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Abstract

During World War I (1914–1918) the birth rates of countries such as France, Germany, the U.K., Belgium and Italy declined by almost 50 percent. The age structure of these countries' populations were significantly affected for the duration of the 20th century. In France, where the population was 40 millions in 1914, the deficit of births is estimated to 1.36 millions over 4 years while military losses are estimated at 1.4 millions. In short, the fertility decline doubled the demographic impact of the War. Why did fertility decline so much? The conventional wisdom is that fertility fell below its optimal level because of the absence of men gone to war. I challenge this view using the case of France. I construct and calibrate a model of optimal fertility choice where households reaching their childbearing years on the eve of WWI face a loss of husband's income during the War as well as an increase in the probability that the wife remains alone after the War. I calibrate this probability using the casualties sustained by the French army. The model accounts for 97% of the fertility decline even though it does not feature any physical separations of couples. It also accounts for no less than half of the increase in fertility after the War, and generates a temporary increase in the age at birth as observed in the French data. This effect of the War on the optimal level of fertility is robust to alternative calibrations.

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1 Introduction

The First World War (WWI) lasted four years, from 1914 to 1918, and ravaged European countries to an extent that had never been seen until then. During the War, the birth rates of countries such as France, Germany, Belgium the United Kingdom or Italy declined by about 50% –see Figure 1. In France, an estimated 1.36 million children were not born because of this decline. This figure amounts to 3.4% of the total French population in 1914 (40 millions), and is comparable to the military losses which are estimated at 1.4 million men.[1] In short, the fertility decline doubled the already large demographic impact of the War.

What prompted such a decline of fertility? Answering this question will shed light on a phenomenon that shaped the European demography for the rest of the Twentieth century. The conventional wisdom is that, during the War, fertility fell below its optimal level because of the absence of men gone to fight.[2] I challenge this view using the case of France. I develop a model of fertility choice where couples reaching their childbearing years on the eve of World War I face a loss of husband's income during the War as well as an increase in the probability that the wife remains the sole adult in the household after the War. Calibrating this probability as the ratio of military losses to the number of men mobilized, and using income data to calibrate a husband's income loss during the War, the model accounts for 97% of the decline in fertility during the War, even though it does not feature any physical separations of couples. Abstracting from the loss of income during the War the model still accounts

[1] See Huber (1931, p. 413). Military losses include people killed and missing in action. They are a lower bound on the death toll of the War since they do not include civilian losses.

[2] See, for example Huber (1931), Vincent (1946) and Festy (1984).

for 87% of the decline. It also accounts for no less than half of the post-war fertility increase and generates, as observed in the data, a temporary rise in the age at birth after the War due to the postponement of fertility by the generation affected by the War.

I develop a model of fertility choice where the unit of analysis is a finitely-lived household which, at age 1, comprises two adults: a husband and a wife. The household derives utility from consumption per member and the number of children it gives birth to as well as from the number of adults. It can choose to have children at age 1 (20-25 in the data) and 2 (25-30 in the data), but children are costly. They require time, goods, and a share of the total household's consumption for an exogenously given number periods (childhood) during which they remain in the household. A husband supplies his time inelastically to the market in exchange for a wage, while a wife splits her time between the market, where she faces a lower wage than a husband, and raising the children. There is a probability that, from age 2 onward, the wife remains the only adult in the household with the children already born. A realization of this event constitutes both a preference and an income shock for the household.

The quantitative strategy is the following. First, I calibrate the model's parameters to fit the time series of the French fertility rate from 1800 to the eve of World War I. That is, I consider generations who entered their fertile years before the War broke out, so I assume that the risk that a wife remains alone after age 1 is zero. Second, using the calibrated parameters I compute the optimal choice of the generation exposed to the War, i.e., a generation facing a partially-compensated loss of the husband's income and a non-zero probability that the wife remains alone in the household from age 2 onward. I calibrate this probability using the ratio of casualties of the army to the number of men mobilized. There are a few noteworthy results. First, the War induces an age 1 household to save more and consume less than it would have otherwise, thereby raising the marginal utility of its consumption. This results from (i) the increased uncertainty due to the war; (ii) the reduction of expected income due to the possibility that the wife remains alone and; (iii) the loss of contemporaneous income due to the mobilization. The increase in the marginal utility of consumption raises the cost of diverting resources away from consumption and toward raising children. This effect is magnified by the fact that the expected marginal benefit of a child is lower when the expected number of adults in the household decreases. Thus, the first consequence of the War is a reduction of fertility for a young household, even though the model does not feature a physical separation hindering its ability to have children. Second, the War induces households to postpone giving birth. The reason is as follows. Children born to an age-2 household are usually more expensive because the opportunity cost of a child increases with the wage throughout a household's life. But this cost is partly offset by the fact when a household who was young during the War gives birth after the War it faces no more risk. Thus, a household can trade-off risk for a higher cost of raising children. This inter temporal reallocation of births implies an increase in the age at birth that is consistent with the French data. Third, the generation affected by the war experiences a lower completed fertility than it would have had in the absence of the War. This is because the income loss experienced during the War makes this generation poorer so that, even after the War, it is not optimal to completely offset the forgone fertility.

This paper contributes to an already large literature focusing on the determinants of fertility across countries and over time. Seminal work was done by Barro and Becker (1988) and Barro and Becker (1989). Galor and Neil (2000) analyze the $\cap$-shaped pattern of fertility over the long-run. Greenwood et al. (2005) propose of theory of the baby boom in the United States. Jones et al. (2008) review alternative theories explaining the negative relationship between income and fertility across countries and over time. The effect of a war on fertility is explored, in the case of World War II and the U.S. baby boom, by Doepke et al. (2007). Albanesi and Olivetti (2010) evaluate the effects of technological improvements in maternal health. Jones and Schoonbroodt (2011) theorize endogenous fertility cycles. Manuelli and Seshadri (2009) ask why do fertility rates vary so much across countries? Bar and Leukhina (2010) investigate, simultaneously, the demographic transition and the industrial revolution. Also related is the work by Ohanian and McGrattan (2008): an example where economic theory is used to investigate the effect of a war. In this case the authors evaluate the effect of the fiscal shock that World War II represented for the U.S. economy. Finally, Abramitzky et al. (2011) evaluate the impact of World War I on assortative matching in the marriage market in France. Sommer (2009) shows that in the U.S. since the 1960s, the age at birth is increasing in the degree of labor market risk.

The paper is organized as follows. In the next Section I present facts relative to the number of births and deaths during the War as well as to the composition of the Army. I argue that, although the mobilization was large, even mobilized men might have had the opportunity to have children. I also discuss relevant facts pertaining to the marriage market and the situation of women during the War. In Section 3 I develop the model and discuss the determinants of optimal fertility for a generation. Section 4 presents the quantitative analysis of the model that is first the calibration strategy, second the results of the main experiment, third the results of an experiment decomposing the effects of the different factors affecting optimal fertility and, finally, a set of experiments to evaluate the sensitivity of the main results to the choice of some parameters. Section 5 concludes.

2 Facts

Some data are from the French census. The last census before the War was in 1911. The first census in the post-war era was in 1921. A census was scheduled in 1916 but was cancelled. This data, and the data from previous censuses, were systematically organized in the 1980s and made available from the Inter-University Consortium for Political and Social Research (ICPSR). It is also available from the French National Institute for Statistics and Economic Studies (Insee). Vital statistics are available during the War years for the 77 regions (départements) not occupied by the Germans. There was a total of 87 regions in France at the beginning of the War. Huber (1931) provides a wealth of data on the french population before, during and after the war. It also contains a useful set of income-related data.

2.1 Births and Deaths

The demographic impact of World War I in France was large and persistent. Consider Figure 2, which shows the age and sex structure of the population before the War, in 1910, and after the War, in 1930, 1950 and 1970. The differences between the pre- and post-war population structures are quite noticeable. The first effects of the War are visible in the 1930 panel. First, there is a deficit of men (relative to women) in the 30-50 age group. These are the men that fought during World War I and died. Second, there is a deficit of men and women in the teens. This is the generation that should have been born during the War but was not because of the fertility decline. The 1950 panel shows again the same phenomenon 20 years later. The men who died at war should have been in the 50-70 age group, and the generation not born during the War should have been in its thirties. Note also the deficit of births that occurred in the early 1940s, that is during World War II. What caused this? It could have been that, as during World War I, individuals had less children because of World War II. For the French, however, the impact of World War II was quite different than that of World War I, possibly because the fighting did not last as long. In fact, the birth rate in the 1940s shows a noticeable increase.[3] Thus, births were low in the 1940s because the generation that should have been in its childbearing period, say people of age 25 in 1940, should have been born in 1915, that is in the midst of World War I. This generation was unusually small, so it gave birth to unusually little children despite a high birth rate. So, the deficit of births during World War I lead, mechanically, to another deficit in births 25 years later not because of a reduction in fertility, but because of a reduction in the size of the fertile population. The 1970 panel shows that, as late as in the seventies, the demographic impact of World War I is still quite noticeable. The generation that should have been born during the War should, by then, have reached its fifties.

The first month of World War I was August 1914, but the first severe reduction in

[3]One can argue that the baby boom was already under way in the early 1940s in France. Greenwood et al. (2005) propose of theory of the baby boom based on technical progress in the household.

the number of live births occurred nine months later: it dropped from 46,450 in April 1915 to 29,042 in May –a 37% decline.[4] During the course of the War the minimum was attained in November 1915 when 21,047 live births were registered. The pre-war level of births was reached again in December 1919. To put these numbers in perspective consider Figure 3, which shows the number of births per month in France and Germany from January 1906 until December 1921. The trend lines provide an estimation of the number of births that would have realized if during the War the trends that prevailed from 1906 to 1914 had remained. For France, the difference between the actual number of births and the trend, summed between May 1915 (9 months after the declaration of war) and August 1919 (9 months after the armistice), yields an estimated 1.36 million children not born. This figure amounts to 3.4% of the French population in 1914 (40 million) and is comparable to the total death toll of the War for the French: 1.4 million.[5] The estimate for Germany is 3.18 million children not born. It amounts to 4.8% of the German population in 1911 (65 million) and exceeds the number of military deaths estimated at 2 million.[6] In short, the fertility reduction that occurred during World War I doubled the demographic impact of the War. Similar calculations, made by demographers, lead to comparable figures: Vincent (1946) reports a deficit of 1.6 million births because of the War and Festy (1984) reports 1.4 million.

Was the deficit of birth during the War compensated by excess fertility after the War? To answer such question is difficult in the absence of a model of the trend in the number of births before and after the War. Vincent (1946) argues that only half

[4]See Bunle (1954, Table XI, p. 309).
[5]See Huber (1931, p. 413).
[6]See Huber (1931, pp. 7 and 449).

of the deficit was made up for in the decade following the War. But, whether the *size* of the French population was durably affected or not by the War is a separate question from whether its *age structure* was. The answer to the latter question is a definite yes.

It is interesting to compare the fertility reduction of the War to the so-called Baby Boom. The drop in the birth rate between before the War (1913) and the trough (1916) is 50% over 3 years. The Baby Boom started in 1941, when the birth rate was 13.1 and peaked in 1947 at 21.3. The difference between the two figures is a 62% increase over 6 years. By this measure the effect of World War I, on impact, is quite large relative to that of the Baby Boom. Yet, the Baby Boom lasted longer than World War I and, therefore, its final effect on the French population is larger.

Finally, it is worth mentioning that the case of France was not unique. This already transpired in Figures 1 and 3. Figure 4 shows, in addition, the age and sex structure of the populations of Germany, Belgium, Italy as well as Europe as a whole and the United States in 1950. All European countries exhibit a deficit of births during the war which, as is the case for France, is still noticeable in the 1950 population. The United States, on the contrary, were not noticeably affected by the War. The United Kingdom appears to have experienced a reduced deficit of births during World War I compared with other European countries. Europe as a whole exhibits a noticeable deficit.

2.2 The Army

The mobilization was massive. A total of 8.5 million men served in the French army over the course of the War, while the size of the 20-50 male population is estimated at 8.7 million on January 1st 1914. On August 1st 1914, the day of the mobilization, the army counted already 1 million men. The remaining 7.5 million were called to serve throughout the four years of the War.[7]

Not all the men serving in the army were sent to the front. On July 1st, 1915, there were 5 million men in the army but 2.3 million of them served in the rear. These men were serving in factories, public administrations and in the fields to help in the production of food for the troops and the population.[8] Between August 1914 and November 1918, the fraction of men in the army actually serving in the rear remained between 30 and 50%. The men in the rear were in touch with the civilian population and, therefore, were more likely to have the opportunities to procreate than the men at the front.

The combat troops did not spent all their time at the front either. Leaves from the front were generalized in June 1915. Starting in October 1916 soldiers at the front were granted 7 days of leave every 4 months, not including the time needed to travel back to their families. These leaves could also be augmented at the discretion of one's superior officer. These leaves augmented the physical opportunities to have children.

[7] See Huber (1931, p. 89).
[8] See Huber (1931, p. 105).

2.3 Women

Figure 5 shows evidence that the women reaching their childbearing years during World War I postponed their childbearing decisions. This observation is important to understand the behavior of fertility after the War. Fertility was above trend in the immediate aftermath of the War because the generation that should have given birth during the War years did so after, together with the young post-war generation. In the model of Section 3 households are allowed to chose how many children to have in 2 periods of their lives to allow this mechanism to operate and assess its importance for the post-war recovery of fertility.

Henry (1966) shows that the marriage market was noticeably perturbed for the generations reaching their marriage and childbearing years during World War I. Women born in 1891-1895 (aged 21 in 1914) either got married before the War or after the War. In the latter case, that is just after the War, the marriage rate of this generation was abnormally high relative to the marriage rates of other generations at the same age: a sign of "recuperation" of postponed marriages. A similar result holds true for the generation of women born in 1896-1900. By some metric, however, the perturbation of the marriage market due to World War I was "short-lived." Henry (1966) reports that the proportion of single women, at the age of 50 for the 1891-1895 generation is 12.5% and for the 1896-1900 generation it is 11.9%. These figures compare with similar figures for generations whose marriage decisions were not affected by the War such as the 1851-1855 generation: 11.2% or the 1856-1860 generation: 11.3%. Henry (1966) concludes that the replacement of the men killed during the War was done through immigration and excess marriage rates for men who did not disappear during the War years. At this stage, two observations are worth making. First, although ex-post (that is at the age of 50) the women from the 1891-1895 and 1896-1900 generations achieved the same marriage rate as the women from other generations, from the perspective of 1914, when they had to decide whether to get married and have children, the probability of keeping (or replacing) a husband must have appeared quite different to them than to the previous generations at the same age. Second, the disruption in the marriage market does not imply that births should be affected. Although it is common, it is not necessary to be married to have children. Figure 6 shows that the proportion of out-of-wedlock births increased significantly during the War. Thus it seems reasonable, as a first approximation, to study fertility behavior abstracting from the marriage market.

Little information is available on female labor during the War. There was no exhaustive census available. Some were planned during the course of the War but ended up being cancelled. Robert (2005) reports that the best information available is from seven surveys conducted by work inspectors. These surveys did not cover all branches of the economy such as railways and state-owned firms. However, data are available for 40,000 to 50,000 establishments in food, chemicals, textile, book production, clothing, leather, wood, building, metalwork, transport and commerce. These establishments employed about 1.5 million workers before the War: about a quarter of the labor force in industry and commerce. Robert (2005, Table 9.1) reports the total number employed and the number of women employed in the establishments surveyed. Although this is not the participation rate *per se* it gives a picture of female labor during the War. The share of women worker was 30% in July 1914 and peaked in January 1915 at 38.2%. It then declined slowly throughout the War and during the following years. It was 32% in July 1920. Downs (1995) and Schweitzer (2002) emphasize that the increase in women's participation during the War is moderated by the fact that most, that is between 80 and 95 percent, of the women who worked during the War also worked in more feminized sectors before the War. Downs (1995, page 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.

In the model of Section 3 a woman's labor is exogenous which, in light of the evidence just presented, is a reasonable abstraction.

2.4 Similar Episodes

Caldwell (2004) presents evidence of fertility decline for a list of thirteen social crises among which the English Civil War, Commonwealth and early Restoration, the French Revolution, the American Civil War, World War I and the revolution in Russia, the Spanish Civil War, the Military Coup and dictatorship in Chile, the Portuguese revolution, etc... For each episode he reports significant reductions in fertility –see Table 1. He also reports that when fertility was already experiencing a declining trend, the reductions observed during the periods of unrest are significantly more pronounced than before and after. For example, he reports that Spain's birth rate fell during the first thirty-five years of the 20th century but that during the Civil War (1935-42) it fell by as much as during the previous 35 years. These observations suggest that episodes of great uncertainty matter for fertility choices, even when men might still be present in their household and have the physical opportunity to procreate. Thus, such observations question the importance of the mobilization through the absence of men as the sole driver of the fertility decline during World War I.

3 The Model

3.1 The Environment

Time is discrete. The economy is populated by overlapping generations of individuals living for $I + J$ periods: I as a child and J as an adult. When an individual becomes an adult he leaves the household in which he was born, and pairs with another adult of the same age and the opposite sex to form a new household of age 1. The marriage and household formation processes are exogenous. Only households make decisions.

An age-1 household, that is a household formed by two individuals of age $I + 1$, faces the risk that only one adult remains at the beginning of age 2. There is no remaining uncertainty from age 2 onward. Let $\pi(m)$ be the probability that a household comprises m adult members at the beginning of age 2. A household with a single adult is headed by a woman, thus the interpretation of $\pi(1)$ is

$$\pi(1) = \Pr\{\text{ husband dies and wife does not remarry }\}$$

and, therefore,

$$\pi(2) = \Pr\{ \text{ husband survives or } \{\text{husband dies and wife remarries}\} \}.$$

Let m_j denote the number of adults in a household of age j.

A household is fecund twice during its life. At age 1 it chooses how many children to give birth to, b_1, while facing risk with respect to its number of adults from age 2 onward. At age 2 it also chooses how many children to give birth to, b_2, but all uncertainty has been resolved. Thus, the household can smooth the effect of the War by reallocating births through time.

Children born when the household is of age 1 remain present until it reaches age I. Children born at age 2 remain until the household reaches age $I+1$. Thus, the stock of children present in the household at age j, denoted by n_j, is given by

$$n_j = b_1 \mathbb{I}\{1 \leq j \leq I\} + b_2 \mathbb{I}\{2 \leq j \leq I+1\}. \tag{1}$$

A household's preferences are represented by

$$E_1 \left\{ \sum_{j=1}^{J} \beta^{j-1} \left[U\left(\frac{c_j}{m_j + n_j} \right) + \theta V(n_j, m_j) \right] \right\}$$

where E_1 is the expectation operator, conditional on information available at age 1. The parameter $\beta \in (0,1)$ is the subjective discount factor, c_j is total household consumption at age j. The parameter θ is positive, and

$$U(x) = \frac{x^{1-\sigma}}{1-\sigma} \quad \text{and} \quad V(n,m) = (n^\rho + m^\rho)^{1/\rho}$$

with $\sigma > 0$ and $\rho \leq 1$.

At this stage, a few observations are in order. First, a household values consumption per member and not total consumption. Thus, one of the costs of having a child is a reduction of consumption per member. Second, children of the same age (born in the same period) and of different age (born in different periods) are perfect substitutes in utility. Third, the degree of substitutability between children and adults depends on ρ, the value of which is disciplined by data in the quantitative exercise of Section 4. When $\rho = 1$ children and adults are perfect substitutes. As ρ decreases children and adults become more complementary. In the limit, as $\rho \to -\infty$, children and adults are perfect complement. The value of ρ is important for the effect of an exogenous shock to the number of adults, m, on fertility. On the one hand, when children and adults are perfect substitute, a reduction in the number of adults (when the husband disappears at war) can be compensated by an increase in fertility, holding everything else constant. On the other hand, when children and adults are complement, a decrease in the number of adults implies a reduction of the optimal number of children. Fourth, the number of adults acts as a preference shock through two channels: (i) a reduction in the number of adults directly affects utility and, in particular, it reduces the marginal utility of children through V; (ii) a reduction in the number of adults allows consumption per member to increase, holding everything else constant. In what follows it transpires that a reduction to the number of adult also acts as an income shock.

Adults are endowed with one unit of productive time per period. A husband supplies his time inelastically while a wife allocates hers between raising children and working. A child requires τ units of a wife's time and e units of the consumption good for each period during which it is present in the household. The parameter τ represents the state of the "childrearing" technology and, therefore, is not a control variable. Thus, a wife's time allocation is indirectly controlled through the number of children she gives birth to. The wage rate for a husband is denoted w^m and is assumed to grow at the constant (gross) rate $g > 1$ per period. The wage rate for a wife is denoted w^f and is assumed to grow at rate g too. Thus, the labor income of a household can be written writes as

$$w^m \left(\frac{w^f}{w^m} + m - 1 \right) - \tau w^f n$$

when there are m remaining adults, n children and wages are w^m and w^f. Note that this amounts to $w^m + w^f(1 - \tau n)$ when there are two adults and $w^f(1 - \tau n)$ when only a wife remains. Let $\mathbf{w}$ denote the vector of wages

$$\mathbf{w} = \left(w^m, w^f \right).$$

A household has access to a one-period, risk-free bond with (gross) rate of interest $1/\beta$. It can freely borrow and lend any amount at this rate. It owns no assets at the beginning of age 1.

The assumption that the household values consumption per member instead of total consumption is not innocuous. It affects the way the marginal cost of a child changes when the number of adult changes. To understand this, remember that the marginal utility of consumption measures the cost of diverting resources away from consumption and into childrearing. Suppose now that an adult member (the husband) disappears. Then total consumption decreases and, if the household values total consumption, the cost of a child increases by a magnitude dictated by the curvature of U. If, instead, the household values consumption per member, this effect is mitigated by the fact that the drop in total consumption *together* with a reduction in the number of adults implies less of a reduction in consumption per member and, therefore, less of an increase in the marginal cost of a child.

3.2 Optimization

3.2.1 Optimization Problem

A household's lifecycle is described in Figure 7. At age 1 it comprises 2 adults and faces risk with respect to the number of remaining adults from the next period onward. It must decide how to consume (c) and save (a') as well as the number of children to give birth to (b_1). Hence, its optimization problem writes

$$\max_{c,b_1,a'} \quad U\left(\frac{c}{2+b_1}\right) + \theta V(b_1, 2) + \beta \sum_{m'=1,2} W_2\left(a', m', b_1, \mathbf{w}'\right)\pi(m') \tag{2}$$

$$\text{s.t.} \quad c + a' + b_1\left(e + \tau w^f\right) = w^m + w^f \tag{3}$$

$$\mathbf{w}' = \left(gw^m, gw^f\right).$$

The right-hand side of the budget constraint represents the "potential" labor income of a household, i.e., the labor income it would receive if no time was devoted to raising children. The time cost of raising b_1 children appears as an expenditure on the left-hand side: $\tau w^f b_1$. Thus, the effective labor income of a household is, as discussed earlier, $w^m + w^f(1-\tau b_1)$. The term $2+b_1$ is the number of members in a household at this age: 2 adults and b_1 children. The function $W_2(a', m', b_1, \mathbf{w}')$ is the value function for a household of age 2 with a' assets accumulated, b_1 children born at age 1, m' surviving adults and facing the vector of wage rates $\left(gw^m, gw^f\right)$. Note that in this discussion of the age 1 optimization problem, the number of children born and the number of children present in the household are the same since $n_1 = b_1$, as per Equation (1).

At age 2 a household learns its number of adults, m, and decides to consume (c) save (a') and how many children to give birth to (b_2). It is assumed that it can have children only when a husband remains. The optimization problem writes

$$\begin{aligned} W_2(a, m, b_1, \mathbf{w}) \quad &= \quad \max_{c, b_2, a'} U\left(\frac{c}{m+b_1+b_2}\right) + \theta V(b_1+b_2, m) \\ &\qquad + \beta W_3(a', m, b_1, b_2, \mathbf{w}') \qquad (4) \\ \text{s.t.} \qquad & c + a' + (b_1+b_2)\left(e + \tau w^f\right) = w^m\left(\frac{w^f}{w^m} + m - 1\right) + \frac{a}{\beta} \qquad (5) \\ & \mathbf{w}' = \left(gw^m, gw^f\right) \end{aligned}$$

and $b_2 = 0$ whenever $m = 1$. The function $W_3(a', m, b_1, b_2, \mathbf{w})$ is the value function for an age 3 household with a' assets accumulated, m adult members, b_1 children born at age 1, b_2 children born at age 2 and facing the vector of wage rates $\left(gw^m, gw^f\right)$. Note that the household must keep track of the number of children born at age 1 and 2 in order to assess the childrearing cost it is facing each period, as well as to compute its size which is relevant for knowing consumption per member. Note also that the right-hand side of the budget constraint represents total income: the sum of "potential" labor income as well as income from assets accumulated during the previous period. The time cost of raising the children present in the household at age 2 appears as an expenditure on the left-hand side. As per Equation (1) the number of children present in the household at age 2 is $n_2 = b_1 + b_2$.

From age 3 onward the household chooses consumption (c) and savings (a'). The number of adults, m, is given and the number of children, n_j, evolves in line with the law of motion described by Equation (1).

$$\begin{aligned} W_j(a, m, b_1, b_2, \mathbf{w}) &= \max_{c,a'} U\left(\frac{c}{m + n_j}\right) + \theta V(n_j, m) \\ &\qquad + \beta W_{j+1}(a', m, b_1, b_2, \mathbf{w}') \qquad (6) \\ \text{s.t.} \quad & c + a' + n_j\left(e + \tau w^f\right) = w^m\left(\frac{w^f}{w^m} + m - 1\right) + \frac{a}{\beta} \qquad (7) \\ & n_j \text{ given by Equation (1)} \\ & \mathbf{w}' = \left(gw^m, gw^f\right) \end{aligned}$$

and $a' = 0$ when $j = J$.

3.2.2 Optimality Conditions

At age 1 the first order conditions for consumption, savings and fertility are

$$
\begin{aligned}
c &: \quad 0 = \frac{\partial}{\partial c} U\left(\frac{c}{2+b_1}\right) - \mu \\
a' &: \quad 0 = \beta \sum_{m'=1,2} \frac{\partial}{\partial a'} W_2(a', m', b_1, \mathbf{w}')\pi(m') - \mu \\
b_1 &: \quad 0 = \frac{\partial}{\partial b_1} U\left(\frac{c}{2+b_1}\right) + \theta \frac{\partial}{\partial b_1} V(b_1, 2) \\
&\qquad\qquad + \beta \sum_{m'=1,2} \frac{\partial}{\partial b_1} W_2(a', m', b_1, \mathbf{w}')\pi(m') - \mu\left(e + \tau w^f\right)
\end{aligned}
$$

where μ is the Lagrange multiplier associated with the budget constraint (3). These conditions imply the Euler equation for assets:

$$
U'\left(\frac{c}{2+b_1}\right)\frac{1}{2+b_1} = \beta \sum_{m'=1,2} \frac{\partial}{\partial a'} W_2(a', m', b_1, \mathbf{w}')\pi(m'). \tag{8}
$$

Note that the marginal cost of a reduction in household consumption (left-hand side) is the marginal utility of consumption per member of the household. The marginal benefit is the expected marginal gain at age 2, measured on the right-hand side of the equation. The first order condition for fertility can be rearranged as

$$
\begin{aligned}
\theta \frac{\partial}{\partial b_1} V(b_1, 2) + \beta \sum_{m'=1,2} \frac{\partial}{\partial b_1} W_2(a', m', b_1, \mathbf{w}')\pi(m') = \\
U'\left(\frac{c}{2+b_1}\right)\frac{1}{2+b_1}\left(e + \tau w^f + \frac{c}{2+b_1}\right)
\end{aligned} \tag{9}
$$

where the left-hand side is the marginal benefit of a child born at age 1, and the right-hand side is the marginal cost. The marginal benefit comprises two parts: the instantaneous benefit at age 1, measured by $\theta \partial V(b_1, 2)/\partial b_1$, and the expected marginal benefit from age 2 onward measured by $\beta \sum_{m'=1,2} \partial W_2(a', m', b_1, \mathbf{w}')/\partial b_1 \times \pi(m')$. The marginal cost comprises three components: the consumption cost of raising an additional child, e, the time cost that is the loss of some of the wife's labor income, τw^f, and the allocation of a share of the household's consumption to the child, $c/(2 + b_1)$. These three costs, expressed in consumption units, are weighted by the marginal utility of consumption per member of the household at age 1.

There are two mechanisms through which the War affects fertility, the second magnifying the effect of the first. First, the expected marginal benefit of a child (left-hand side of 9) decreases during the War. This is because the war implies a reduction of the expected number of adults in the household from 2 to $E(m) = 2 - \pi(1)$, and the marginal benefit of a child is increasing in the number of adults: $V_{nm} > 0$. When the marginal cost of a child (right-hand side of 9) is increasing, the decrease in the marginal benefit implies a reduction in the optimal number of children. The second reason why the War reduces optimal fertility is because it also implies an increase of the marginal cost of raising a child. This increase occurs because consumption decreases and, therefore, the marginal utility of consumption increases, i.e. the cost of diverting resources away from consumption and toward raising a child increases. The decrease in consumption is the result of three separate causes: (i) a contemporaneous loss of income due to the mobilization of the husband, i.e. is a decrease of w^m; (ii) an increase in savings due to the decrease in future expected income, i.e. a decrease of $E(m)$; and (iii) additional risk with respect to m. Since the marginal utility of a child is decreasing the optimal number of children born when the household is of age 1 decreases when the marginal cost increases.

At age 2, when $m = 2$, the first order conditions for consumption, savings and fertility are

$$\begin{aligned}
c &: \quad 0 = \frac{\partial}{\partial c} U\left(\frac{c}{m + b_1 + b_2}\right) - \mu \\
a' &: \quad 0 = \beta \frac{\partial}{\partial a'} W_3(a', m', b_1, b_2, \mathbf{w}') - \mu \\
b_2 &: \quad 0 = \frac{\partial}{\partial b_2} U\left(\frac{c}{m + b_2 + b_1}\right) + \theta \frac{\partial}{\partial b_2} V(b_1 + b_2, m) \\
& \qquad + \beta \frac{\partial}{\partial b_2} W_3(a', m', b_1, b_2, \mathbf{w}') - \mu\left(e + \tau w^f\right)
\end{aligned}$$

where μ is the Lagrange multiplier associated with the budget constraint (5). They imply the Euler equation for assets:

$$U'\left(\frac{c}{m + b_1 + b_2}\right) \frac{1}{m + b_1 + b_2} = \beta \frac{\partial}{\partial a'} W_3(a', m', b_1, b_2, \mathbf{w}'). \tag{10}$$

and the following condition for b_2

$$\begin{aligned}
&\theta \frac{\partial}{\partial b_2} V(b_1 + b_2, m) + \beta \frac{\partial}{\partial b_2} W_3(a', m', b_1, b_2, \mathbf{w}') = \\
&\qquad U'\left(\frac{c}{m + b_1 + b_2}\right) \frac{1}{m + b_1 + b_2} \left(e + \tau w^f + \frac{c}{m + b_1 + b_2}\right).
\end{aligned} \tag{11}$$

Equations (10) and (11) have the same interpretations as Equations (8) and (9), with the difference that the household does not face any remaining uncertainty at age 2. When $m = 1$ the household cannot give births to children, therefore $b_2 = 0$.

At age 3 and above the only choice faced by the household is that of consumption and savings. The optimality conditions are

$$\begin{aligned} c &: \quad 0 = \frac{\partial}{\partial c} U\left(\frac{c}{m+n_j}\right) - \mu \\ a' &: \quad 0 = \beta \frac{\partial}{\partial a'} W_{j+1}(a', m, b_1, b_2, \mathbf{w}') - \mu, \end{aligned}$$

implying the following Euler equation:

$$U'\left(\frac{c_j}{m+n_j}\right)\frac{1}{m+n_j} = U'\left(\frac{c_{j+1}}{m+n_{j+1}}\right)\frac{1}{m+n_{j+1}}.$$

Thus, the household maintains the marginal utility of consumption per member constant from one period to the next. This implies constant consumption across periods where the number of members in the household remains constant. At age J the optimal saving is $a' = 0$.

4 Quantitative Analysis

In this section I calibrate the model to fit the time series of the French fertility rate from 1800 until the eve of World War I. Using the calibrated parameters, I conduct two experiments where I compute the optimal decisions of the generation facing the War. In the first experiment this generation experiences two shocks that its predecessors did not: a higher risk that the wife remains alone in the household after age 1, and a loss of husband's income during the war years. In the second experiment I abstract from the loss of husband's income but keep the higher risk that the wife remains alone to provides a quantitative decomposition of the contribution of the two shocks. I also discuss the sensitivity of the results with respect to the choice of some parameters.

4.1 Calibration

A model period is 5 years. Thus, an individual of age 1 in the model can be interpreted as a child between the age of 0 and 5 in the data. Let $I = 4$ and $J = 7$ so that an individual remains in the household in which he was born until he reaches the age of 15-20, and a young household is composed of two individuals between the age of 20 and 25. Households in the model have their children in the first and second period of their adult lives, which correspond to their 20s in the data. Life ends between the age of 50 and 55.

Let the rate of interest on the risk free asset be 4 percent per year. This implies a subjective discount factor $\beta = 1.04^{-5}$. For the rate of growth of w^m and w^f I use the rate of growth of the Gross National Product per capita: 1.6 percent per year –see Carré et al. (1976, Tables 1.1 and 2.3). Thus, $g = 1.016^5$. Huber (1931, pp. 932-935) reports figures for the daily wages for men and women in agriculture, industry and commerce in 1913. In industry a woman's wage in 1913 was 52% of a man's. In agriculture the gap was 64%, and in commerce it was 77%. Since commerce was noticeably smaller than agriculture and industry I use $w^f/w^m = 0.6$. The initial value for w^m is normalized to 1. In Section 4.4 I present sensitivity results with respect to w^f/w^m. Note that a gender gap in earnings of 60% is consistent with the findings of the more recent literature studying the United States. Blau and Kahn (2006, Figure 2.1) report that women working full-time earned between 55% and 65% of what men earned from the 1950s to the 1980s. Knowles (2010) reports that, throughout the 1960s, the ratio of mean wages of women to those of men was slightly below 60% in the U.S.

Let $\alpha = (\sigma, \theta, \rho, \tau)'$ be the vector of remaining parameters where the first three elements are preference parameters and τ is the time-cost of a child. They are chosen in order to solve the following minimization problem:

$$\min_{\alpha} \sum_{t \in \mathcal{I}} (f_t(\alpha) - \mathbf{f}_t)^2 + (\tau \times n_{1911}(\alpha) - 0.1)^2 \tag{12}$$

where $\mathcal{I}$ is an index set: $\mathcal{I} = \{1806, 1811, 1816, \ldots, 1911\}$. This objective function deserves a few comments. First, $f_t(\alpha)$ is the fertility rate implied by the model for a given value of α. Since women in households of age 1 and 2 give births at each date, $f_t(\alpha)$ is the sum of births from these two generations at date t, divided by 2. Second, $\mathbf{f}_t$ is the empirical counterpart of $f_t(\alpha)$. It is constructed from birth rates from Mitchell (1998) as well as fertility data from the French National Institute for Statistics and Economic Studies (Insee). The birth rate, that is the number of birth per population is a different measure of fertility than the fertility rate which is the number of birth per fertile women. The latter is the empirical counterpart of the decisions of households of age 1 and 2 in the model. The French fertility rate, unfortunately, is not available before 1900 while Mitchell's data goes back to 1800. After splicing the two series together in 1900, however, one can verify that their behavior is quite close on the period over which they overlap.[9] I use this constructed time series to calibrate the model and evaluate the effect of the War. Third, $n_{1911}(\alpha)$ is the total number of

[9]Data available upon request.

children born to the 1911 generation, that is the last generation not affected by the War. Thus, the second part of the objective function is the distance between the time spent by this generation raising its children and its empirical counterpart, 10%. The latter figure comes from Aguiar and Hurst (2007, Table II). They report that in the 1960s a woman in the U.S. spends close to 6 hours per week on various aspect of childcare, that is primary, educational and recreational. This amounts to 10% of the sum of market work, non-market work and childcare (61 hours). Thus, τ is set to imply that the time spent by a women on childcare, on the eve of the War, is 10% as well. The good cost of raising a child is assumed to be zero, i.e., $e = 0$. Note that if e was proportional to w^f that is, if the good cost of raising a child was growing at rate g, then setting e to 0 would be innocuous since e could be subsumed into τ. In Section 4.4 I present sensitivity results with respect to the target figure for the time cost of raising a child. Finally, note that for this minimization I assume that $\pi(1) = 0$, i.e., the pre-war generations do not face a risk relative to the presence of the husband from age 2 onward.

Although σ, θ, ρ and τ are determined simultaneously, some aspects of the data are more important than others for some parameters. The level of fertility, in particular, is critical to discipline the parameter θ which measures the intensity of a household's taste for children. The time cost of a child, that is 10% of a woman's time, is critical in determining the value of τ. The parameter σ determines the curvature of the marginal utility of consumption and, since the number of adults in a household in constant, the parameter ρ determines the curvature of the marginal utility of fertility. Thus the decline in fertility which results from a comparison between its marginal cost (partly driven by the marginal utility of consumption) and its marginal benefit, disciplines the parameters ρ and σ.

The calibrated parameters are displayed in Table 2. Figure 8 displays the computed and actual fertility rate for the pre-war period. The model fits the data well. It generates a downward trend in the birth rate due to the rising opportunity cost of raising children when the wage rate increases. The model also generates a moderate downward trend in the age at birth, as observed in the data of Figure 5 before the War. The cause of this decline is that, as the wage rate increases, the cost of raising a child born to a household of age 2 increases faster relative to the cost of a child born to a household of age 1. Thus, households tend to give birth earlier in their lives: the 1806 generation, gives births to 70% of all its children at age 1. For the 1911 generation, this figure is 71%. It is this changing intertemporal allocation of births across generations which reduces the age at birth in the model.

4.2 Main Experiment

The last generation not affected by the War in the model is the generation reaching adulthood in 1911. The next generation reaches adulthood in 1916. It differs from its predecessors because (i) its women are more likely to remain alone after age 1, that is $\pi(1) > 0$ for this generation and (ii) its households experience a loss of husbands income during the war, that is w^m is below trend for one period.

I calibrate $\pi(1)$ as

$$\pi(1) = \frac{\text{military losses of World War I}}{\text{total men mobilized}}.$$

The military losses where 1.4 millions while 8.5 million men were mobilized. Thus, I used $\pi(1) = 1.4/8.5 = 0.16$. The following generation in the model reaches adulthood in 1921 and, therefore, faces $\pi(1) = 0$ as the pre-war generations. The figure used for $\pi(1)$ is not perfect. On the one hand it might exaggerate the risk from the perspective of a wife since she has the possibility of remarrying after the War if her husband dies. This possibility would allow a wife to raise her children with hers and another husband's income. On the other hand the probability may underestimate the risk since the husband may survive the War but come home disabled. In the case of World War I this was a distinct possibility since the massive use of artillery and gases made this conflict quite different from any other conflicts before. Huber (1931, p. 448) reports 4.2 million wounded during the War: half of the men mobilized. The number of invalid was 1.1 million among which 130,000 were mutilated and 60,000 were amputated. In Section 4.4 I present sensitivity results with respect to $\pi(1)$ to address these concerns.

Men did not get fully compensated for income while they were mobilized. Downs (1995) cites a compensation amounting to somewhere between 35 and 60% of a man's pre-war salary in agriculture or industry.[10] To represent this loss, I let w^m be 50% of what it would have been for the men of this generation had the War not broken out. This drop is temporary: i.e. only at age 1 for this generation. Thus, if there is a husband in the household from age 2 onward, w^m will be as prescribed by the constant-growth trend that prevailed before the War. Formally, the age 1 budget constraint for the 1916 generation, that is Equation (3), is replaced with

$$c + a' + b_1 \left(e + \tau w^f\right) = 0.5 \times w^m + w^f.$$

[10] See Downs (1995, p. 49) and Huber (1931, pp. 932-935).

In Section 4.4 I present sensitivity results with respect to the magnitude of the income loss of the husband.

Figure 9 shows the result of the experiment. The fertility rate falls by 48% in 1916 in the model versus 49% in the data. Thus the model accounts for $48/49 = 97\%$ of the decline of the birth rate observed in the French data. After the War fertility increases by 66% in the model versus 118% in the data. Thus the model accounts for $66/118 = 56\%$ of the increase in fertility in the aftermath of the War. This increase in fertility after the War has two components. First, the young households of 1921 (the first post-war generation in the model) do not face the risk and income loss faced by the 1916 generation. Hence they do not need to lower their age-1 consumption and, therefore, they face a lower cost of raising children. So, this generation has an age-1 fertility that is consistent with the trend that prevailed before the War broke out. Second, the 1916 generation gives birth to an unusually low number of children in 1921. This is because, despite the fact that uncertainty has been resolved, this generation is poorer than its predecessor because of the temporary income loss incurred during the War. The low number of children born to the 1916 generation in 1921 is the reason why the 1921 fertility figure is not back on trend.

Although the 1916 generation gives birth to few children in 1921, its intertemporal allocation of births differs noticeably from its predecessors. For the members of this generation that were able to have children after the War, only 56% of their total fertility was completed during the War, when they were of age 1. This compares with the pre- and post-war generations, who completed 71% of their fertility at age 1. This different allocation implies a temporary increase in the age at birth that is consistent with the pattern observed in the data of figure 5.

This exercise shows that the combination of a husband's mobilization, i.e., his inability to earn income during the War, and the likelihood that his wife might remains alone after age 1 are enough to account for all the decline in fertility during the war, and no less than half of the catch-up in its aftermath. Note again that although the husband is unable to receive income during the War, there are no physical separations of couples in the model.

4.3 Decomposition

What is the relative contribution of the two shocks faced by households to the fertility decline. That is, how important was the temporary income loss due to the mobilization versus the risk and expected income loss due to the killings? To answer this question, consider two counterfactual experiments. In the first, the only shock affecting the 1916 generation is the increase of $\pi(1)$. That is, this generation faces increased income risk and lower expected income after age 1, but no contemporaneous loss of income at age 1 during the War. In the second experiment the only shock affecting the 1916 generation is the loss of income due to the mobilization, but there is no change in the probability $\pi(1)$.

Figure 10 shows the result of the first counterfactual experiment. The fertility rate falls by 43% in 1916 in the model versus 49% in the data. Thus, the increase in $\pi(1)$ alone accounts for $43/49 = 87\%$ of the decline of the birth rate observed in the French data. After the War fertility increases by 105% in the model versus 118% in the data. Thus the model accounts, in this experiment, for $105/118 = 89\%$ of the increase in fertility in the aftermath of the War. As in Section 4.2 the increase in fertility after the War has two components. First, the young household in 1921 has an age-1 fertility that is consistent with the trend that prevailed before the War. Second, and contrary to the result of Section 4.2, the 1916 generation gives birth to an unusually large number of children in 1921. This is because it significantly postponed its fertility during the War, but did not suffer any income loss as in the main experiment of Section 4.2. For the members of this generation that were able to have children after the War, only 36% of their total fertility was completed during the War, when they were of age 1 (v. 56% in the previous experiment). It is interesting to note that in this experiment, the post-war level of fertility is above trend. Thus, the ability of households to postpone their fertility, combined with a moderate income loss during the War would be able to replicate the increase of actual fertility above its trend.

To summarize, this experiment shows that the bulk of the fertility decline during the War is accounted for by the increased income risk and lower expected income faced by the 1916 generation. The temporary income loss of mobilized men was a significant contributor to the fertility decline but its quantitative contribution was less than that of $\pi(1)$.

4.4 Sensitivity

I consider alternative values for (i) the probability that a woman remains alone after age 1, $\pi(1)$; (ii) the magnitude of the husband's income loss during the War; (iii) the time cost of raising children; and (iv) the gender wage gap in earnings.

a - Sensitivity to $\pi(1)$, the Risk that a Wife Remains Alone after World War I

Consider two alternative values for $\pi(1)$, the probability that a woman in the 1916 generation remains alone in her household after the War. The first is $\pi(1) = 0.1$ instead of 0.16 in the baseline. The second is $\pi(1) = 0.2$. In both cases the baseline experiment of Section 4.2 is performed with the new value for $\pi(1)$. Table 3 reports the results. It transpires that the probability $\pi(1)$ matters noticeably for the results of the exercise but that, even in the conservative case where the risk for a wife to remain alone is 10%, the model still accounts for 79% of the actual decline in fertility (v. 97% in the baseline). In the case where the probability is 20%, the model accounts for 104% of the decline.

b - Sensitivity the Income Loss of a Husband During World War I

In the experiment of Section 4.2 a husband's loses 50% of its income because of mobilization. I consider two alternative values: one where the loss of income is 25% and one where it is 75%. Performing the same experiment as in Section 4.2 with these values implies results that are reported in Table 4. As the income loss gets smaller, the model accounts for a smaller proportion of the actual decline and a larger proportion of the actual increase in fertility. In the case of an income loss of 25% during the war, the model accounts for 92% (v. 97% in the baseline) of the decline in fertility during the War, and 73% (v. 56% in the baseline) of the post-war increase. When the income loss is 75% the model accounts for 103% and 40% of the decline an increase, respectively.

c - Sensitivity to the Time Cost of Raising a Child

Consider now alternative targets for the time cost of raising children. For each new value the model needs to be calibrated again, in exactly the same fashion as in Section 4.1 with the exception of the target in the second component of the objective function (12). Then the experiment of Section 4.2 is performed. I consider two alternative targets: a time cost of 5% and a time cost of 20%. The results are displayed in Table 5. There are two observations worth making here. First, the model's worst performance remains quite high: it accounts for no less than 75% of the decline in fertility during the war (v. 97 in the baseline) and no less than 27% of the increase after (v. 56 in the baseline). Second, the fraction of decline accounted for by the model rises as the time cost of a child decreases. This may appear "counter-intuitive" as one might expect the effect of the war to be dampened when children are less costly. The reason for this result is that, as the target figure for the time cost of a child changes, other parameters change too. In particular, a lower time cost of raising a child implies, through the calibration procedure, a lower value for ρ. This can be understood as follows: as the opportunity cost of raising a child decreases the marginal cost decreases too. Since the model is calibrated to fit the data, marginal cost and marginal benefit must be equalized at the same fertility level. This implies that the marginal benefit of a child must also decrease, which is achieve through lower values for ρ and θ. Lower values for ρ, however, imply more complementarity between adults and children in utility. This, in turn, makes the war more costly. In the results of Table 5, this effect is stronger that the effect from the reduction in the cost of a child.

Another experiment with respect to the time cost of children consists in changing τ without recalibrating the model. In this case the time series of fertility will not fit the data, but conclusions can be drawn from the change in fertility during the War. In the case where τ is divided by two relative to its baseline value, the change in fertility during the War is 77% of the data (v. 97 in the baseline), and the increase after the War is 36% of the data (v. 56 in the baseline). If τ is set at twice its baseline value the model accounts for 130% and 115% of the changes in fertility during and after the War. Thus, the effect of the War is indeed increasing in the time cost of raising a child. However, even with a time cost parameter twice as little as in the baseline calibration the model still accounts for more than half of the changes in fertility during the War.

d - Sensitivity to w^f/w^m, the Gender Earning Gap

In Table 6 I perform a sensitivity analysis with respect to w^m/w^f, the gender earning gap. I consider two alternative values: 40 and 80%. As for the sensitivity analysis with respect to τ, the model's paramaters are calibrated again for each alternative value of w^m/w^f and the experiment of Section 4.2 is performed. The effect of the War on fertility is large in all these experiments: the model accounts for no less than 88% of the decline in fertility and no less than 43% of the increase after the War.

5 Conclusion

The human losses of World War I were not only on the battlefield. In France, the number of children not born during the War was as large as military casualties (larger in the case of Germany). The age structure of population in France and other European countries was significantly changed by this event, and the effect lasted for the entire twentieth century. In this paper I argue that this phenomenon was for a large part, that is between 87 and 97%, the optimal reaction of generations exposed to the effects of the War, namely the loss of income for a husband during the War, and the risk that a wife remains alone in her household at the end of the War. These two mechanisms alone can also account for the rise of fertility after the War. The physical separation of couples which is often cited to explain the fertility decline during the War may have been a factor of secondary importance. This finding is consistent with a general pattern exhibited by fertility, across countries and over time, i.e., it tends to decline during periods of significant unrest even though there may be no physical separations of couples.

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Table 1: Changes in Fertility for Countries Experiencing Major Social Upheavals

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, Table 1).

Note: CBR is Crude Birth Rate.

Table 2: Calibration

Preferences	$\beta = 1.04^{-5}$, $\theta = 0.44$, $\rho = -0.24$, $\sigma = 0.90$
Wages	$w = 1$ for initial generation, $g = 1.016^5$
Cost of children	$\tau = 1.82$, $e = 0$
Gender wage gap	$\lambda = 0.6$
Demography	$I = 4$, $J = 7$

Table 3: Sensitivity to $\pi(1)$, the Risk that a Wife Remains Alone in her Household after World War I

	%age of decline	%age of increase
$\pi(1) = 0.10$	79	27
$\pi(1) = 0.16$ (baseline)	97	56
$\pi(1) = 0.20$	104	68

Note: The first column reports the percentage of the fertility decline during the War that is accounted for in the experiment. The second column reports the percentage of the fertility increase after the War that is accounted for.

Table 4: Sensitivity the Income Loss of a Husband During World War I

	%age of decline	%age of increase
25%	92	73
50% (baseline)	97	56
75%	103	40

Note: The first column reports the percentage of the fertility decline during the War that is accounted for in the experiment. The second column reports the percentage of the fertility increase after the War that is accounted for.

Table 5: Sensitivity to the Time Cost of Raising a Child

Time cost	%age of decline	%age of increase
5%	103	69
10% (baseline)	97	56
20%	75	27

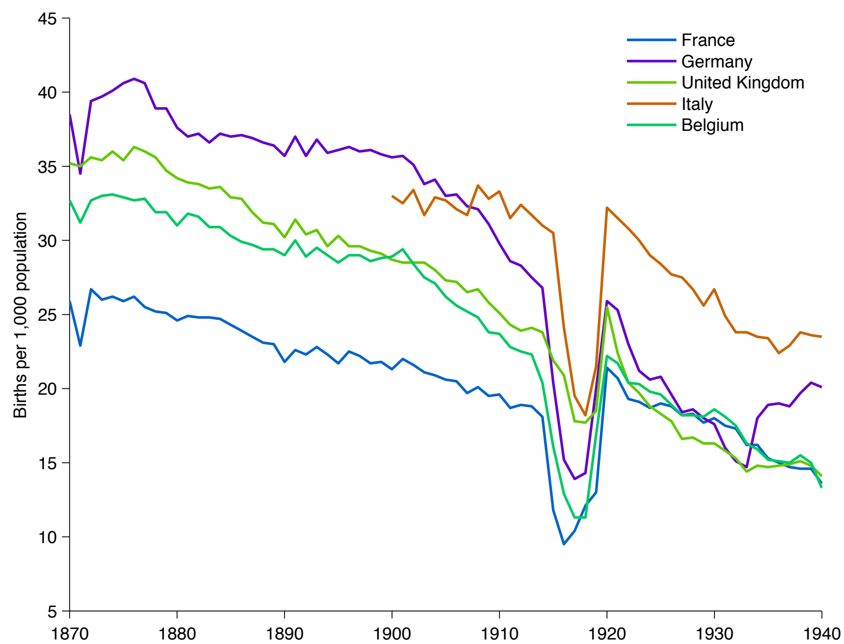
Note: The first column reports the percentage of the fertility decline during the War that is accounted for in the experiment. The second column reports the percentage of the fertility increase after the War that is accounted for.

Table 6: Sensitivity to w^f/w^m, the Gender Earning Gap

	%age of decline	%age of increase
$w^f/w^m = 0.4$	111	81
$w^f/w^m = 0.6$ (baseline)	97	56
$w^f/w^m = 0.8$	88	43

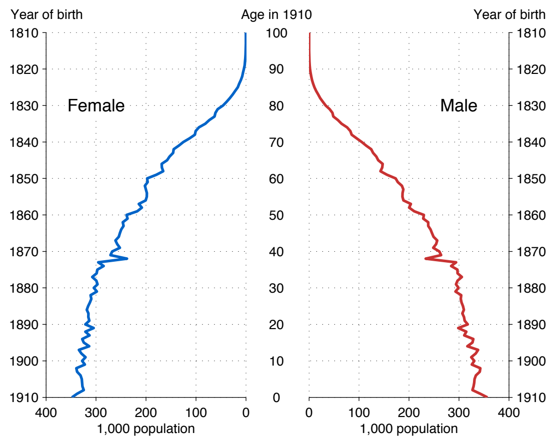
Note: The first column reports the percentage of the fertility decline during the War that is accounted for in the experiment. The second column reports the percentage of the fertility increase after the War that is accounted for.

Figure 1: Birth Rates in Some European Countries

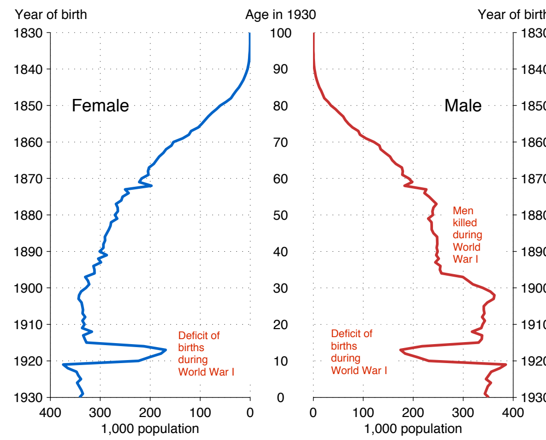


Source: Mitchell (1998).

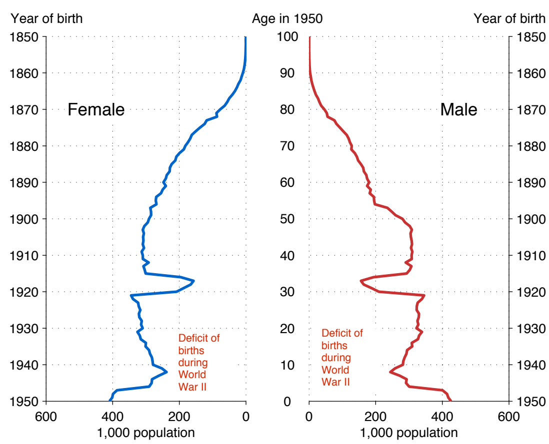
Figure 2: French Population by Age and Sex, January 1, Selected Years



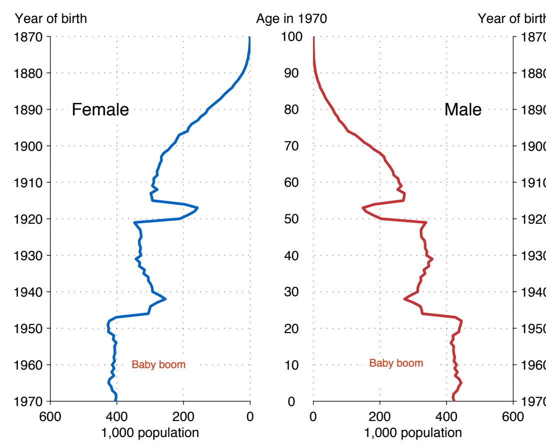
1910



1930



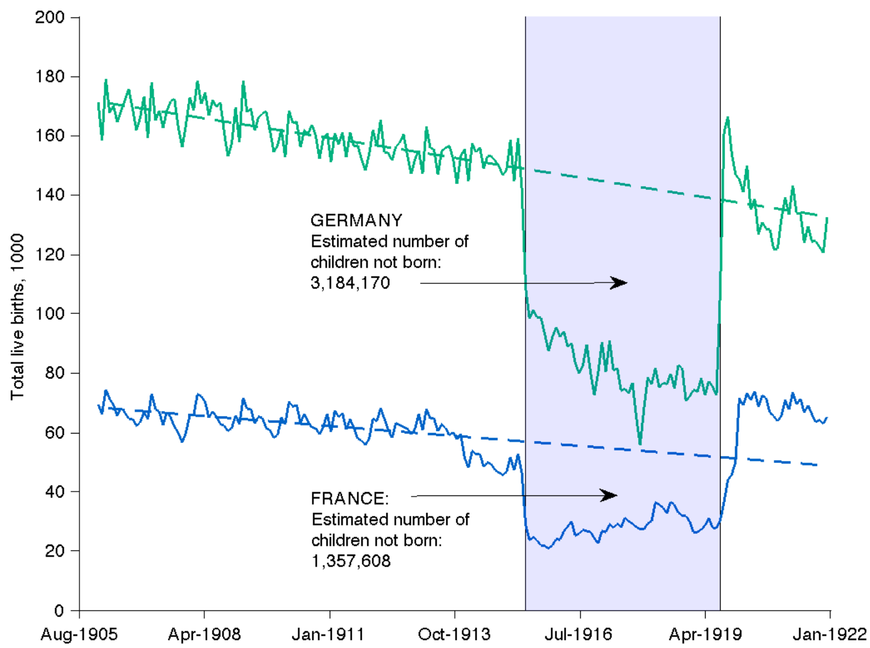
1950



1970

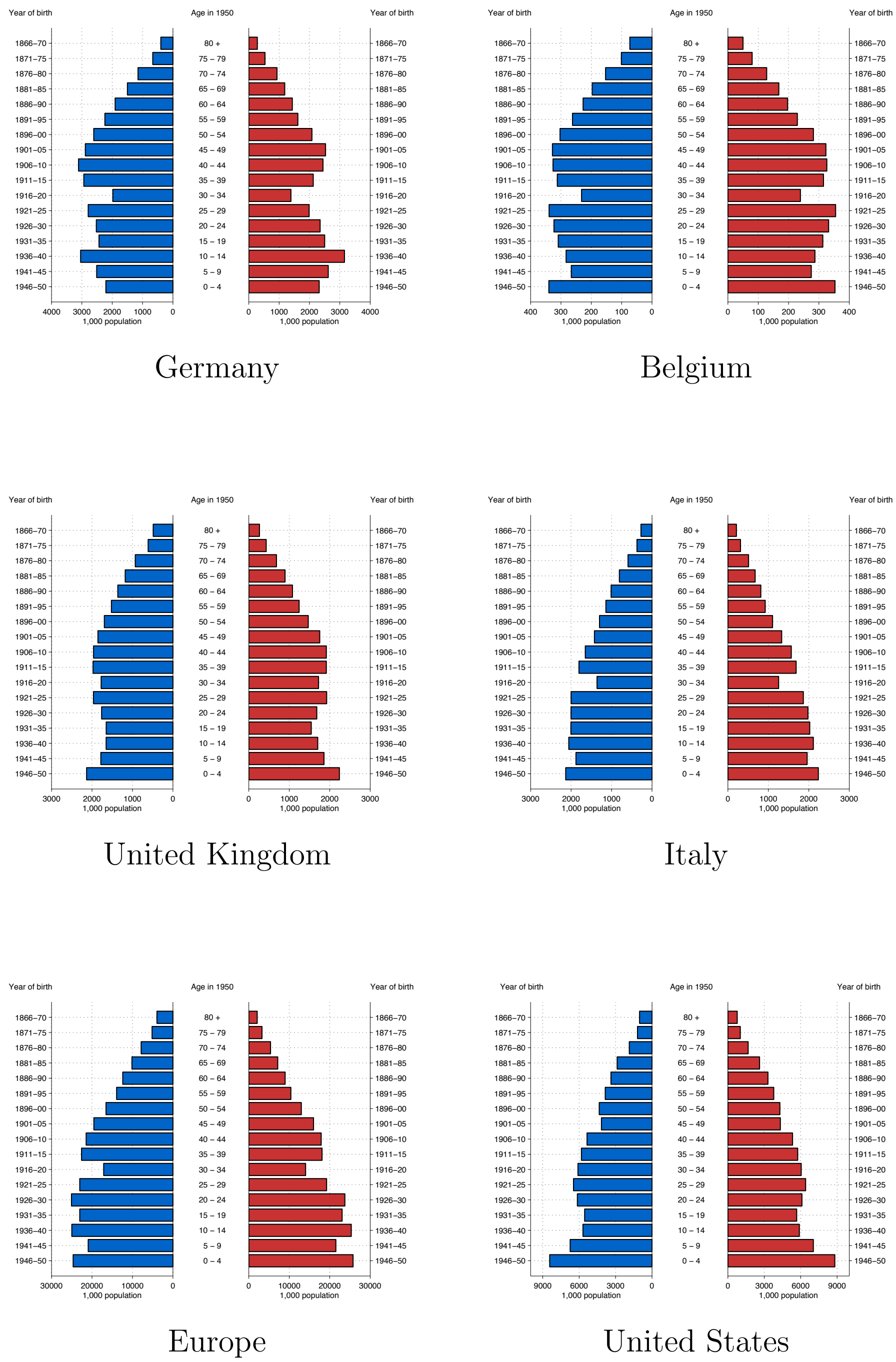
Source: Insee, état civil et recensement de population.

Figure 3: Number of Births per Month in France and Germany



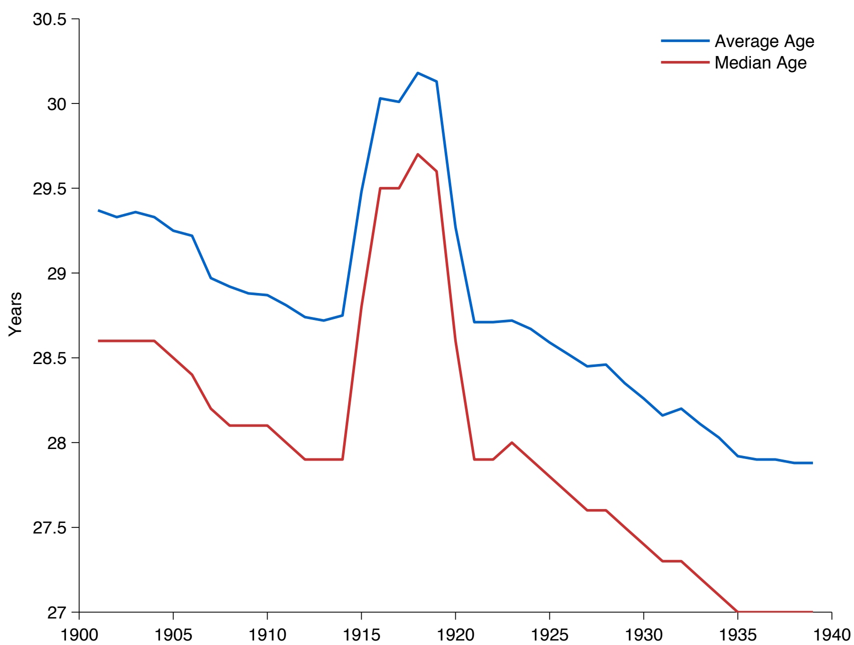
Note: The source of data is Bunle (1954, Table XI). The linear trends are estimated using the data from January 1906 until July 1914. The shaded area is from May 1915, that is 9 months after the declaration of War between France and Germany in August 1914, until August 1919 that is 9 months after the armistice was signed in November 1918.

Figure 4: Population by Age and Sex, Selected Countries, 1950



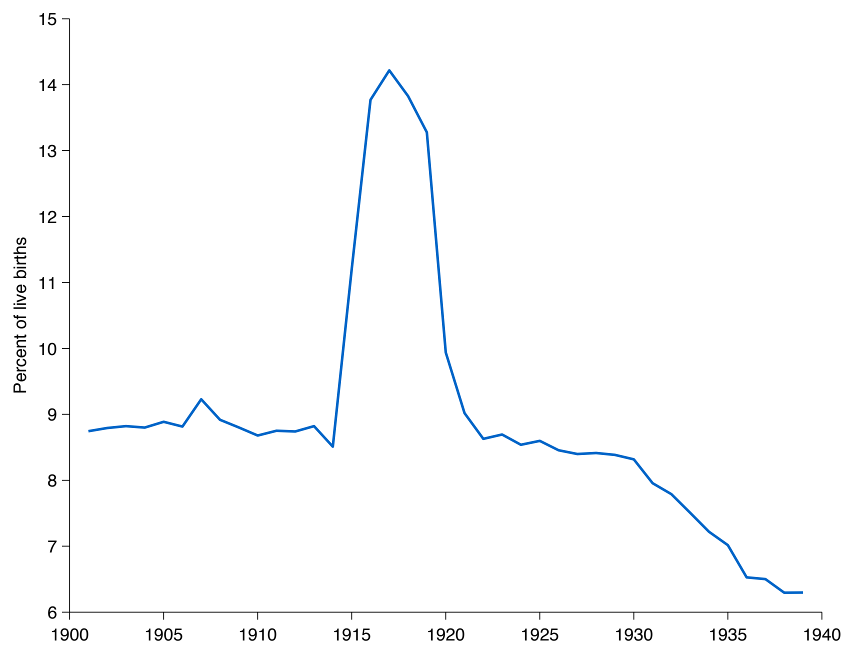
Source: United Nations, Department of Economic and Social Affairs, Population Division.

Figure 5: Average and Median Age at Birth in France



Source: Insee, état civil et recensement de population.

Figure 6: Proportion of Out-of-Wedlock Live Births in France



Source: Insee, état civil et recensement de population.

Figure 7: Timing of Events and Decisions

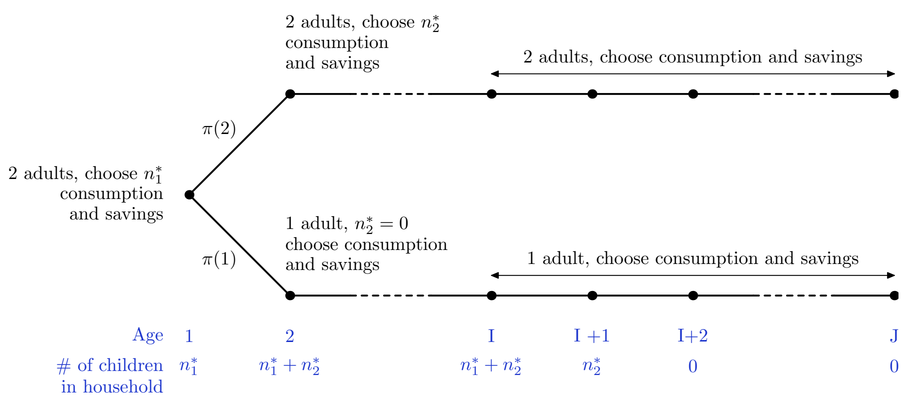
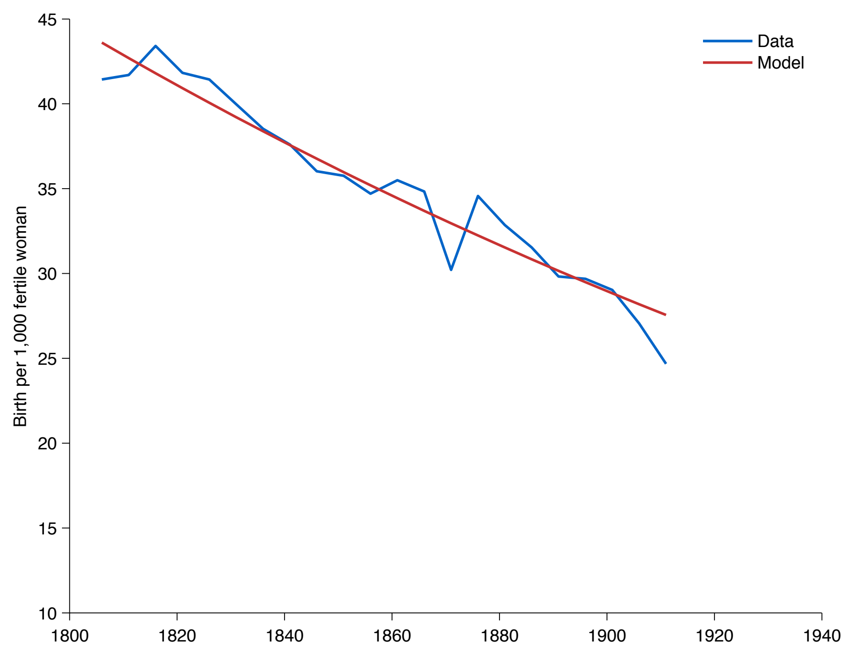
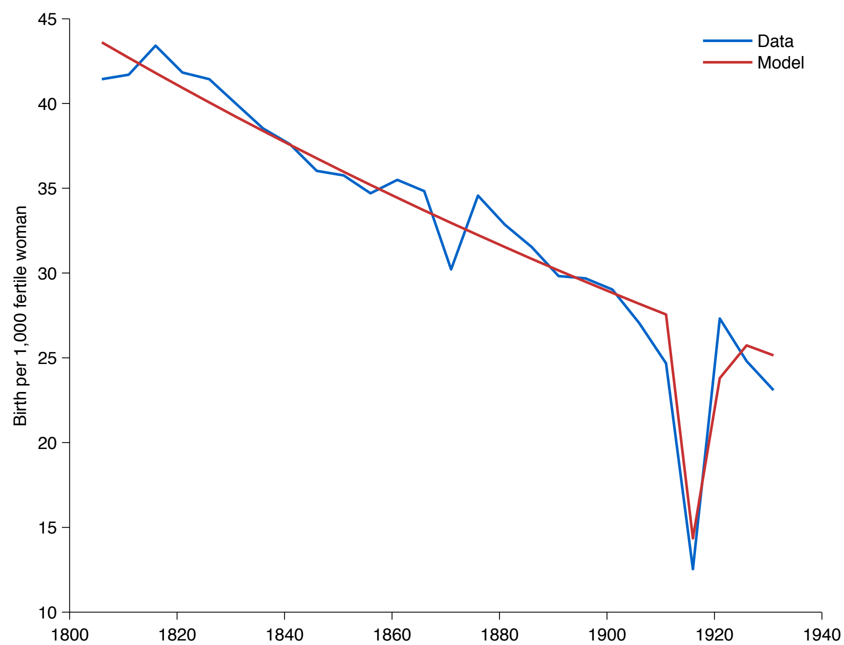


Figure 8: Calibration: Fertility Rate in France, Model and Data



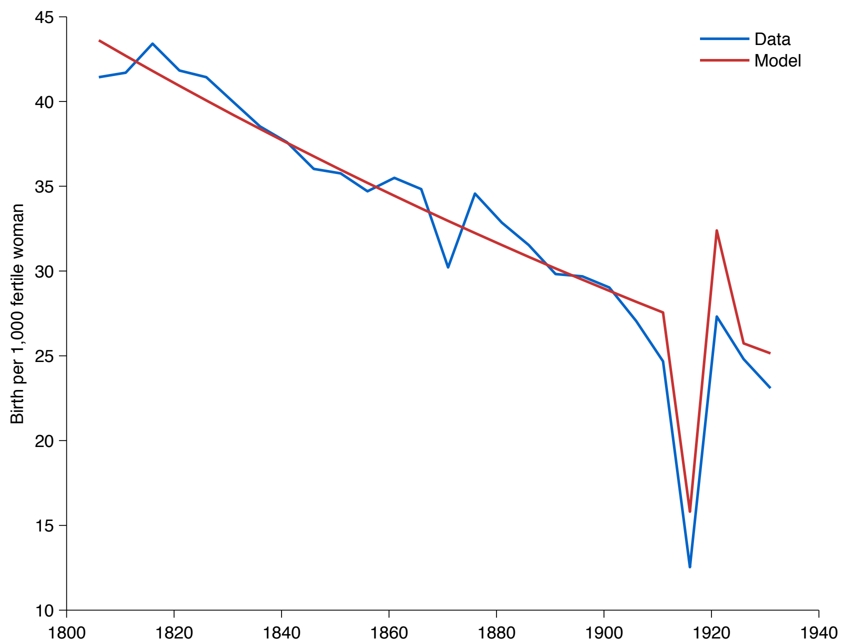
Note: This figure displays the result of the calibration procedure where the model parameters are chosen to fit the time series of fertility during the pre-war period. The probability that a wife remains alone in a household is 0 for all generations.

Figure 9: Baseline Model: Fertility Rate in France, Model and Data



Note: In this experiment the generation affected by the War faces both an increased probability that a wife remains alone after age 1 and a temporary loss of a husband's income during the War.

Figure 10: Counterfactual Experiment 1: Fertility Rate in France, Model and Data



Note: In this experiment the generation affected by the War faces an increased probability that a wife remains alone after age 1. There is no temporary loss of a husband's income during the War.