force 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. The unavailability of substantial pensions to war widows during the 1920s further increased their supply of 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.

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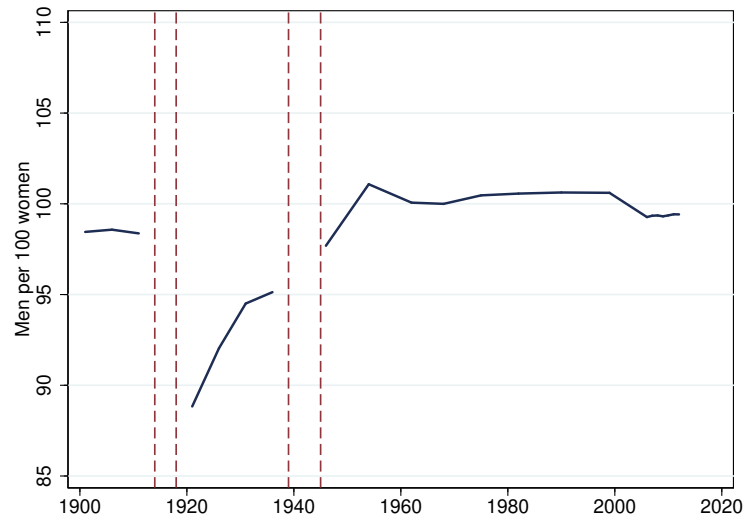
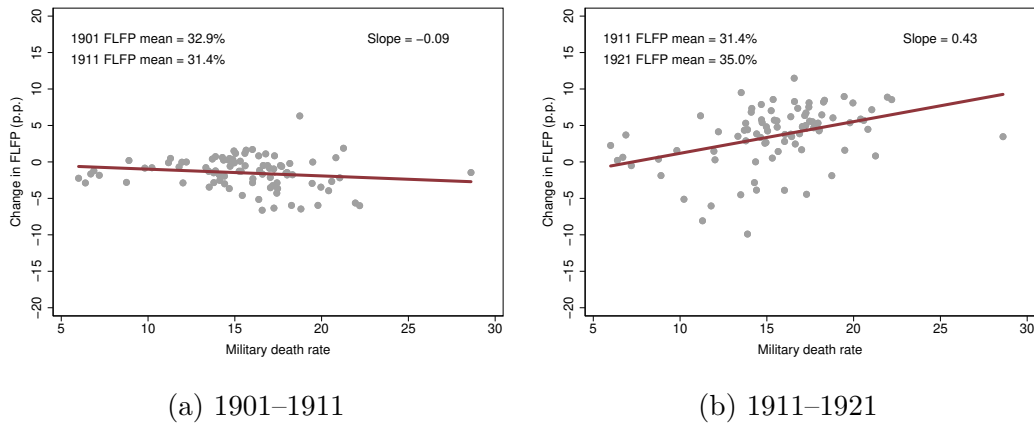


Figure 1. Adult Sex Ratio (1900–2012)

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



(a) 1901–1911

(b) 1911–1921

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).

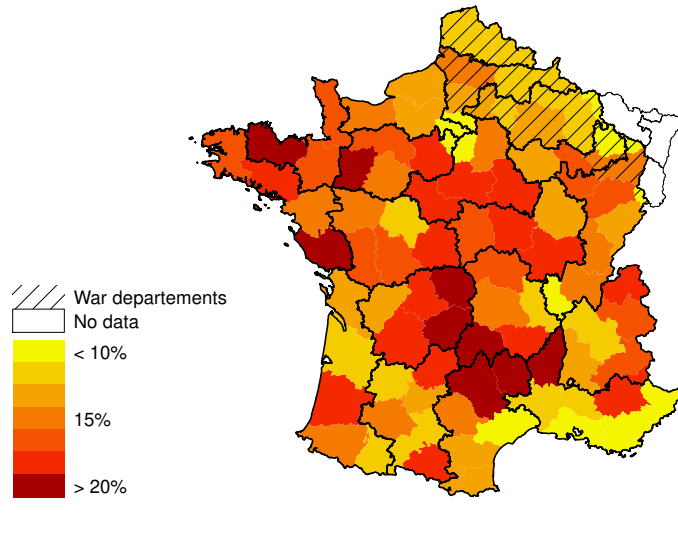


Figure 3. Distribution of Military Death Rates Across 87 Départements

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

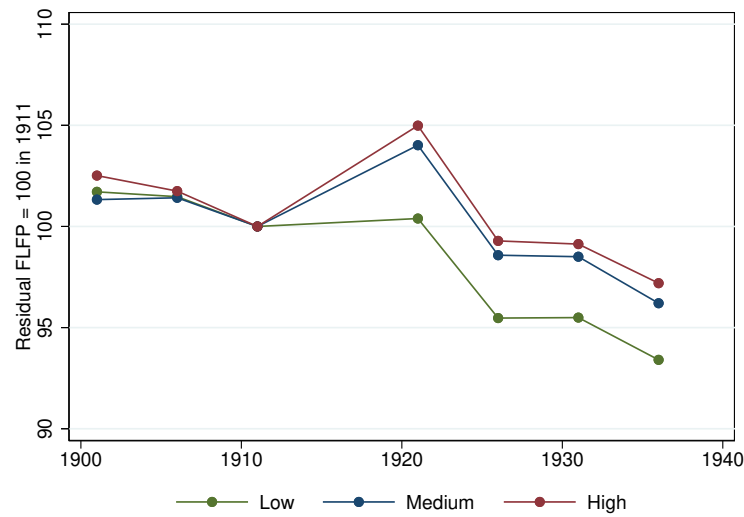


Figure 4. Relative Trends in Female Labor Force Participation

Notes. This figure displays relative trends in residual female labor force participation rates between 1901 and 1936 across groups of 29 départements with high, medium, and low military death rates. Residuals are normalized to 100 in 1911. They are purged from variations in the share of rural population and the share of population born in the département.

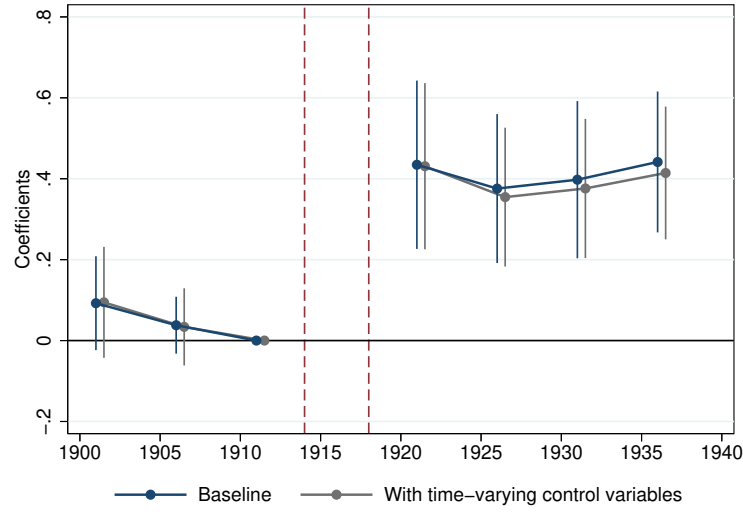


Figure 5. Impact of WWI Military Fatalities on FLFP

Notes. This figure reports year-specific OLS coefficients from estimating specification 3. The dependent variable is female labor force participation (FLFP) in percent. Time-varying control variables 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.

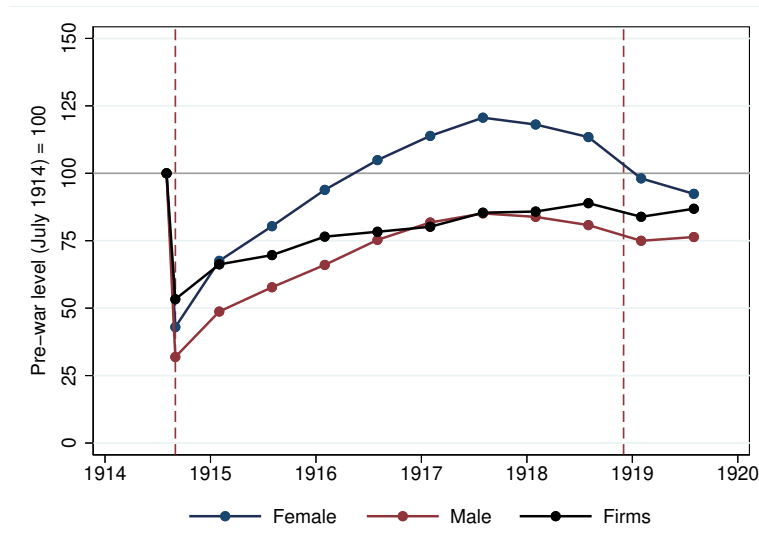


Figure 6. Labor During World War I (August 1914–July 1919)

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.

Table 1. Average Female Labor Force Participation Rates

	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.

Table 2. Impact of Military Death Rates on Sex Ratios (1911–1921)

Dependent variable:	Sex Ratio						
Age group:	20–24	25–29	30–34	35–39	40–44	45–49	50–54
Death rate	0.61 [0.95]	-0.46** [0.19]	-0.58*** [0.13]	-0.37*** [0.13]	-0.32** [0.13]	-0.09 [0.14]	0.00 [0.12]
Départements	87	87	87	87	87	87	87
R ²	0.328	0.892	0.932	0.929	0.794	0.348	0.109
1911 sex ratio mean	107	99	100	100	99	99	97
1921 sex ratio mean	86	80	82	84	91	96	95

Notes. This table reports OLS coefficients from estimating specification 1. The dependent variable is the change in sex ratio between 1911 and 1921 for a given age group in percentage points. Sex ratios are the ratio of the male to the female population in percent. Robust standard errors are in brackets.

*** Significant at the 1 percent level. ** Significant at the 5 percent level.

Table 3. Military Death Rates and Pre-War Characteristics

Dependent variable:	Military death rate				
	(1)	(2)	(3)	(4)	(5)
FLFP	-0.15*** [0.05]		0.03 [0.03]	-0.06 [0.07]	-0.01 [0.07]
Rural		0.12*** [0.01]	0.12*** [0.01]	0.11*** [0.03]	0.16*** [0.04]
Born in dép.		0.12*** [0.03]	0.13*** [0.03]	0.15*** [0.04]	0.11* [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 characteristics measured in 1911. *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 per km², average age, average height in cm, the share of active population in industry and the share of active population in agriculture in percent, km of roads and km of rails per km², the share of cultivated land in percent, personal wealth, banking deposits, and direct taxes in Francs per inhabitant, the share of population that can read and write and the share of population with primary education in percent, the minimum distance to the war in km, the share of students in religious schools in percent, turnout in 1914 in percent. Robust standard errors are in brackets.

*** Significant at the 1 percent level, * Significant at the 10 percent level.

Table 4. Impact of WWI Military Fatalities on FLFP

Dependent variable:	FLFP			
	(1)	(2)	(3)	(4)
Death rate $\times$ post	0.37*** [0.08]	0.35*** [0.07]	0.37*** [0.07]	0.35*** [0.07]
Rural	No	Yes	No	Yes
Born in dép.	No	No	Yes	Yes
Département FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	609	609	609	609
Départements	87	87	87	87
Within R ²	0.578	0.579	0.579	0.581
1911 FLFP mean	31.4	31.4	31.4	31.4

Notes. This table reports OLS coefficients from estimating specification 2. *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. Census years are 1901, 1906, 1911, 1921, 1926, 1931, and 1936. Standard errors are in brackets and are clustered at the département level.

*** Significant at the 1 percent level.

Table 5. Impact of WWI Military Fatalities on Female Marital Status

Dependent variable:	A. Share Single			B. Share Widowed		
Age group:	20–29	30–39	40–49	20–29	30–39	40–49
	(1)	(2)	(3)	(4)	(5)	(6)
Death rate $\times$ post	0.27*** [0.07]	0.23*** [0.05]	0.14*** [0.04]	-0.00 [0.01]	0.09*** [0.03]	0.17*** [0.03]
Rural	Yes	Yes	Yes	Yes	Yes	Yes
Born in dép.	Yes	Yes	Yes	Yes	Yes	Yes
Département FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	522	522	522	522	522	522
Départements	87	87	87	87	87	87
Within R ²	0.824	0.258	0.321	0.848	0.928	0.633
1911 outcome mean	38.9	14.6	11.2	1.3	4.7	11.5

Notes. This table reports OLS coefficients from estimating specification 4. The dependent variable is the share of single women in percent in panel A, and the share of widowed or divorced women in percent in panel B. *Rural* denotes the share of rural population in percent; *Born in dép.*, the share of population born in the département in percent. Census years are 1901, 1911, 1921, 1926, 1931, and 1936. Standard errors are in brackets and are clustered at the département level.

*** Significant at the 1 percent level.

Table 6. The Marriage Market Channel

Dependent variable:	FLFP					
Age group:	A. 20–29		B. 30–39		C. 40–49	
	(1)	(2)	(3)	(4)	(5)	(6)
Death rate $\times$ post	0.27*** [0.09]	0.21** [0.09]	0.48*** [0.10]	0.26*** [0.08]	0.47*** [0.10]	0.30*** [0.10]
Share single		0.27*** [0.07]		0.64*** [0.12]		0.78*** [0.14]
Share widows		1.08*** [0.41]		0.62*** [0.14]		0.41*** [0.15]
Rural	Yes	Yes	Yes	Yes	Yes	Yes
Born in dép.	Yes	Yes	Yes	Yes	Yes	Yes
Département FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	435	435	435	435	435	435
Départements	87	87	87	87	87	87
Within R ²	0.685	0.704	0.685	0.736	0.591	0.664
1901 FLFP mean	34.7	34.7	30.1	30.1	27.7	27.7

Notes. This table reports OLS coefficients from estimating specification 5. *FLFP* denotes female labor force participation of the relevant age group in percent; *Share single*, the share of single women of the relevant age group in percent; *Share widowed*, the share of widowed or divorced women of the relevant age group in percent; *Rural*, the share of rural population in percent; *Born in dép*, the share of population born in the département in percent. Census years are 1901, 1921, 1926, 1931, and 1936. Standard errors are in brackets and are clustered at the département level.

*** Significant at the 1 percent level. ** Significant at the 5 percent level.

Table 7. Impact of WWI Military Fatalities on Wages

Dependent variable:	Log Hourly Wage Rate				
	A. Manufacturing			B. Domestic	
Occupation:	Ironer	Seamstress	Milliner	Cook	Housekeeper
	(1)	(2)	(3)	(4)	(5)
Death rate $\times$ post	-0.010*** [0.004]	-0.012*** [0.003]	-0.008** [0.003]	-0.006*** [0.002]	-0.002* [0.001]
Rural	Yes	Yes	Yes	Yes	Yes
Born in <i>dép.</i>	Yes	Yes	Yes	Yes	Yes
Département FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	386	395	366	173	171
Départements	87	87	87	87	87
Within R^2	0.951	0.955	0.951	0.901	0.948
1911 mean (francs)	0.21	0.23	0.25	0.20	0.16

Notes. This table reports OLS coefficients from estimating specification 2. The dependent variable is log hourly wage rate. *Rural* denotes the share of rural population in percent; *Born in dép.*, the share of population born in the département in percent. Survey years are 1901, 1906, 1911, 1921, and 1926 in columns 1–3, and 1913 and 1921 in columns 4 and 5. Standard errors are in brackets and are clustered at the département level.

*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.