Fertility and Wars: The Case of World War I in France

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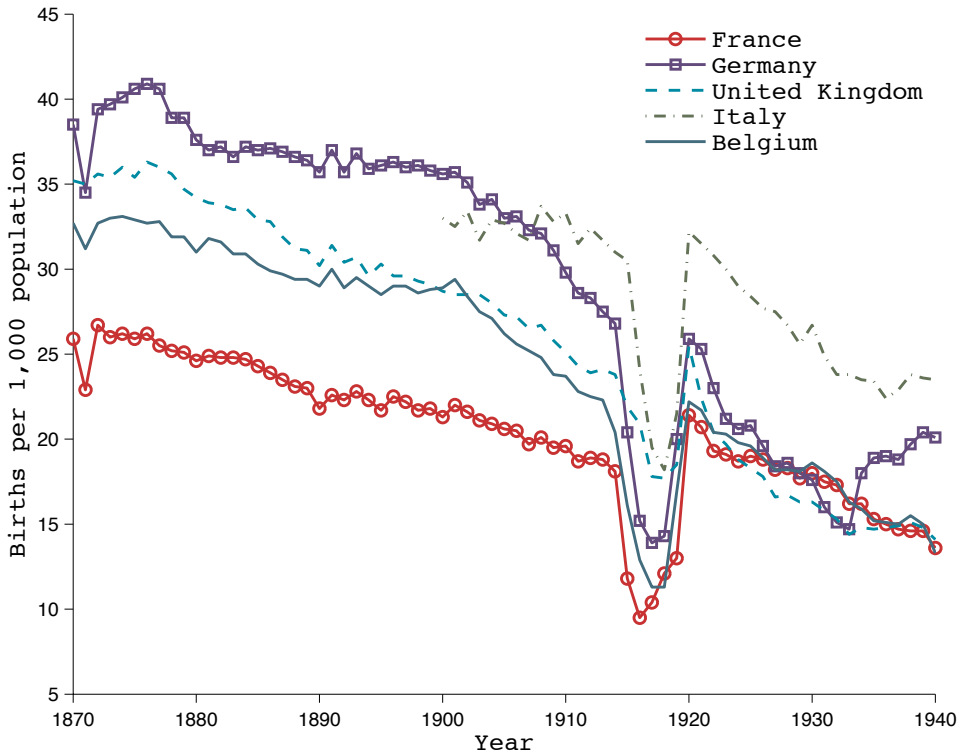
Introduction

Birth Rates in Europe

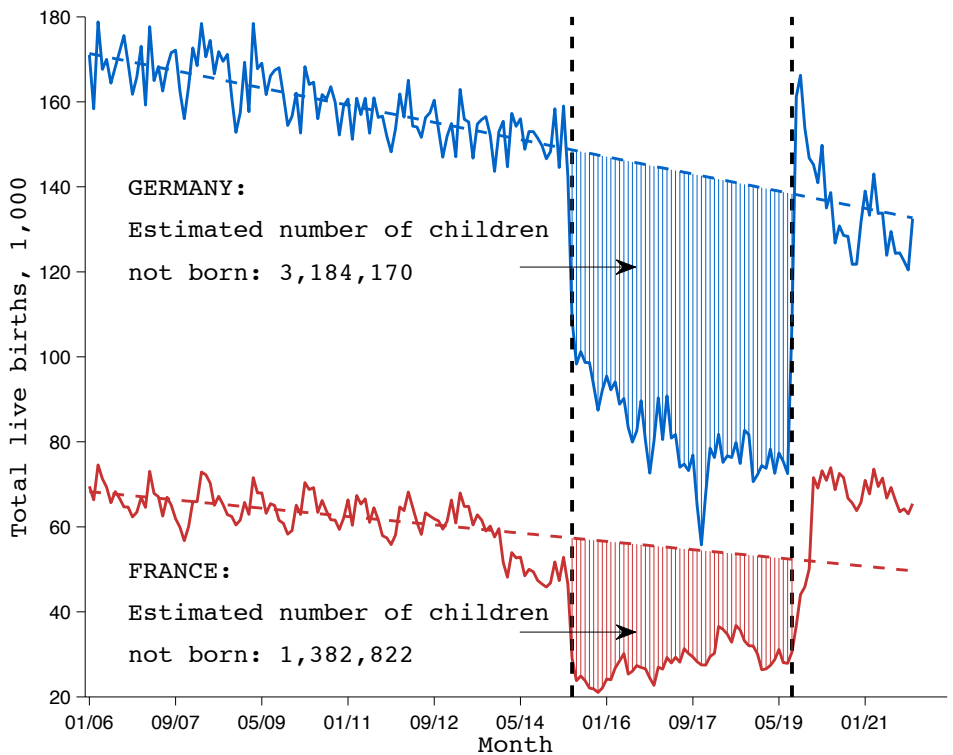


Source: Mitchell (1998)

Fertility and Wars

- World War I and France: not special cases
- Fertility declines in periods of upheaval (Caldwell, 2004)
  - U.S. Civil War
  - French Revolution
  - Spanish Civil War
  - etc... ▸ More

Births in France and Germany



Source: Bunle (1954)

Some Statistics

France

- Deficit of births: 1.4 million
- Casualties: 1.4 million
- Pre-war population: 40 million
- See ▸ Fertility ▸ Total Fertility ▸ Completed Fertility

Some Statistics

France

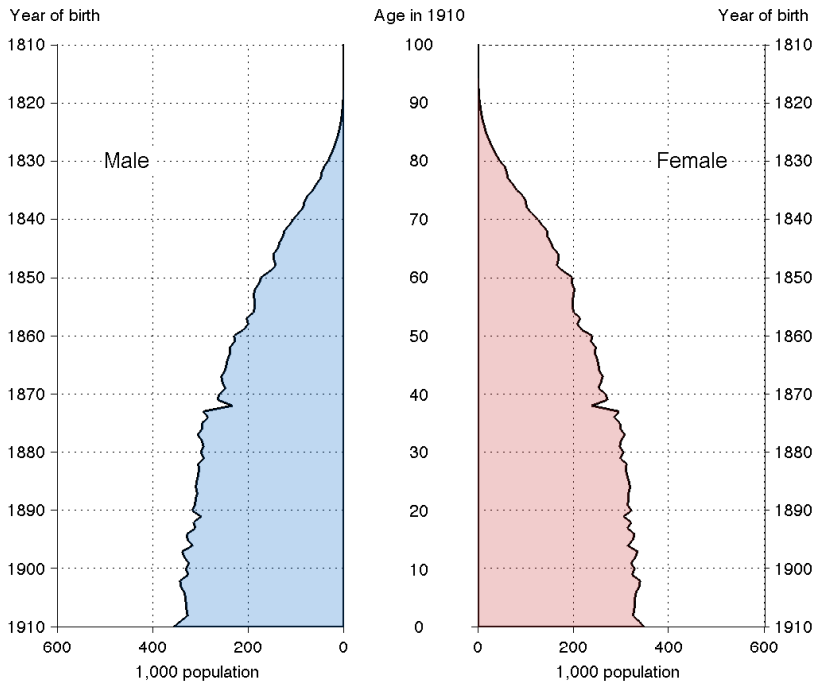
- Deficit of births: 1.4 million
- Casualties: 1.4 million
- Pre-war population: 40 million
- See ▸ Fertility ▸ Total Fertility ▸ Completed Fertility

Germany

- Deficit of births: 3.2 million
- Casualties: 2 million
- Pre-war population: 65 million

A Long-run Consequence of the War

France in 1910



Source: Insee, état civil et recensement de population.

▸ Other countries

A Long-run Consequence of the War

France in 1930

Source: Insee, état civil et recensement de population.

▸ Other countries

A Long-run Consequence of the War

France in 1950

Source: Insee, état civil et recensement de population.

▸ Other countries

A Long-run Consequence of the War

France in 1970

Source: Insee, état civil et recensement de population.

▸ Other countries

A Long-run Consequence of the War

France in 1990

Source: Insee, état civil et recensement de population.

▸ Other countries

Why did fertility decline so much?

Conventional view

- Constant "desired" fertility
- Men away $\rightarrow$ fertility sub-optimally low
  - 8.5 million men served out of 8.7 aged 20-50 in 1914

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Conventional view

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This paper

- War $\rightarrow$ fertility optimally low
  - Loss of expected income
  - Loss of contemporaneous income
  - Faster growth after
- How much do these factors account for?

Strategy

Model of household fertility

- Children take time to raise
- Number of adults random
- Unexpected war

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Model of household fertility

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- Number of adults random
- Unexpected war

Exercise

1. Fit time series of fertility before WWI
2. Calibrate the war shock:
   - Proba. that wife stays alone
   - Income loss from mobilization
   - Loss of productivity and post war growth
3. Compute fertility of generations affected by WWI

Findings

- Accounts for 91% of decline
- Over-predicts post-war increase by 4%
- Main contribution from risk of wife staying alone
- Catch-up effect and decline in completed fertility, consistent with data

The Model

Environment

- Households form with 2 age-1 adults
- Households live J periods
  - Fertile at age 1 and 2 only
  - Time (of wife) cost of a child: γ
  - Fraction $1-\nu$ of children leave each period
- Men and women are productive ▸ Discussion
- Exogenous wages: w^m and w^f
- One-period bond, $r = 1/\beta$

Environment

- $\omega_t \in \{\text{peace}, \text{war}\}$: state of the world
- $z_{j,\tau} \in \{1, 2\}$: adults in age-j household of generation τ
- In peace:
  - $z_{j,\tau}$ constant
  - Probability of war next period is 0
- In war:
  - Probability of husband dying is p
  - Probability of peace next period is q

Environment

- In peace:

$$w_{t+1}^{i}\left(\text{peace}\right) = w_{t}^{i}\left(\text{peace}\right) \times \begin{cases} g & \text{before the war} \\ g_{\text{post war}} & \text{after the war} \end{cases}$$

- In war

$$\begin{aligned} w_{t}^{i}(\text{war}) &= \left(1-\pi^{i}\right) \times w_{\text{last period before war}}^{i} \\ w_{t+1}^{i}(\text{peace}) &= g_{\text{post war}} \times w_{t}^{i}(\text{war}) \end{aligned}$$

Preferences

- Utility of an age-1 household

$$E\left\{\sum_{j=1}^{J}\beta^{j-1}\left[U\left(\frac{c_{j,\tau}}{\phi(n_{j,\tau}+b_{j,\tau},z_{j,\tau})}\right)+\theta V(n_{j,\tau}+b_{j,\tau})\right]\right\}$$

- $c_{j,\tau}$: total consumption, age j, generation τ
- $n_{j,\tau}$: stock of children already born
- $b_{j,\tau}$: new born
- $z_{j,\tau}$: number of adults
- ϕ: adult-equivalent scale

Preferences

- Functional forms

$$U(x) = \frac{x^{1-\sigma} - 1}{1 - \sigma}$$

$$V(x) = \frac{x^{1-\rho} - 1}{1 - \rho}$$

The Decision Problem

$$W_{j,\tau}(a,n;z,\omega) = \max_{c,a',b} \; U\left(\frac{c}{\phi(n+b,z)}\right) + \theta V(n+b) + \beta E\left[W_{j+1,\tau}\left(a',n';z',\omega'\right)\right]$$

subject to

$$c + a' + \gamma w^f_{\tau+j-1}(\omega)(n+b) = \begin{cases} w^m_{\tau+j-1}(\omega) + w^f_{\tau+j-1}(\omega) + a/\beta & z = 2 \\ w^f_{\tau+j-1}(\omega) + a/\beta & z = 1 \end{cases}$$

and

$$n' = \nu(n+b)$$

Optimality

FOC for births (when $z = 2$)

$$\theta V_1(n+b) + \beta\nu E\left[W_{j+1,\tau,2}(a', n'; m'\omega')\right] = U_1\left(\frac{c}{\phi(n+b,2)}\right)\frac{1}{\phi(n+b,2)} \times \left(\gamma w^f_{\tau+j-1}(\omega) + \frac{c}{\phi(n+b,2)}\phi_1(n+b,2)\right)$$

Optimality

FOC for births (when $z = 2$)

$$\theta V_1(n+b) + \beta\nu E\left[W_{j+1,\tau,2}(a', n'; m'\omega')\right] = U_1\left(\frac{c}{\phi(n+b,2)}\right)\frac{1}{\phi(n+b,2)} \times \left(\gamma w^f_{\tau+j-1}(\omega) + \frac{c}{\phi(n+b,2)}\phi_1(n+b,2)\right)$$

When $\nu = 0$ and $\phi(\cdot,\cdot) = 1$

$$\theta V_1(n+b) = U_1(c)\,\gamma w^f_{\tau+j-1},$$

▸ Discussion

Optimality

- Euler condition

$$U_1\left(\frac{c}{\phi(n+b,2)}\right)\frac{1}{\phi(n+b,2)} = E\left[U_1\left(\frac{c'}{\phi(n'+b',2)}\right)\frac{1}{\phi(n'+b',2)}\right]$$

Quantitative Analysis

Calibration

Model period	5 years	
Demography	$\nu = 0.8$ $J = 7$	exp. length of childhood is 4 periods
Discount factor	$\beta = 1.04^{-5}$	
Wages	$w^m_{1806} = 1$ and $w^f / w^m = 0.6$	Huber (1931)
Wage growth	$g = 1.016^5$	Carré et al. (1976)
Adult Eq. scale	$\phi(n, m) = 1/2 + m/2 + 0.3n$	OECD

Calibration

Strategy

- Remaining parameters $\alpha = (\sigma, \theta, \rho, \gamma)$
- Fit time series of fertility before the war

Calibration

Strategy

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Motivation

- Declining trend "bounds" the income effect
- Use this discipline to evaluate an income shock: WWI

Calibration

- Model fertility:

$$f_t(\alpha) = \frac{b_{1,t}(\alpha) + b_{2,t-1}(\alpha)}{2}$$

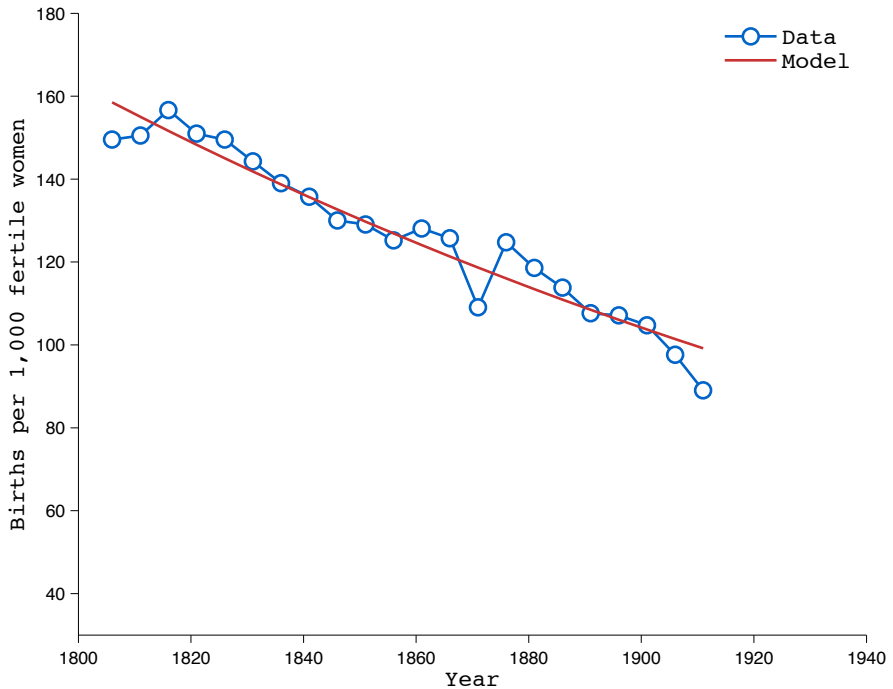
▸ Discussion

- Solve

$$\min_{\alpha} \sum_{t \in \mathcal{I}} [f_t(\alpha) - \mathbf{f}_t]^2 + [\gamma(b_{1,1906}(\alpha) + b_{2,1906}(\alpha)) - 0.1]^2$$

- ▸ Last term
- ▸ Parameters

Fertility Rate in France, Model and Data



Source: Mitchell (1998) and model

Main Experiment

The war

- breaks out in 1916
- expected to end with $q \in \{1, 0.9, 0.8\}$
- is over in 1921
- not expected to come back

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- is over in 1921
- not expected to come back

Decisions of

- Age 1 in 1916
- Age 2 in 1916 with state inherited from previous path
- Age 2 in 1921 with state inherited from 1916
- etc...

Main Experiment

Expectations

$$p = \frac{\text{military losses of World War I}}{\text{total men mobilized}} = \frac{1.4}{8.5} = 0.16$$

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$$p = \frac{\text{military losses of World War I}}{\text{total men mobilized}} = \frac{1.4}{8.5} = 0.16$$

Income

- $\pi^f = 0.3$ ▸ Data
- $g_{\text{post war}} = 1.025^5$ ▸ Data
- $\pi^m = 0.5$ Downs (1965): income compensation between 30 and 60% of a man's pre-war salary

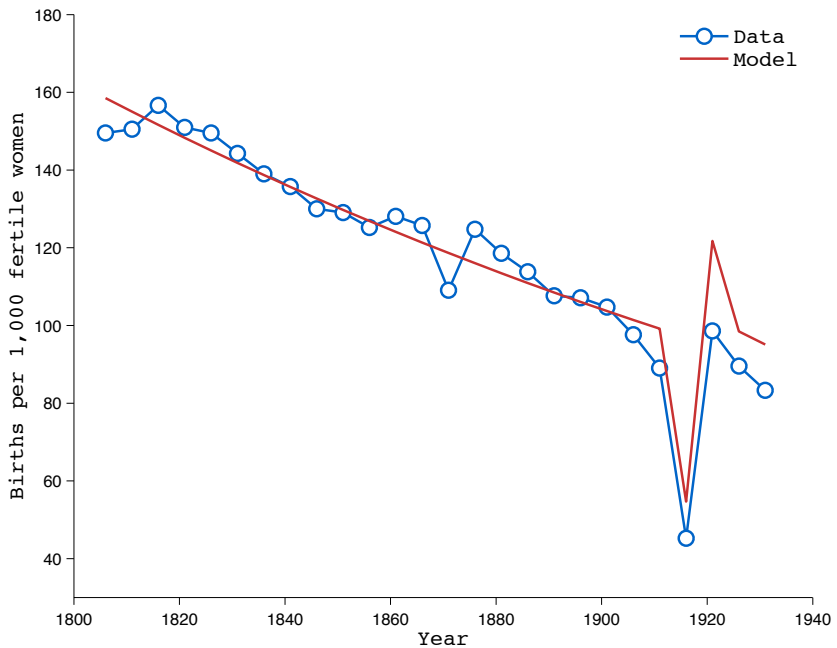
Main Experiment

1911-16

Fertility ↓ 45% v. 49 in data

1916-21

Fertility ↑ 123% v. 118 in data



$q = 1.0$

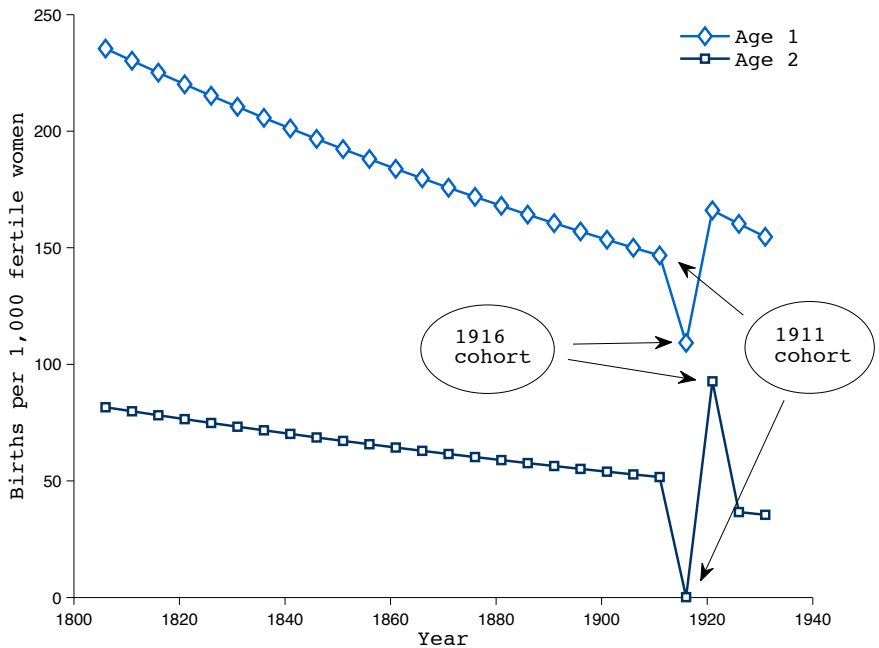
Age-Specific Fertility

1911-16

Decline for age 1 and 2

1916-21

Increase for age 1 and 2

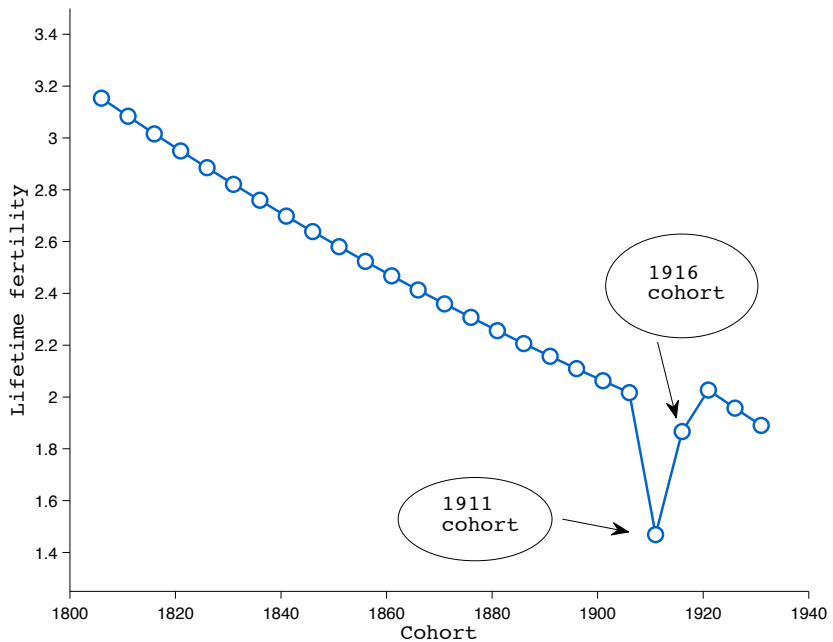


$q = 1.0$

Lifetime Fertility

1911 cohort
"strong" decline

1916 cohort
"moderate" decline



$q = 1.0$

Experiments

	$q = 1$		$q = 0.9$		$q = 0.8$	
	1911-16	1916-21	1911-16	1916-21	1911-16	1916-21
Data						
Baseline						
Baseline / Data						
1 - war with only p						
Exp. 1 / Baseline						
2 - war with only π^m						
Exp. 2 / Baseline						
3 - war with only π^f						
Exp. 3 / Baseline						
4 - war with only $g_{\text{post war}}$						
Exp. 4 / Baseline						

▸ Figure

Experiments

	$q = 1$		$q = 0.9$		$q = 0.8$	
	1911-16	1916-21	1911-16	1916-21	1911-16	1916-21
Data	−49	+118				
Baseline	−45	+123				
Baseline / Data	0.91	1.04				
1 - war with only p	−45	+97				
Exp. 1 / Baseline	1.00	0.79				
2 - war with only π^m	−19	+28				
Exp. 2 / Baseline	0.42	0.23				
3 - war with only π^f	+12	−5				
Exp. 3 / Baseline	−0.28	−0.04				
4 - war with only $g_{\text{post war}}$	+4	−10				
Exp. 4 / Baseline	−0.08	−0.09				

▸ Figure

Experiments

	$q = 1$		$q = 0.9$		$q = 0.8$	
	1911-16	1916-21	1911-16	1916-21	1911-16	1916-21
Data	−49	+118	−49	+118		
Baseline	−45	+123	−45	+126		
Baseline / Data	0.91	1.04	0.92	1.07		
1 - war with only p	−45	+97	−45	+99		
Exp. 1 / Baseline	1.00	0.79	1.00	0.79		
2 - war with only π^m	−19	+28	−19	+27		
Exp. 2 / Baseline	0.42	0.23	0.41	0.22		
3 - war with only π^f	+12	−5	+13	−5		
Exp. 3 / Baseline	−0.28	−0.04	−0.28	−0.04		
4 - war with only $g_{\text{post war}}$	+4	−10	+3	−9		
Exp. 4 / Baseline	−0.08	−0.09	−0.07	−0.07		

▸ Figure

Experiments

	$q = 1$		$q = 0.9$		$q = 0.8$	
	1911-16	1916-21	1911-16	1916-21	1911-16	1916-21
Data	−49	+118	−49	+118	−49	+118
Baseline	−45	+123	−45	+126	−46	+129
Baseline / Data	0.91	1.04	0.92	1.07	0.93	1.09
1 - war with only p	−45	+97	−45	+99	−45	+100
Exp. 1 / Baseline	1.00	0.79	1.00	0.79	0.99	0.78
2 - war with only π^m	−19	+28	−19	+27	−19	+27
Exp. 2 / Baseline	0.42	0.23	0.41	0.22	0.41	0.21
3 - war with only π^f	+12	−5	+13	−5	+13	−5
Exp. 3 / Baseline	−0.28	−0.04	−0.28	−0.04	−0.28	−0.04
4 - war with only $g_{\text{post war}}$	+4	−10	+3	−9	+3	−8
Exp. 4 / Baseline	−0.08	−0.09	−0.07	−0.07	−0.06	−0.06

▸ Figure

Sensitivity Analysis

Sensitivity Analysis

	1911-16	1916-21
Data	−49	+118
Baseline	−45	+123
$p = 0.10$	−33	+80
$p = 0.20$	−49	+144
$\pi^m = 0.25$	−42	+110
$\pi^m = 0.75$	−53	+165
Time cost of children 5%	−20	+31
Time cost of children 15%	−40	+95
$w^f/w^m = 0.65$	−38	+84
$w^f/w^m = 0.55$	−43	+99

Conclusion

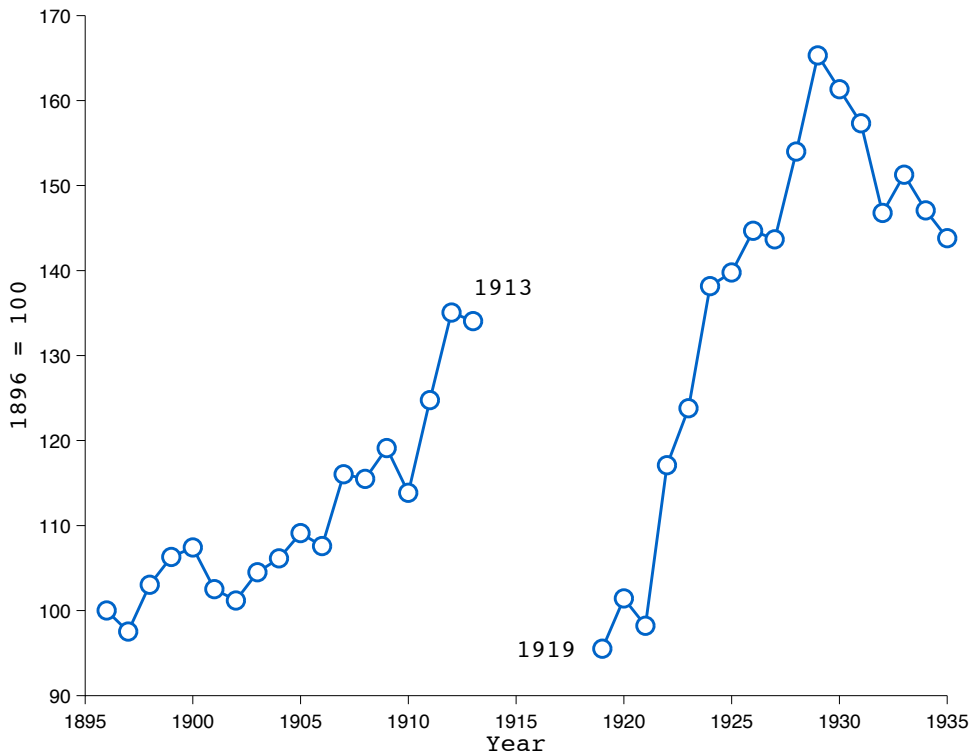
Conclusion

- Large collapse of fertility during WWI
- Model with random number of adults
- Expected loss of a husband is an income shock
- Time series of fertility before WWI "disciplines" the size of income effect

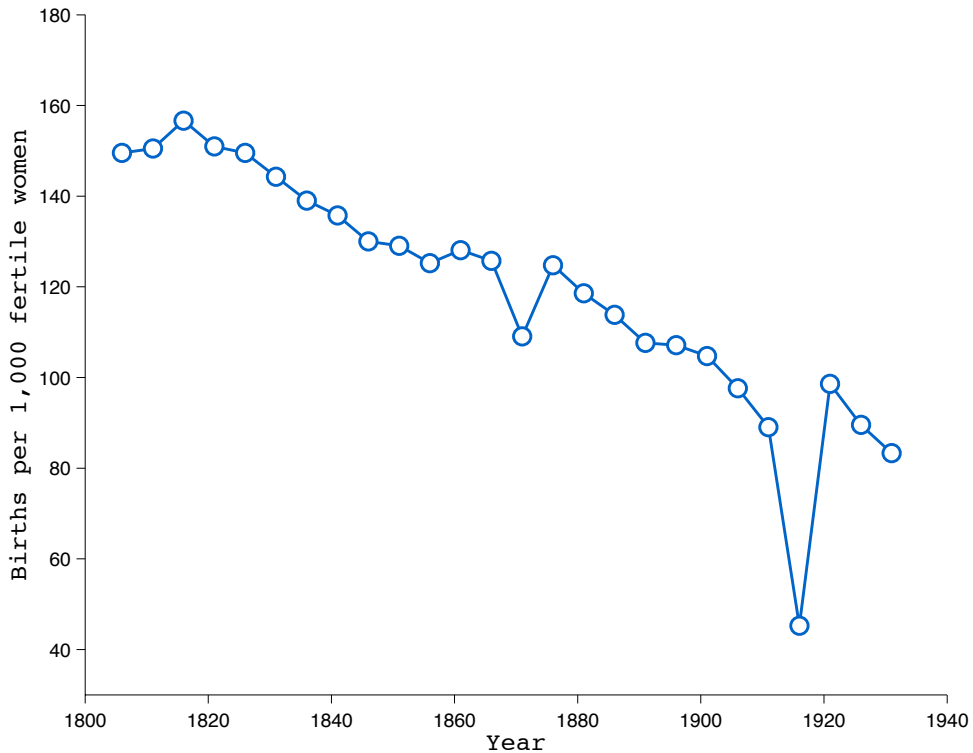
- Accounts for 91% of decline
- Over-predicts post-war increase by 4%
- Shock to expectations most important contributor

Extra Material

Index of Output Per Worker in France

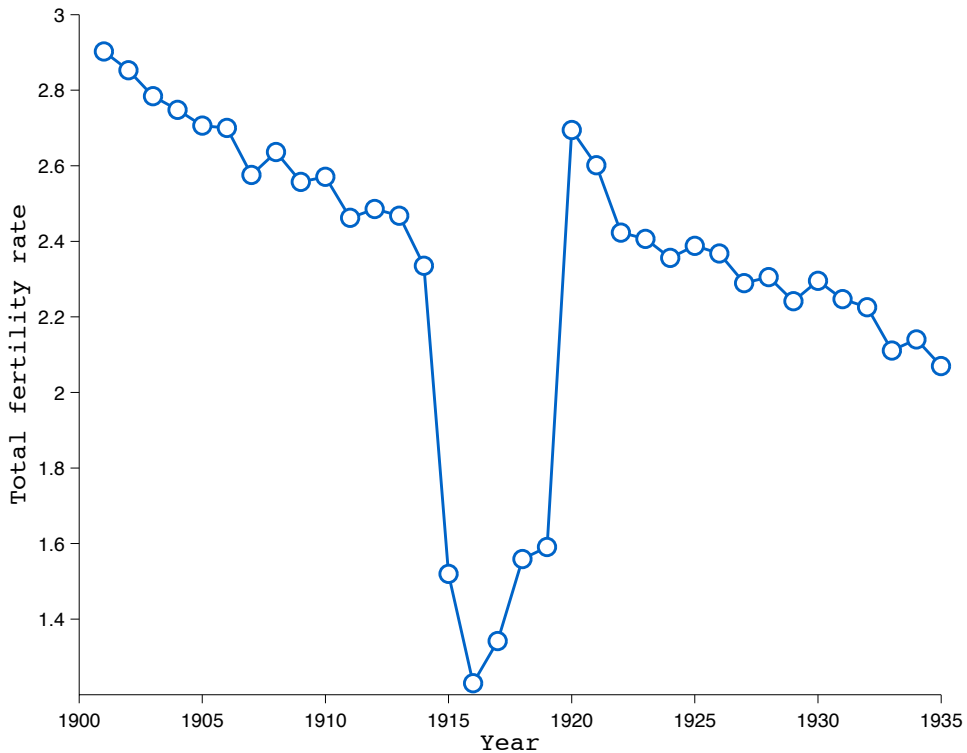


French Fertility Rate



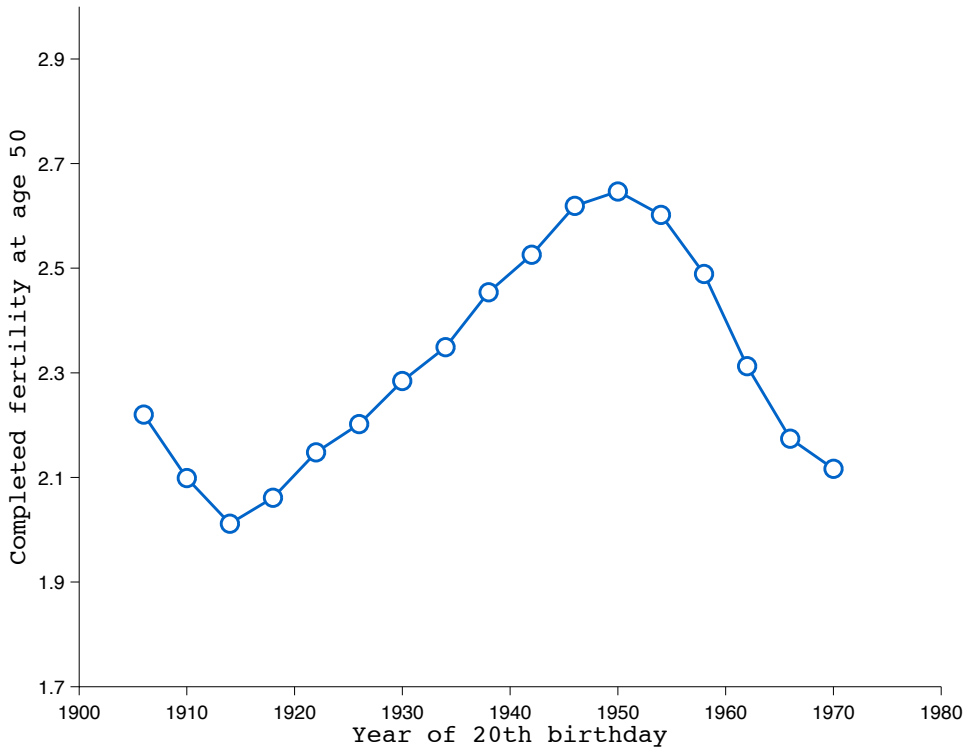
Source: Mitchell (1998).

French Total Fertility Rate



Source: Insee, état civil et recensement de population.

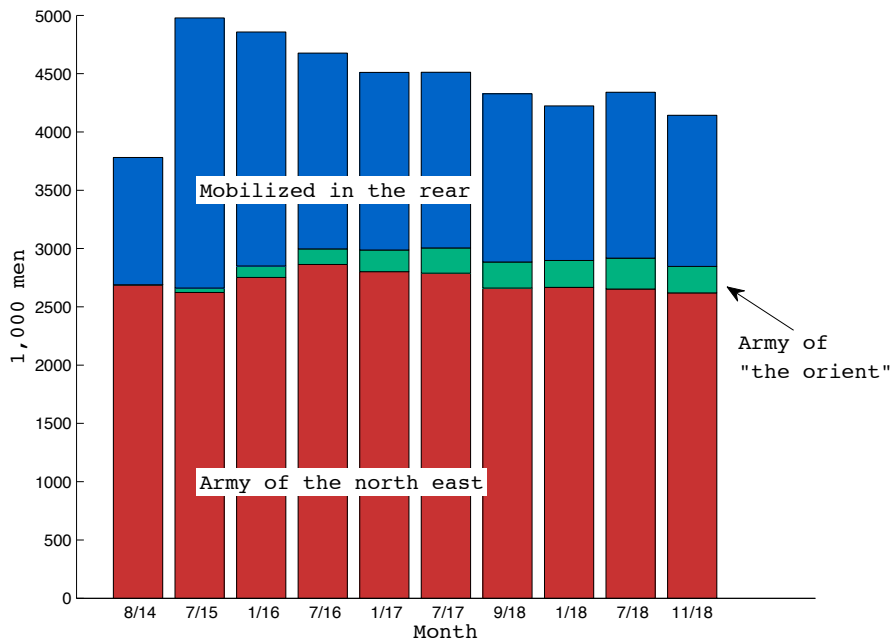
French Completed Fertility Rate



Source: Insee, état civil et recensement de population.

Composition of the French Army

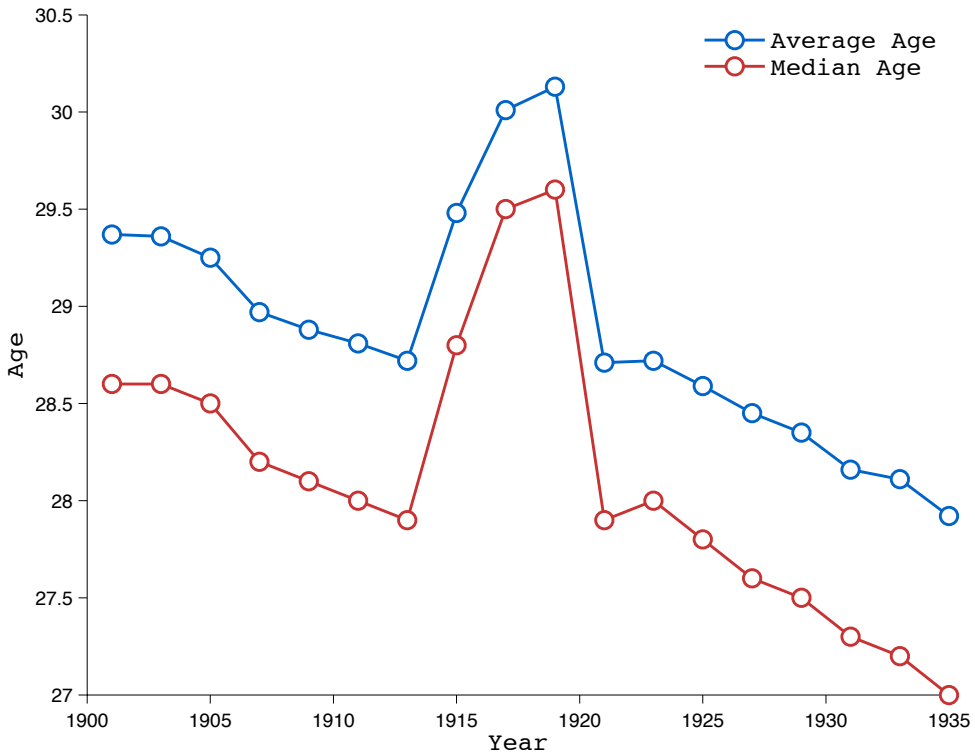
- 8.5 million men served
- Not all at the front
  - 30 to 50% in the rear
  - In the rear $\sim$ in touch with civilian population
- Leave policies generalized in June 1915
  - 7 days every 4 months
  - then more



Source: Huber (1931).

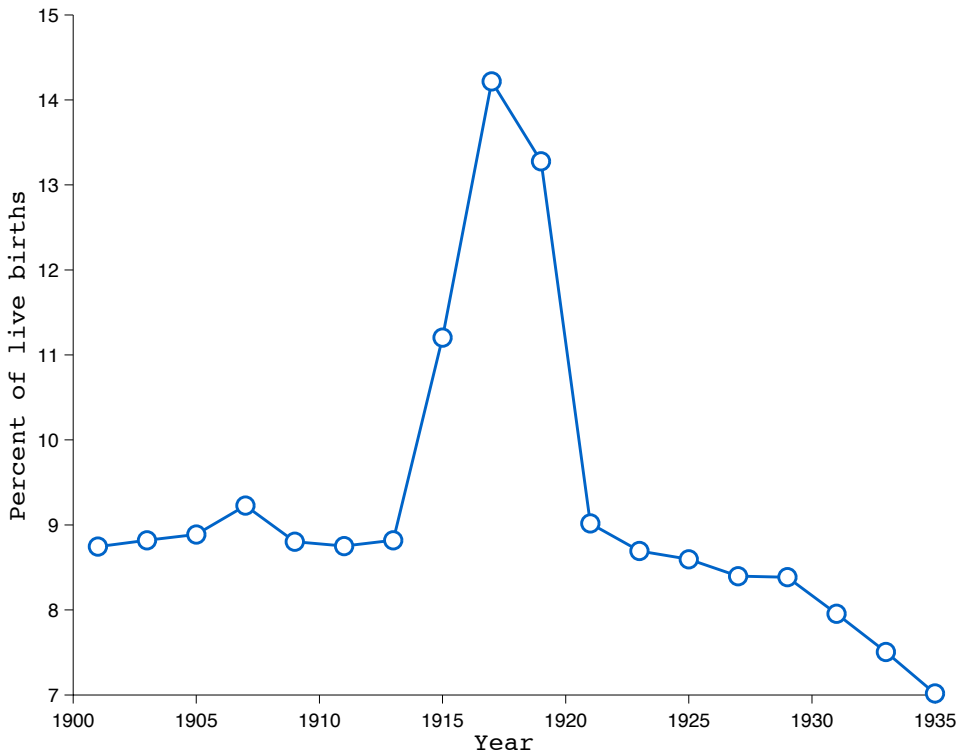
Age at Births, Out-of-Wedlock Births and Mortality

Age at Birth



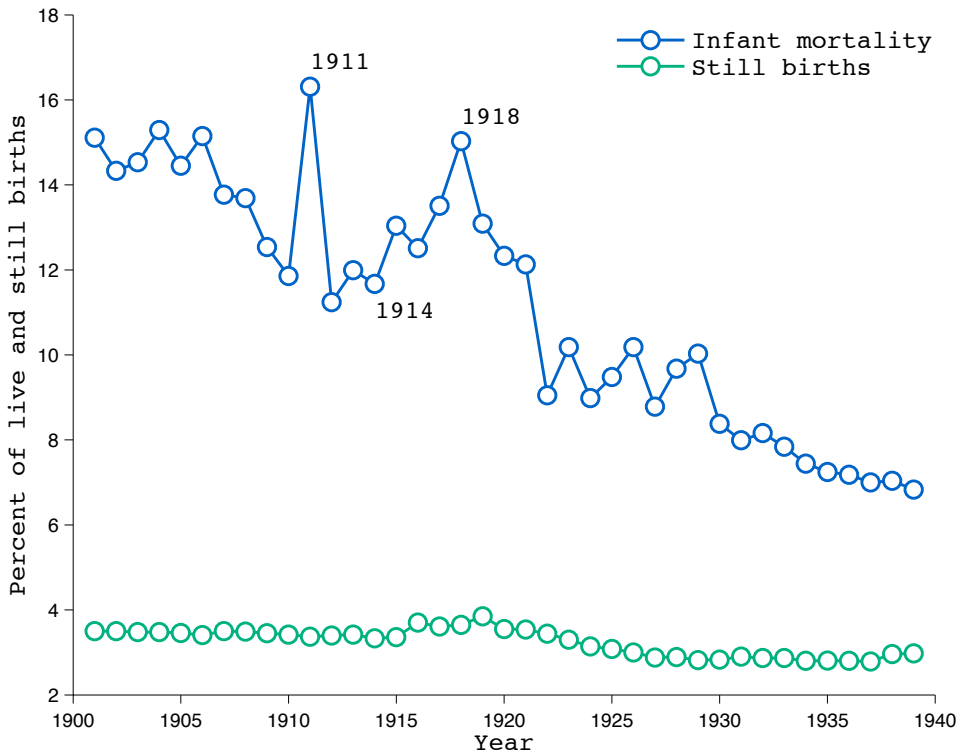
Age at Births, Out-of-Wedlock Births and Mortality

Out-of-Wedlocks Births



Age at Births, Out-of-Wedlock Births and Mortality

Infant Mortality



The Marriage Market

- Marriage market significantly disrupted, Henry (1966)
- Generation aged 21 in 1914 disproportionately married after the War

- "Recuperation" effect
  - Prop. of single at age 50 for 1891-1895 generation: 12.5%
  - Prop. of single at age 50 for 1896-1900 generation: 11.9%
  - Prop. of single at age 50 for 1851-1855 generation: 11.2%
  - Prop. of single at age 50 for 1856-1850 generation: 11.3%

Women's Labor

- Women's participation: 30% before and after the war
- Some increase during the war (Robert, 2005)
- 85-95% of women working during the war worked before (Downs, 1995 and Schweitzer, 2002)

> "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."
>
> Downs, 1995, p. 48

Similar Episodes

Country	Episode	Period	Change in CBR (%)
England	Civil War, Commonwealth, and early Restoration	1641-66	−17.3
France	Revolution	1787-1804	−22.5
USA	Civil War	1860-70	−12.8
Russia	WWI and Revolution	1913-21	−24.4
Germany	War, revolution, defeat, inflation	1913-1924	−26.1
Austria	War, defeat, empire dismembered	1913-24	−26.9
Spain	Civil war and dictatorship	1935-42	−21.4
Germany	War, defeat, occupation	1938-50	−17.3
Japan	War, defeat, occupation	1940-55	−34.0
Chile	Military coup and dictatorship	1972-78	−22.3
Portugal	Revolution	1973-85	−33.3
Spain	Dictatorship to democracy	1976-85	−37.2
Eastern Europe	Communism to capitalism	1986-98	
	Russia		−56.0
	Poland		−40.0
	Czechoslovakia (Czech Republic)		−38.0

Source: Caldwell (2004)

The Gender Gap

- Data from Huber (1931)
  - Industry: woman's wage 52% of a man's in 1913
  - Agriculture: woman's wage 64% of a man's in 1913
  - Commerce: woman's wage 77% of a man's in 1913

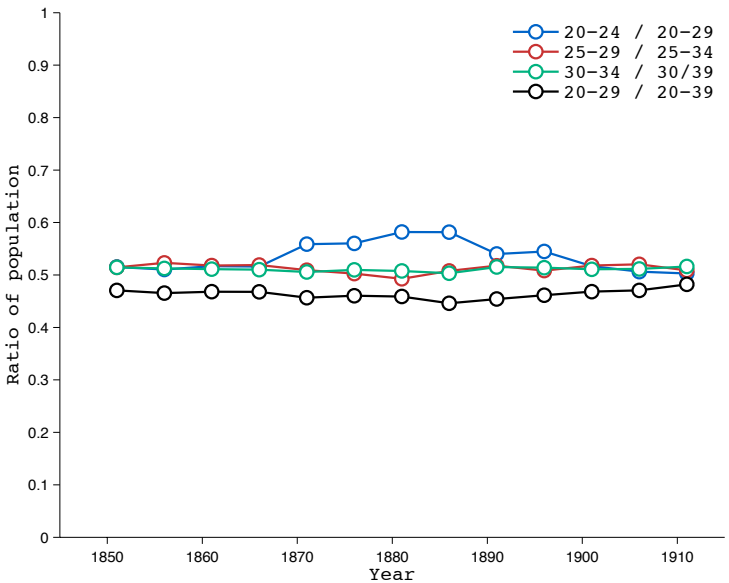
Model Fertility

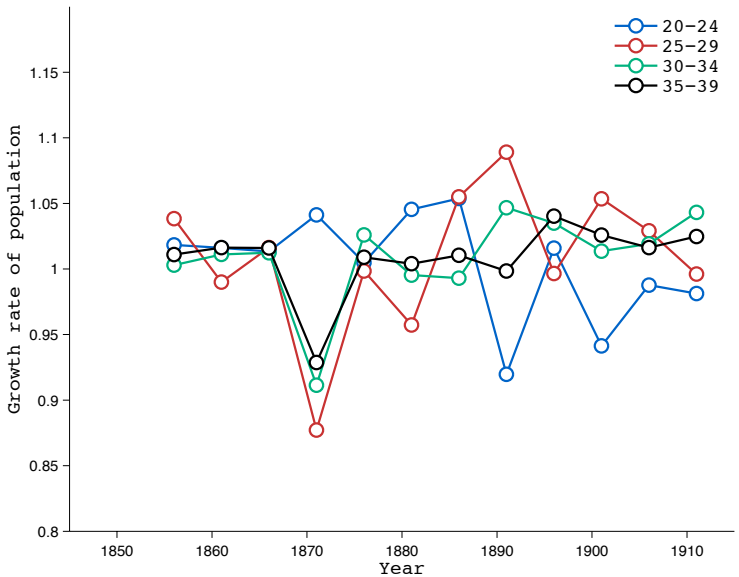
- Model fertility:

$$f_t(\alpha) = \frac{b_{1,t} + b_{2,t-1}}{2}$$

- Not weighted by model population
- Actual weights stable at 50%
- Declining fertility is only demographic change $\rightarrow$ cannot account for stable age composition of population
- Would need exogenous change in life expectancy

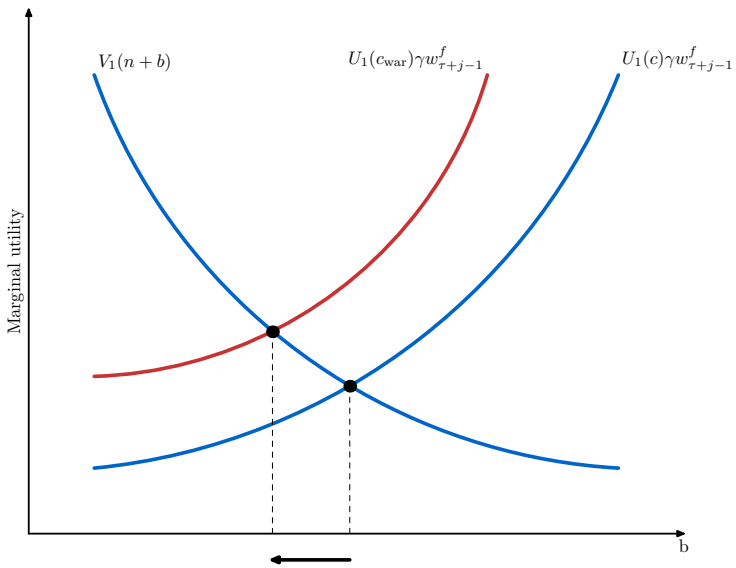
Model Fertility



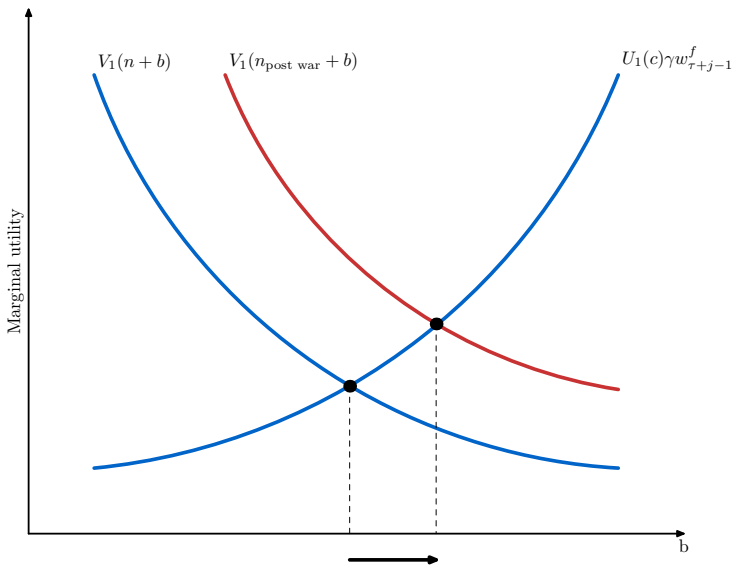


Source: Mitchell (1998)

Optimal Fertility and the War



Decline during the war

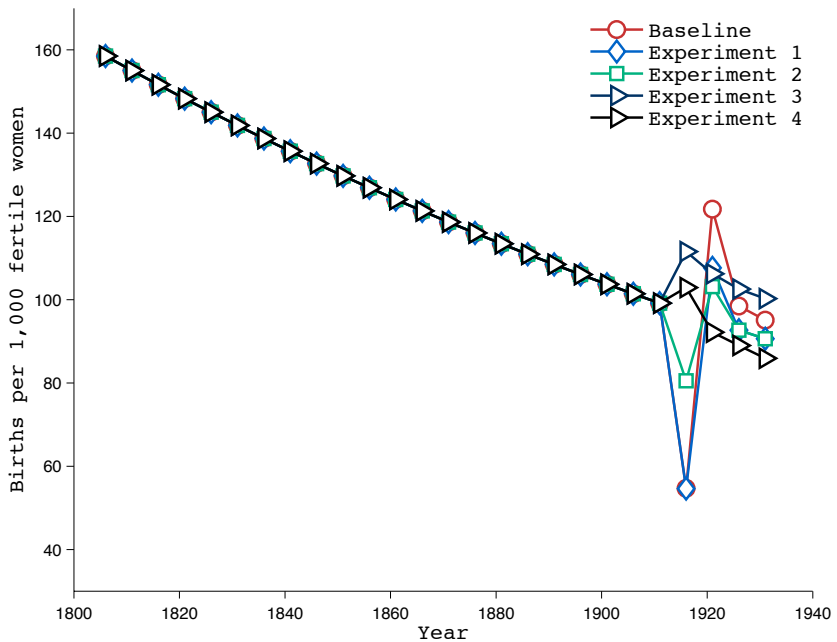


Catch-up after the war

Time Spent on Child Care

- Data from Aguiar and Hurst (2007)
  - In 1960 a woman in the U.S. spends 6 hours/week on childcare
  - Total market + non market + childcare = 61

Experiments



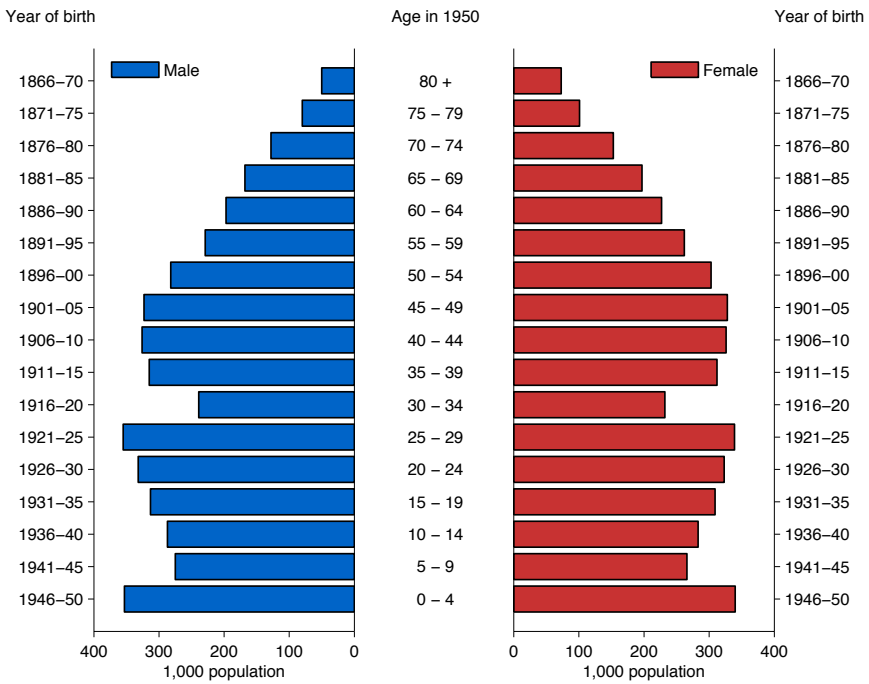
$q = 1.0$

Calibrater Parameters

Preferences	$\beta = 1.04^{-5}$, $\theta = 0.216$, $\rho = 0.644$, $\sigma = 0.815$
Wages	$w^m = 1$, $w^f = 0.6$ for initial (1806) generation
	$g = 1.016^5$
Cost of children	$\gamma = 1.01$
Adult equivalent scale	$\phi(n, m) = 1/2 + m/2 + 0.3n$
Demography	$J = 7$, $\nu = 0.805$

A Long-run Consequence of the War

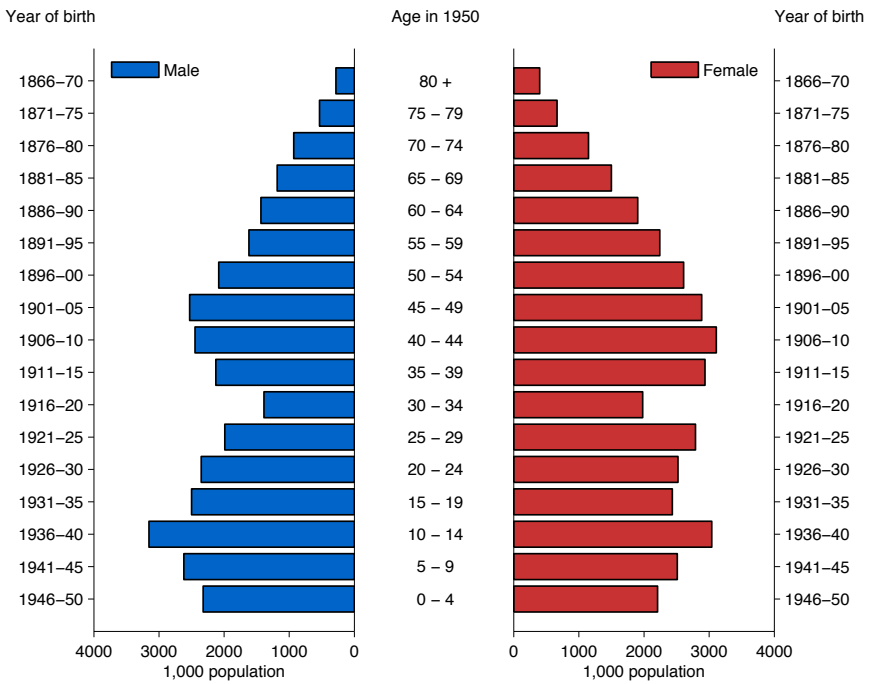
Belgium in 1950



Source: United Nations.

A Long-run Consequence of the War

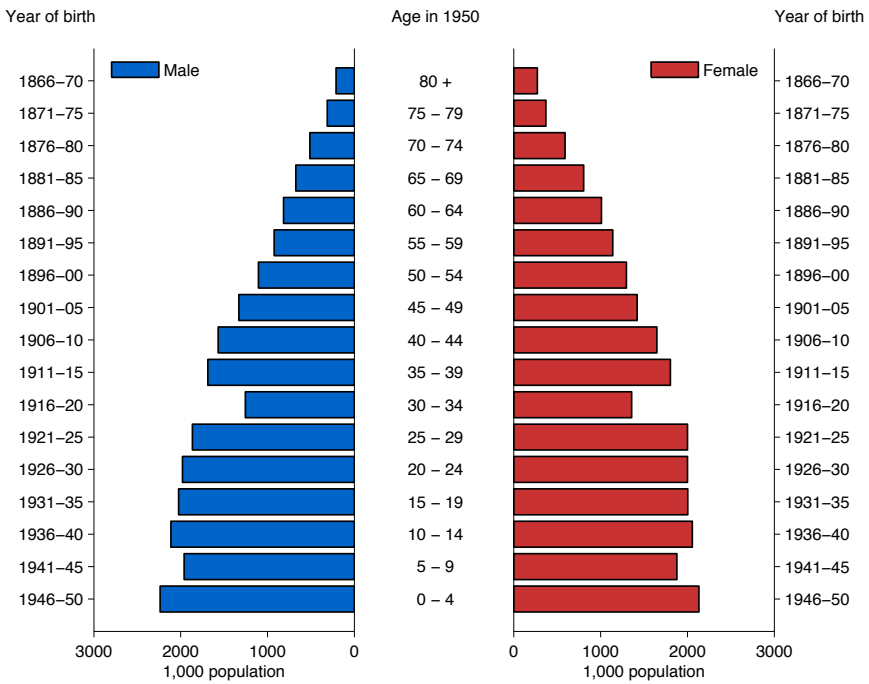
Germany in 1930



Source: United Nations.

A Long-run Consequence of the War

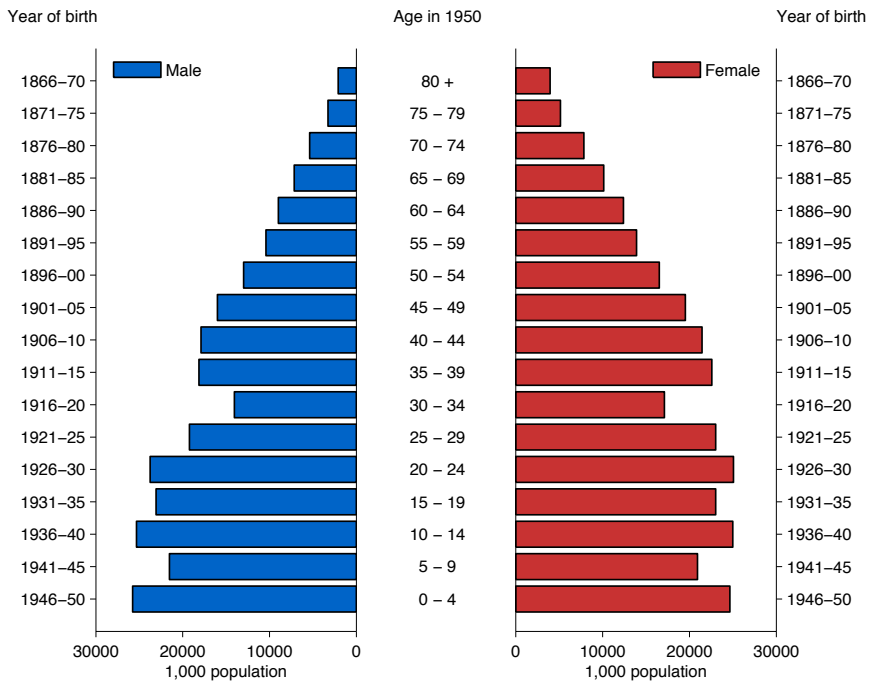
Italy in 1950



Source: United Nations.

A Long-run Consequence of the War

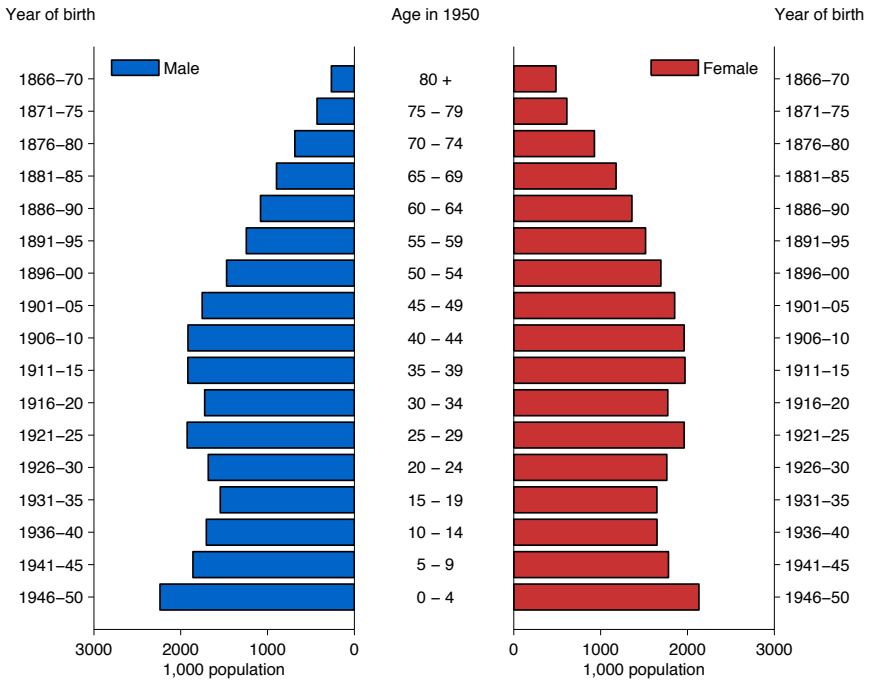
Europe in 1950



Source: United Nations.

A Long-run Consequence of the War

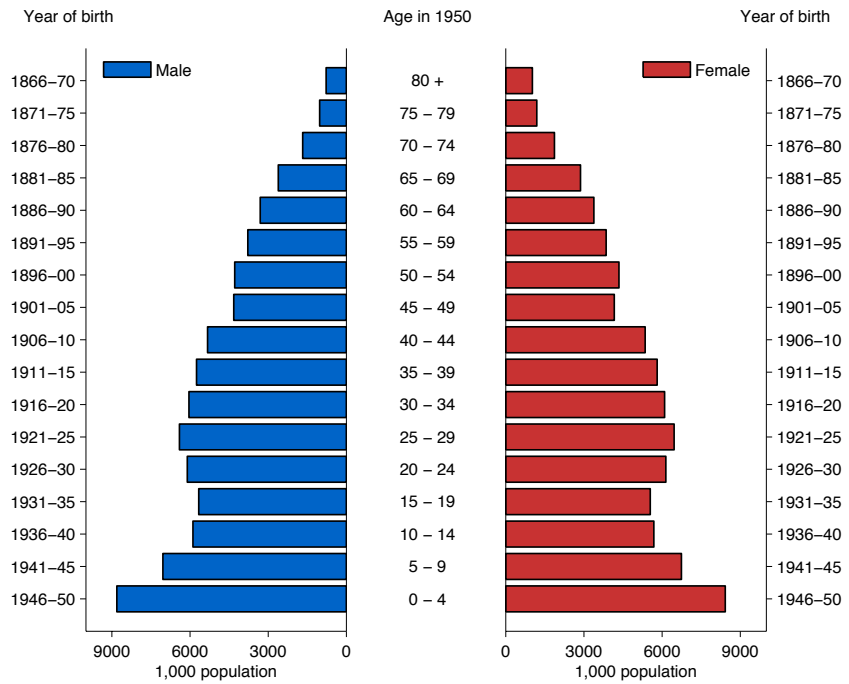
United Kingdom in 1950



Source: United Nations.

A Long-run Consequence of the War

United States in 1950



Source: United Nations.

The Quality-Quantity Model

$$\max_{c,c',a',b,e} \alpha \ln(c) + \gamma \ln(b) + \delta \ln(q) + \beta E[\alpha \ln(c')]$$

subject to

$$q = Q(e)$$

$$c + b\left(e + \tau w^f\right) + a' = w^m + w^f,$$

and

$$c' = \begin{cases} a'/\beta + g(w^m + w^f) & \text{with probability } 1-p \\ a'/\beta + g w^f & \text{with probability } p \end{cases}$$

Solution

- Assume $Q(e) = \kappa_0 + \kappa_1 e$ and $w^m/w^f = \eta$
- Solution is

$$1/c = E[1/c']$$

$$e = \frac{w^f \tau \delta/\gamma - \kappa_0/\kappa_1}{1 - \delta/\gamma}$$

$$b = \frac{\gamma - \delta}{\alpha} \times \frac{c}{w^f} \times \frac{1}{\tau - \frac{\kappa_0/\kappa_1}{w^f}}.$$

- c/w^f constant in peace times
- b decreases in peace times
- b decreases with war