

The Missing Men

World War I and Female Labor Force Participation

Jörn Boehnke¹ Victor Gay²

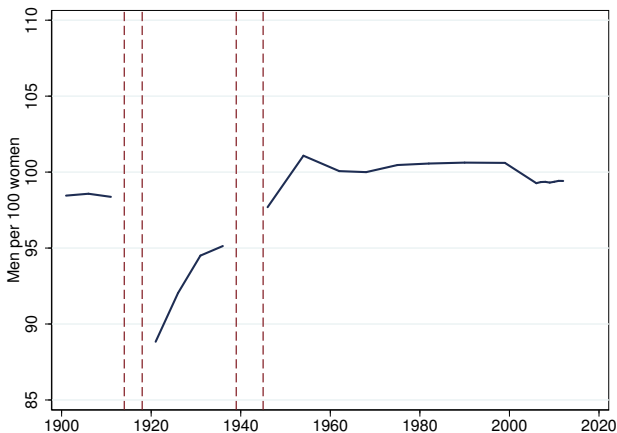
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WWI in France: a Shock to the Sex Ratio



Adult Sex Ratio (1900–2012)

- 1.3 million French fatalities \implies 16% of men aged 15–50 in 1914.

Research Question

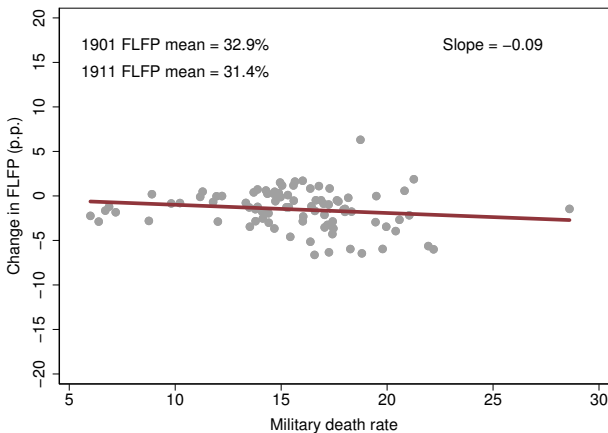
What was the impact of WWI in France on FLFP?

Research Question, Redux

During the interwar period, did FLFP increased relatively more in départements that experienced greater military death rates?

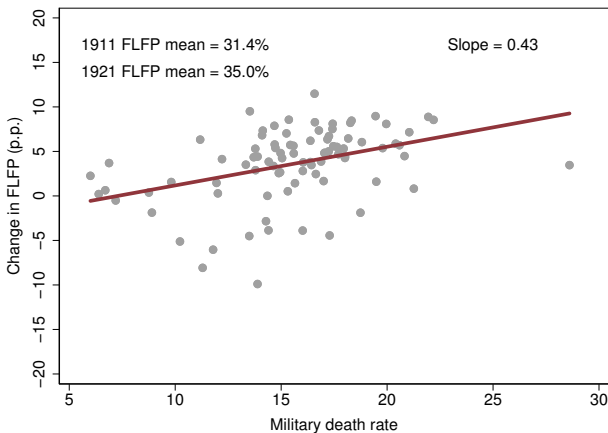
Short Answer: Yes

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WWI Military Death Rates and Changes in FLFP (1901–1911)

Short Answer: Yes



WWI Military Death Rates and Changes in FLFP (1911–1921)

Main Result

- Difference-in-differences strategy (1901–1936):
 - 20% vs 10% military death rates \implies FLFP \uparrow 4 p.p.
 - 4 p.p. \simeq 12% of pre-war FLFP mean (0.4 s.d.).

Main Result

- Difference-in-differences strategy (1901–1936):
 - 20% vs 10% military death rates \implies FLFP \uparrow 4 p.p.
 - 4 p.p. \simeq 12% of pre-war FLFP mean (0.4 s.d.).
- Women mostly enter industrial sector.

Mechanisms

- Supply channels through post-war marriage market:
 - Increased shares of (older) widows and (younger) single women.
 - Negative income shocks \implies \uparrow labor supply.

Mechanisms

- Supply channels through post-war marriage market:
 - Increased shares of (older) widows and (younger) single women.
 - Negative income shocks \implies \uparrow labor supply.
- Little evidence of demand channel through substitution across inputs.
- No persistence of female wartime employment.

Plan

- Contributions and related literature.
- Data and historical context.
- Main results.
- Mechanisms.
- Conclusion

Contribution 1

War mobilization and FLFP

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War mobilization and FLFP

- WWII mobilization in US.
 - Wartime mobilization increased FLFP after WWII. [Goldin \(1991\)](#)
[Acemoglu et al. \(2004\)](#) [Goldin and Olivetti \(2013\)](#)
 - Better measurement: little to no effect. [Rose \(2018\)](#)
- ⇒ Renewed evidence on wars and FLFP.

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⇒ Renewed evidence on wars and FLFP.
- Historiography: war as a parenthesis. [Thébaud \(1986, 2014\)](#)
⇒ Confirm and nuance historical accounts.

Contribution 2

WWI in France and economic outcomes

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WWI in France and economic outcomes

- Marriage market outcomes. [Abramitzky et al. \(2011\)](#)
- Fertility outcomes. [Vandenbroucke \(2014\)](#)

⇒ Superior measure of military death rates locally.

Contribution 3

Identification of consequences of sex ratio imbalances on FLFP

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- Short-run effects.
 - Differences in sex ratio across cohorts in US (1965–2005). [Amuedo-Dorantes and Grossbard \(2007\)](#)
 - Changes in immigrants sex ratios in US (1910–1940). [Angrist \(2002\)](#)

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⇒ Permanent, sharp, large, exogenous shock to sex ratios.

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- Long-run effects.
 - Scarcity of men in Africa due to slave trade. [Teso \(2019\)](#)
 - Scarcity of women in Australia throughout 19th century. [Grosjean and Khattar \(2019\)](#)
 - Scarcity of men in France due to WWI. [Gay \(2021\)](#)

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 - Scarcity of men in France due to WWI. [Gay \(2021\)](#)
- ⇒ Historical and quantitative foundations for persistence studies.

Measuring FLFP (1901–1936)

- FLFP at département level: censuses 1901–1936.

Measuring FLFP (1901–1936)

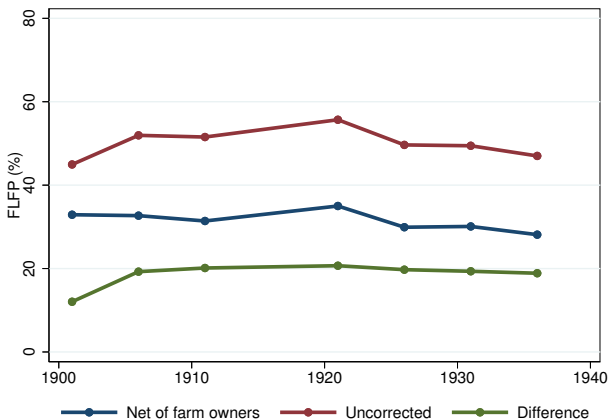
- FLFP at département level: censuses 1901–1936.
- FLFP: share of women aged 15+ in labor force.

Measuring FLFP (1901–1936)

- FLFP at département level: censuses 1901–1936.
- FLFP: share of women aged 15+ in labor force.
- Focus on paid employment:
 - Farmer's wives to be classified as labor force participant.
 - Not consistent in 1901. [Maruani and Meron \(2012\)](#)
 - Subtract female farm owners for consistency.

Measuring FLFP (1901–1936)

Average Female Labor Force Participation Rates (%)



WWI Military Fatalities: Data

- Original dataset:
 - Individual military records for all 1.3 million deceased French soldiers.
 - Information: département of birth, dates of birth and death.

WWI Military Fatalities: Data

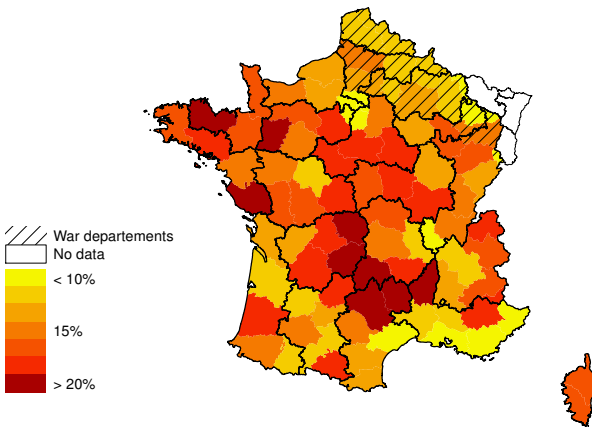
- Original dataset:
 - Individual military records for all 1.3 million deceased French soldiers.
 - Information: département of birth, dates of birth and death.
- Measure of military death rates at the département level:

$$\text{death_rate}_d = \frac{\text{dead soldiers born in } d}{\underbrace{\text{male pop. aged 15–44 in } d \text{ in 1911}}_{\text{Draft pool in census 1911}}}$$

- Summary statistics:
 - Mean = 15%, 25th percentile \simeq 10%, 75th percentile \simeq 20%.
 - Minimum = 6%, maximum = 29%.

WWI Military Fatalities: Distribution

Military Death Rates Across 87 Départements



WWI Military Fatalities: Data Generating Process

- Until end 1914: territorial organization of military recruitment.

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- Policies by the Ministry of War to support the industrial war effort:
 - ⇒ Up to 15% of soldiers allocated to war industries. [▶ Figure](#)

WWI Military Fatalities: Data Generating Process

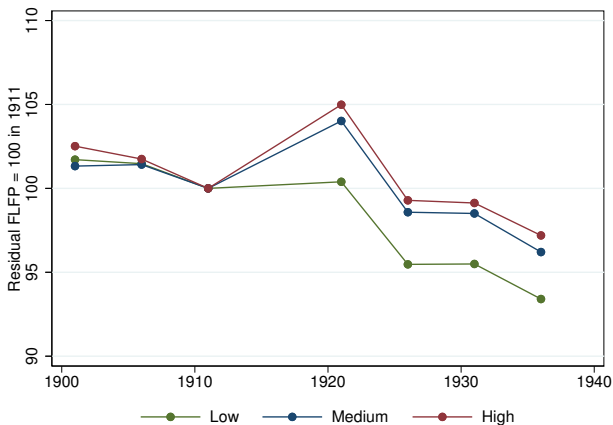
- Until end 1914: territorial organization of military recruitment.
- Policies by the Ministry of War to support the industrial war effort:
⇒ Up to 15% of soldiers allocated to war industries. [▶ Figure](#)
- Pre-war characteristics:
 - Correlated with measures of rurality.
 - Uncorrelated with other pre-war characteristics.
 - Uncorrelated with pre-war levels and trends in FLFP.

Military Fatalities and Pre-War Characteristics

Dependent variable:	Military death rate		
	(1)	(2)	(3)
FLFP	0.03 [0.03]	-0.06 [0.07]	-0.01 [0.07]
Rural	0.12*** [0.01]	0.11*** [0.03]	0.16*** [0.04]
Born in dép.	0.13*** [0.03]	0.15*** [0.04]	0.11* [0.06]
Other characteristics	No	Yes	Yes
Military region FE	No	No	Yes
Départements	87	87	87
Adj. R ²	0.739	0.790	0.838

Other characteristics: fertility, wealth, female education, population density, age, height, share in industry, roads and rails per km², share cultivated land, direct taxes, banking deposits, distance to war, share religious schools, turnout, distance to war, share literate.

Military Fatalities and Pre-War Trends in FLFP



Baseline Results

- Empirical strategy: difference-in-differences.

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

- post_t = indicator for $t > 1918$.
 - γ_d = department fixed effects.
 - δ_t = year fixed effects.
- Standard errors clustered at département level.
 - Censuses: 1901, 1906, 1911, 1921, 1926, 1931, 1936.

Baseline Results

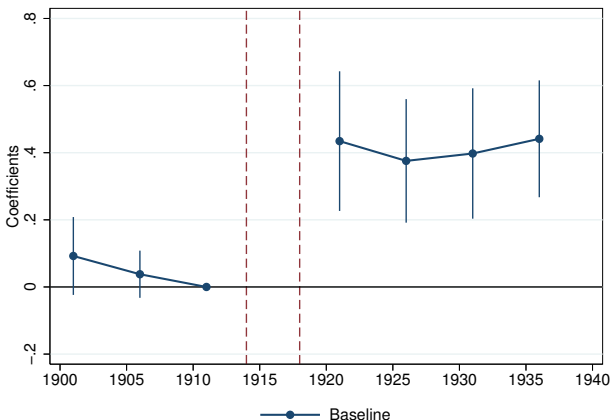
$$\text{FLFP}_{d,t} = \beta \text{ death_rate}_d \times \text{post}_t + \gamma_d + \delta_t + \varepsilon_{d,t}$$

Dependent variable:	FLFP	
	(1)	(2)
Death rate \times post	0.37*** [0.08]	0.35*** [0.07]
Rural	No	Yes
Born in dép.	No	Yes
Départements	87	87
1911 FLFP mean	31.4	31.4

- 20% vs 10% military death rates \implies FLFP \uparrow 4 p.p.
- 4 p.p. \simeq 12% of pre-war FLFP mean (0.4 s.d.).

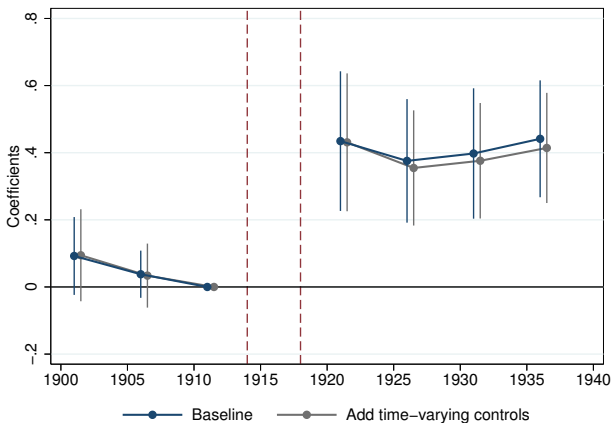
Baseline Results

$$\text{FLFP}_{d,t} = \sum_{t \neq 1911} \beta_t \text{death_rate}_d \times \text{year}_t + \gamma_d + \delta_t + \varepsilon_{d,t}$$



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$$\text{FLFP}_{d,t} = \sum_{t \neq 1911} \beta_t \text{death_rate}_d \times \text{year}_t + \gamma_d + \delta_t + \varepsilon_{d,t}$$



Baseline Results: Sectors Decomposition

Sector:	FLFP by Sector				
	Agriculture	Industry	Commerce	Liberal	Domestic
	(1)	(2)	(3)	(4)	(5)
Death rate \times post	0.02 [0.03]	0.28*** [0.05]	-0.03 [0.02]	-0.01 [0.01]	0.09*** [0.02]
Départements	87	87	87	87	87
1911 outcome mean	6.8	14.0	4.5	2.0	4.0

Controls: rurality, year and département FE.

- 20% vs 10% military death rates \implies FLFP \uparrow 20% of pre-war levels in industrial and domestic sectors.

Baseline Results: Sectors Decomposition

Dependent variable:	FLFP by Sector				
	Agriculture	Industry	Commerce	Liberal	Domestic
Sector:	(1)	(2)	(3)	(4)	(5)
Death rate \times post	0.13* [0.07]	0.28*** [0.05]	-0.03 [0.02]	-0.01 [0.01]	0.09*** [0.02]
Départements	87	87	87	87	87
1911 outcome mean	27.0	14.0	4.5	2.0	4.0

Controls: rurality, year and département FE.

- Include female farm owners: \uparrow 5% of pre-war level.

Robustness

- Placebo test with MLFP.
- Département-specific time trends.
- Alternative measurement of FLFP.
- War destruction and the reconstruction.
- Pre-war health conditions.
- Correcting military death rates for pre-war migration.

Robustness: Placebo Test with MLFP

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Dependent variable:	FLFP	MLFP
	(1)	(2)
Death rate \times post	0.35*** [0.07]	-0.01 [0.06]
Départements	87	87

Controls: rurality, year and département FE.

Robustness: Département-Specific Time Trends

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Dependent variable:	FLFP			
	(1)	(2)	(3)	(4)
Death rate \times post	0.35*** [0.07]	0.41*** [0.15]	0.47*** [0.16]	0.47*** [0.16]
Département \times year	No	Yes	Yes	Yes
Polynomial order	0	1	2	3
Départements	87	87	87	87

Controls: rurality, year and département FE.

Robustness: Alternative Measurement of FLFP

Include female farm owners

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Include female farm owners

Dependent variable:	FLFP		
	(1)	(2)	(3)
Death rate \times post	0.35*** [0.07]	0.39*** [0.07]	0.45*** [0.10]
1901 census	Yes	No	No
Female farm owners	No	No	Yes
Départements	87	87	87
1911 FLFP mean	31.4	31.4	51.5

Controls: rurality, year and département FE.

- 4 p.p. \simeq 12% of pre-war FLFP mean without female farm owners.
- 4 p.p. \simeq 9% of pre-war FLFP mean with female farm owners.

Robustness: Alternative Measurement of FLFP

Exclude unemployed

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Exclude unemployed

Dependent variable:	FLFP	
	(1)	(2)
Death rate \times post	0.35*** [0.07]	0.38*** [0.07]
Unemployed	Yes	No
Départements	87	87
1911 FLFP mean	31.4	31.1

Controls: rurality, year and département FE.

Robustness: War Destruction and Reconstruction

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Exclude war départements

Dependent variable:	FLFP	
	(1)	(2)
Death rate \times post	0.35*** [0.07]	0.28*** [0.07]
War départements	Yes	No
Départements	87	76
1911 FLFP mean	31.4	30.5

Controls: rurality, year and département FE.

- War départements more industrial (50% versus 30% in industry).
- Military death rates uncorrelated with war destruction and reconstruction measures. [Michel \(1932\)](#)

Robustness: Pre-War Health Conditions

- 78.5% of men aged 20–48 enlisted throughout WWI. [Huber \(1931\)](#)
- Recruitment lists at age 20 for classes 1905–1911 from *Compte Rendus sur le Recrutement de l'Armée*.
- Measure of non-incorporation for health reasons.
- Correlated with conscripts height and local mortality rates.
- Variation fully captured by rurality.

Robustness: Pre-War Health Conditions

	Age Classes		
	1905	1908	1911
Enlisted in armed forces (%)	66.3 (4.9)	68.9 (4.9)	71.0 (5.7)
Not incorporated in armed forces for health reasons (%)	24.3 (3.6)	22.8 (3.5)	20.8 (4.1)
Incorporation adjourned (%)	9.4 (3.4)	8.3 (3.8)	8.1 (5.4)
Départements	87	87	87

Robustness: Pre-War Health Conditions

Dependent variable:	FLFP		
	(1)	(2)	(3)
Death rate \times post	0.35*** [0.07]		0.36*** [0.07]
Enlistment rate \times post		-0.04 [0.06]	-0.07 [0.05]
Départements	87	87	87

Controls: rurality, year and département FE.

- Enlistment rate: average across 1905–1911 cohorts.

Robustness: Correct for Pre-War Migration

- 19% of men aged 15–44 live outside département of birth in 1911.
- Attenuation bias due to measurement error.

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- If rural men migrate systematically to urban areas:
 - Military death rates in urban areas understated.
 - Military death rates in rural areas overstated.

Robustness: Correct for Pre-War Migration

- 19% of men aged 15–44 live outside département of birth in 1911.
- Attenuation bias due to measurement error.
- If rural men migrate systematically to urban areas:
 - Military death rates in urban areas understated.
 - Military death rates in rural areas overstated.
- FLFP more responsive in industrial (urban) areas.
⇒ Downward bias in estimates.

Robustness: Correct for Pre-War Migration

- 19% of men aged 15–44 live outside département of birth in 1911.
- Attenuation bias due to measurement error.
- If rural men migrate systematically to urban areas:
 - Military death rates in urban areas understated.
 - Military death rates in rural areas overstated.
- FLFP more responsive in industrial (urban) areas.
⇒ Downward bias in estimates.
- Use 1911 bilateral migration matrices to correct death rate measure.

Robustness: Correct for Pre-War Migration

Dependent variable:	FLFP	
	(1)	(2)
Death rate \times post	0.35*** [0.07]	0.55*** [0.13]
Corrected death rate	No	Yes
Départements	87	87

Controls: rurality, year and département FE.

- $(2) - (1) = 0.20 [0.15]$.

Potential Mechanisms

- Supply channel through post-war marriage market.
- Demand channel through substitution across inputs.
- Persistence of female wartime employment.

Supply factors: A Marriage Market Channel?

- Demographic changes of female marital statuses:
 - Increased share of single women.
 - Increased share of widowed (and divorced) women.
- ⇒ Non-married women structurally supply more labor.

Supply factors: A Marriage Market Channel?

- Demographic changes of female marital statuses:
 - Increased share of single women.
 - Increased share of widowed (and divorced) women.
- ⇒ Non-married women structurally supply more labor.
- Increased relative labor supply due to negative income shocks:
 - War widows (very low subsidies until 1930s).
 - Young single women (if deceased soldier in family).
 - Married women.
 - Lower quality husbands. [Abramitky et al. \(2011\)](#)
 - Lower bargaining power in household. [Grossbard \(2014\)](#)

Supply factors: Data

- Data relatively scarce at département level.

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- Data relatively scarce at département level.
- Marital status data:
 - Single, widowed/divorced, married by decennial age groups.
 - Drop 1906: inconsistent age groups.
- No data on FLFP by marital status.
- FLFP by decennial age groups but only 1901 as pre-war census.

The Post-War Marriage Market

- Empirical strategy: difference-in-differences.

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

- $Y_{m,a,d,t}$ = share of women of marital status m in age group a .
 - post_t = indicator for $t > 1918$.
 - γ_d = department fixed effects.
 - δ_t = year fixed effects.
- Standard errors clustered at département level.

The Post-War Marriage Market

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

Dependent variable:	Share Widowed		
	20–29	30–39	40–49
Age group:	(1)	(2)	(3)
Death rate \times post	-0.00 [0.01]	0.09*** [0.03]	0.17*** [0.03]
Départements	87	87	87
1911 outcome mean	1.3	4.7	11.5

Controls: rurality, year and département FE.

- No differential pre-war trends.

The Post-War Marriage Market

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

Dependent variable:	Share Single		
	20–29	30–39	40–49
Age group:	(1)	(2)	(3)
Death rate \times post	0.27*** [0.07]	0.23*** [0.05]	0.14*** [0.04]
Départements	87	87	87
1911 outcome mean	38.9	14.6	11.2

Controls: rurality, year and département FE.

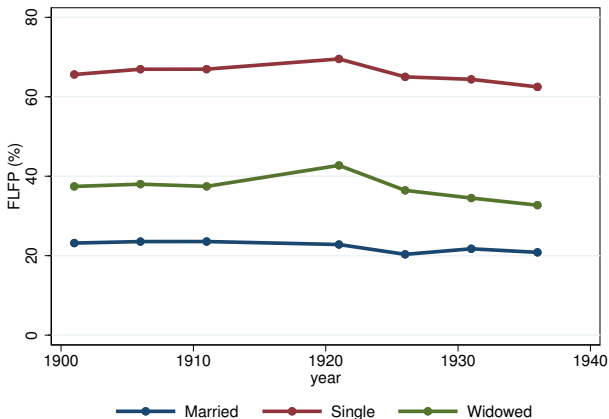
- No differential pre-war trends.

The Post-War Marriage Market

- Women delay marriage during interwar period.
- Women marry down. [Abramitzky et al. \(2011\)](#)
- But rates of definitive singlehood not affected (evidence from census micro data 1962–1982).

FLFP by Marital Status

Aggregate Female Labor Force Participation Rates (%)



FLFP by Age

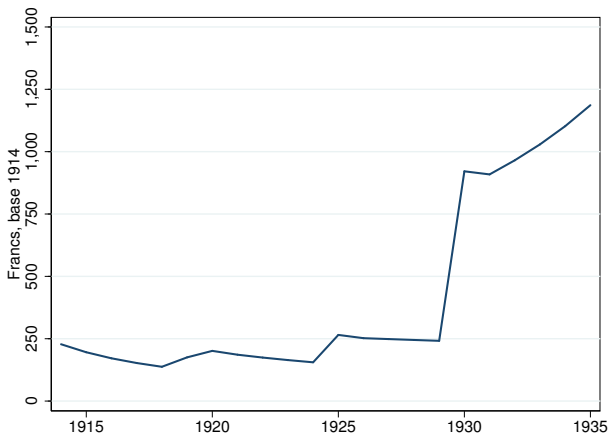
$$\text{FLFP}_{a,d,t} = \beta \text{ death_rate}_d \times \text{post}_t + \gamma_d + \delta_t + \varepsilon_{a,d,t}$$

Dependent variable:	FLFP		
	20–29	30–39	40–49
Age group:	(1)	(2)	(3)
Death rate \times post	0.27*** [0.09]	0.48*** [0.10]	0.47*** [0.10]
Départements	87	87	87
1911 outcome mean	34.7	30.1	27.7

Controls: rurality, year and département FE.

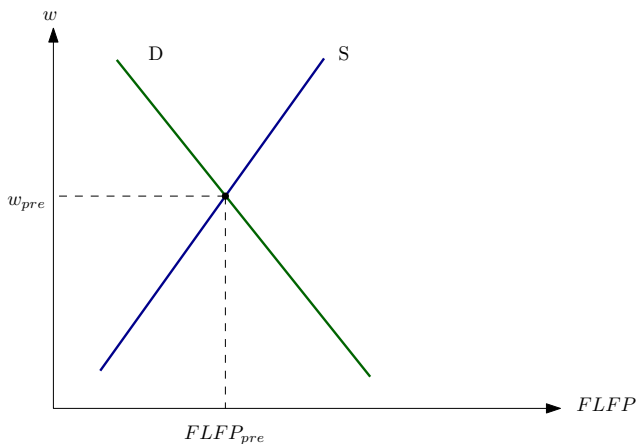
A Negative Income Shock

Annual subsidies to War Widows



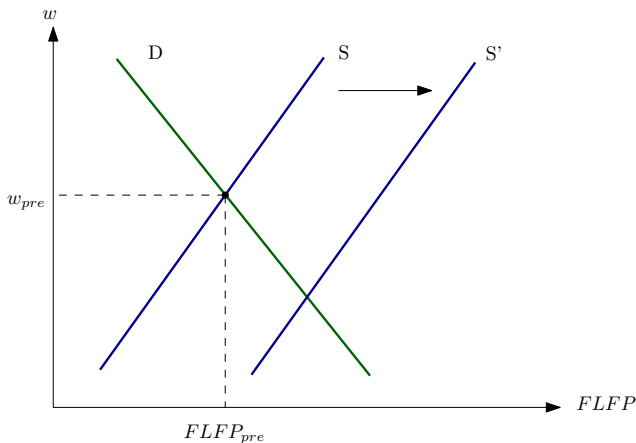
Demand Factors: A Substitution Channel?

Potential Post-War Equilibria



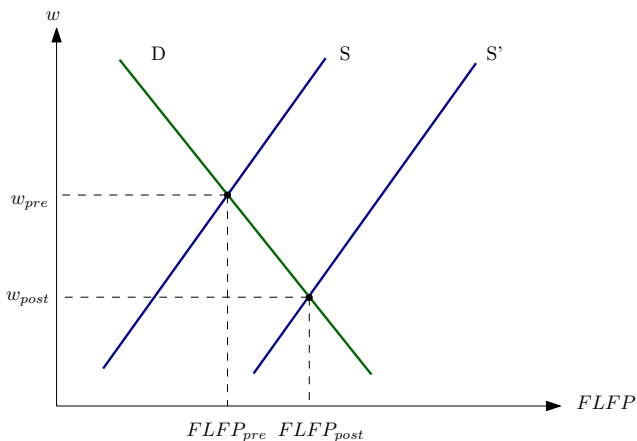
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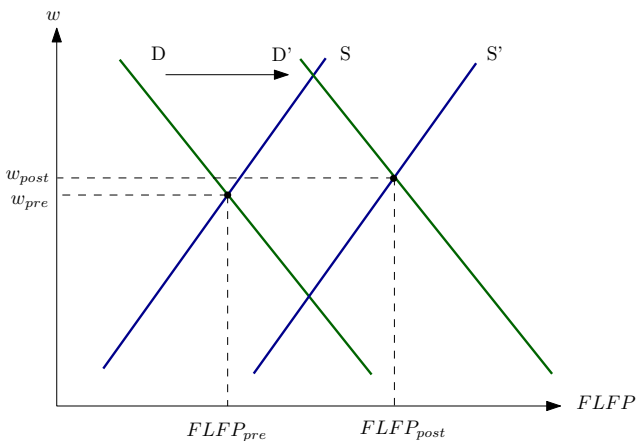
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- Changes in female wages across occupations with different substitutability relative to male labor.

Demand Factors: A Substitution Channel?

- Increase in FLFP compatible with (large) increase in demand for female labor?
- Changes in female wages across occupations with different substitutability relative to male labor.
 - Textile manufacturing sector: low substitutability.
 - Domestic services sector: high(er) substitutability.

The Textile Manufacturing Sector

- Nearly exclusively women.
- Occupations: ironers, seamstresses, milliners.
- No other female occupations available before the war.
- City-level hourly wage rates 1901–1926.
- Enables to fix demand curve across départements with \neq military death rates.

The Textile Manufacturing Sector

$$\log w_{o,d,t} = \beta \text{ death_rate}_d \times \text{post}_t + \gamma_d + \delta_t + \varepsilon_{o,d,t}$$

Dependent variable:	Log Hourly Wage Rate		
	Ironer	Seamstress	Milliner
Occupation:	(1)	(2)	(3)
Death rate \times post	-0.010*** [0.004]	-0.012*** [0.003]	-0.008** [0.003]
Départements	87	87	87
1911 outcome mean (francs)	0.21	0.23	0.25

Controls: rurality, year and département FE.

- No differential pre-war trends.

The Domestic Services Sector

- Balanced gender composition.
- Occupations: cooks and housekeepers.
- City-level yearly wage rates 1913 and 1921.
- Upper bound for changes in demand curve.

The Domestic Services Sector

$$\log w_{o,d,t} = \beta \text{death_rate}_d \times \text{post}_t + \gamma_d + \delta_t + \varepsilon_{o,d,t}$$

Dependent variable:	Log Hourly Wage Rate	
	Cook	Housekeeper
Occupation:	(1)	(2)
Death rate \times post	-0.006*** [0.002]	-0.002* [0.001]
Départements	87	87
1911 outcome mean (francs)	0.20	0.16

Controls: rurality, year and département FE.

- No differential pre-war trends.

Substitution Toward Foreign Labor?

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Dependent variable:	LFP	Share pop.
	(1)	(2)
Death rate \times post	-0.11 [0.22]	-0.08 [0.06]
Départements	87	87
Pre-war outcome mean (level)	0.35	2.26

Controls: rurality, year and département FE.

Substitution Toward Capital (Engine Power)?

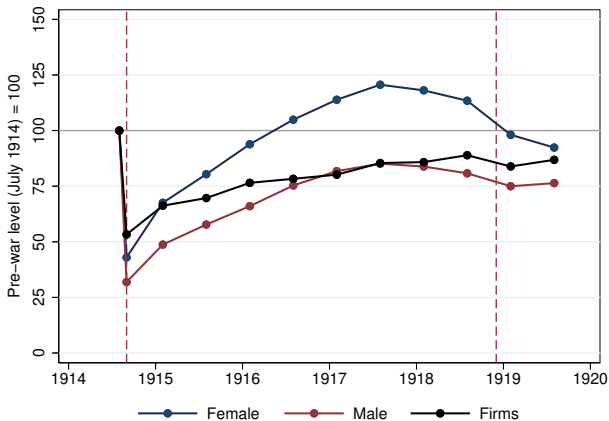
Substitution Toward Capital (Engine Power)?

Dependent variable:	Log total	Per worker
	(1)	(2)
Death rate \times post	0.03** [0.01]	6.58*** [2.37]
Départements	87	87
Pre-war outcome mean (level)	29,782	35.76

Controls: rurality, year and département FE.

Female Wartime Employment

Wartime Employment in Industrial Sector



Female Wartime Employment

- Women who entered labor force could have remained, improved skills, information. . .
- Measure relative intensity of female wartime employment as:

$$\frac{L_{\text{July 1917}} - L_{\text{July 1914}}}{L_{\text{July 1914}}}$$

Female Wartime Employment

- Women who entered labor force could have remained, improved skills, information. . .
- Measure relative intensity of female wartime employment as:

$$\frac{L_{\text{July 1917}} - L_{\text{July 1914}}}{L_{\text{July 1914}}}$$

- Not correlated with military death rates.
- Same result if use July 1918.

Female Wartime Employment

Dependent variable:	FLFP		
	(1)	(2)	(3)
Death rate \times post	0.35*** [0.07]		0.35*** [0.07]
Wartime employment \times post		-0.01 [0.01]	-0.00 [0.01]
Départements	87	87	87

Controls: rurality, year and département FE.

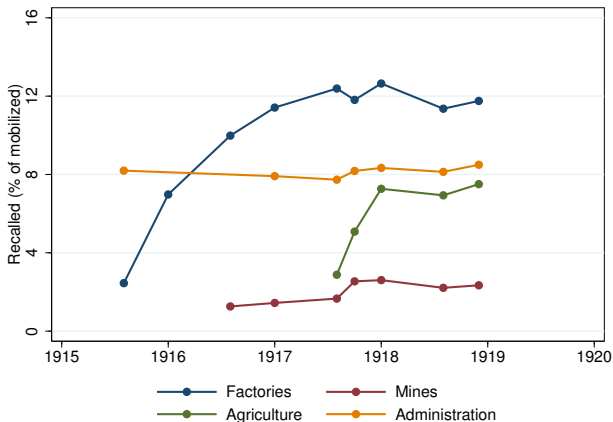
Conclusion

- WWI generated inflow of women in labor force after the war.
- Compatible with supply-side explanation and marriage market channel.
- Little evidence for first-order demand-side explanation and input substitution channel.
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- WWI generated inflow of women in labor force after the war.
- Compatible with supply-side explanation and marriage market channel.
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- No persistence of female wartime employment.
- Results dependent upon context:
 - Magnitude.
 - Base rates if FLP.
 - Structural change and Taylorisation.

Shares of Recalled Soldiers (1915–1919)


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 Data from [Fontaine \(1924\)](#).