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War finance and the baby boom ☆

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ABSTRACT

In this paper, I extend the Barro–Becker model of endogenous fertility to incorporate specific fiscal policies and use it to study the effects of the fiscal policy changes following WWII on fertility in the United States. The US government went through large changes in fiscal policy after the beginning of WWII. The marginal income tax rate for an average American jumped from 4% on average before 1940 to approximately 25% during the war and stayed around 20% afterwards. The government debt–GDP ratio jumped from approximately 30% on average before WWII to 108% in 1946 and then dropped gradually in the following two decades to about 30% again at the end of 1960s. I find that the dramatic increase in the marginal income tax rate was an important cause of the postwar baby boom in the US because it lowered the after-tax wage and thus the opportunity cost of child-rearing. I also find that the differential change in taxes by income was an important reason why the baby boom was more pronounced among richer households (as documented by Jones and Tertilt, 2008). Furthermore, I argue that the government's debt policy may also matter for understanding fertility choices because government debt implies a tax burden on children in the future and thus affects their utility, which is a key determinant of current fertility choice in the Barro–Becker model. The results of a computational experiment show that the US government's postwar debt policy also contributed to the baby boom, but its quantitative importance is relatively small.

1. Introduction

The United States experienced a massive baby boom following the Second World War (WWII). As documented by Jones and Tertilt (2008), the completed fertility rate was 2.4 for the cohort of women born in 1911–1915 (who completed most of their fertility by the 1940s), and it increased to 3.2 for the cohort of women born in 1931–1935 (who completed most of their fertility by the 1960s).[1] Meanwhile, the US government went through large changes in fiscal policy (see Fig. 2). The marginal income tax rate was 4% before 1940 for an average American, and it went above 20% during the war and kept around 20% since then. On the other hand, the government debt–GDP ratio jumped from approximately 30% on average

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[1] See Fig. 1. A similar pattern is observed in the data for total fertility rate, which is also plotted in Fig. 1. In this paper, I focus on the baby boom measured by cohort fertility since this measurement better matches the fertility definition in my model.

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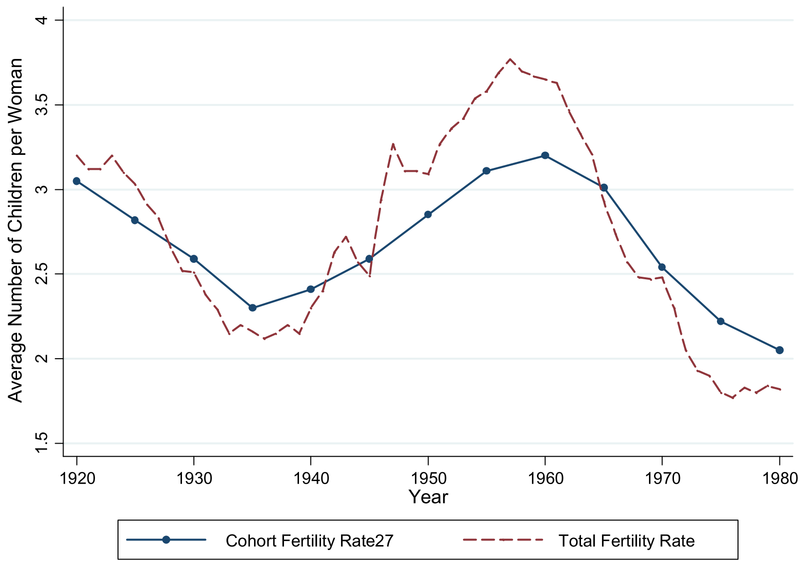

Fig. 1. The baby boom in the US. Note: cohort fertility rate 27 is completed fertility rate by cohort (shifted to right by 27 years from birth year). Data source: completed fertility rate is from Jones and Tertilt (2008), total fertility rate is from Chesnais (1992).

before WWII to 108% in 1946, and then dropped gradually in the following two decades to about 30% again at the end of 1960s.[2]

What impact do these fiscal policy changes have on fertility? Is there a role for fiscal policy in accounting for the postwar baby boom in the US? I answer these questions in this paper.

I argue that a rise in the marginal labor income tax rate can increase fertility by reducing the opportunity cost of child-rearing, that is the after-tax wage (when the cost of child-rearing involves parental time). The government's debt policy also affects fertility choice as government debt implies a tax burden on children in the future and thus affects their lifetime utility, which is an important determinant of current fertility choice in the Barro–Becker model (in which the children's utility is included in the parents' utility function).

To formalize the above-described mechanisms, I develop an extended Barro–Becker model of endogenous fertility in which specific fiscal policies are incorporated. In the model, there are three periods: childhood, middle age, and old age. Only the middle-age agents are endowed with one unit of time which can be used to either rear children or work. The middle-age agents have Barro–Becker type altruism toward their children (the children's utility is included in the parents' utility function) (Barro and Becker, 1989; Becker and Barro, 1988). After they receive an ability shock at the beginning of the middle age, the agents maximize their lifetime utility by choosing fertility, middle-age consumption, and saving for their old age. In the benchmark model, the children and old-age agents make no economic decisions. On the production side, I assume a standard Cobb–Douglas production technology for simplicity. On the government side, the model contains utility-increasing government expenditures, which are financed by government debt and labor income taxes.

To assess the extent to which the fiscal policy changes can account for the postwar baby boom in the US, I conduct the following quantitative exercise. First, I calibrate the model such that the initial stationary equilibrium matches some key moments of the US economy prior to the baby boom. Second, I shock the economy by introducing the fiscal policy changes that mimic what happened during the baby boom period in the US, and then compute the transition path along which the economy eventually converges to a new stationary equilibrium. I find that the model can generate a baby boom along the transition path, which in magnitude is over a third of that observed in the data. I also run computational experiments to decompose the effects of different fiscal policy changes on fertility, and find that the baby boom in the model was mainly due to the increase in the marginal income tax rate. The US government's postwar debt policy also contributed to the baby boom, but its quantitative importance was relatively smaller.

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[2] The drop in the debt level was partly due to the fact that the US government then favored debt reduction to tax cut. Some supporting evidence for the government's preference toward debt reduction can be found in the following letter written by President Harry S. Truman to the House of Representatives:

> "… My fundamental objection to the bill is that it would not strengthen, but instead would weaken, the United States.
> …
> … the bill would reduce Government revenues to such an extent as to make likely a deficit in Government finances, at a time when responsible conduct of the financial affairs of this Nation requires a substantial surplus in order to reduce our large public debt…"
>
> [President Harry S. Truman, April 1, 1948, Truman's Veto of the Income Tax Reduction Bill]

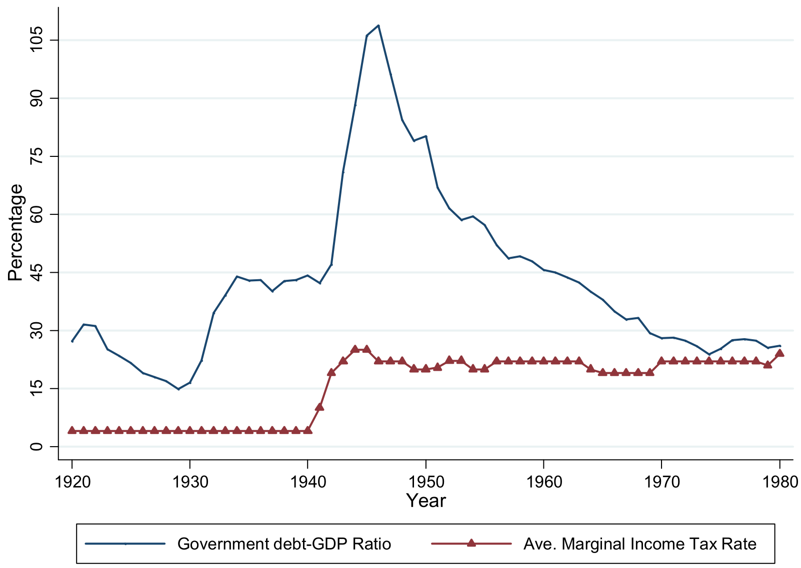

Fig. 2. The fiscal policy changes following WWII. Data source: 1. Debt–GDP ratio: the data before 1940 comes from CBO, and the data since 1940 is from the Office of Management and Budget. 2. Tax rates: income data are from US Census Bureau, and tax rates are from the Tax Foundation.

It is worth mentioning that the model can also match a related empirical observation from the same period. That is, the baby boom was more pronounced among richer households in the US (see Fig. 9).[3] As a result, the fertility differential between the poor and the rich shrank significantly during the baby boom period, which was called "the compression of fertility" by Jones and Tertilt (2008).[4] "The compression of fertility" can be seen by looking at how the income elasticity of fertility changed during the baby boom period. As estimated by Jones and Tertilt (2008), the income elasticity of fertility changed from -0.35 to -0.17 during this period, and therefore the fertility–income relationship became much flatter after the baby boom. Note that this fact can be very important because existing studies have shown that differential fertility has important aggregate and distributional effects.[5] Thus, a successful theory about the baby boom should also be consistent with the simultaneous change in the fertility–income relationship. I show that the model in this paper can also generate a larger baby boom among richer households, thus matching the change in the fertility–income relationship over the baby boom period. The reason for that is because most Americans faced a flat income tax rate before WWII, but after WWII the US income taxes became progressive for the majority of the population. As a result, richer Americans experienced a larger increase in the marginal income tax rate following WWII, and therefore their fertility rate increased by more during the postwar baby boom period.

Recently, there has been a growing literature that tries to account for the baby boom using quantitative macroeconomic models.[6] Several explanations have been proposed. Greenwood et al. (2005) argue that the baby boom was due to a positive shock in home production technology. Here the positive shock refers to the widespread diffusion of electrical appliances such as refrigerators, laundry machines, and dishwashers during the baby boom period. These appliances freed women from housework and lowered the opportunity cost of child-rearing. The Greenwood et al. model can produce a baby boom comparable to the one observed in the data, but it fails to produce an immediate baby bust following the baby boom.

Another important explanation is from Doepke et al. (2012). They argue that WWII produced a large number of women with work experience. Since the market rewards work experience, women with work experience would tend to remain in the labor force after the war, making the labor market more competitive for young women with little work experience. Therefore, these young women would be more likely to get married earlier and have more children. An important piece of empirical evidence supporting their story is that the baby boom was mainly generated by young women. The theory proposed in this paper is complementary to their theory. Both focus on the role of WWII in generating the baby boom, and both argue that the low opportunity cost of child-rearing was one of the forces driving the baby boom. While Doepke et al. (2012) emphasize how a more competitive labor market reduces the cost of child-rearing by lowering the market wage rates, I argue that what matters is the after-tax wage rate and therefore focus on how changes in government taxation affect the after-tax wage rates and the cost of child-rearing. I also point out that government debt may also affect fertility choice

[3] As can be seen in Fig. 9, while cohort fertility rate increased by 33% for the whole population over the baby boom period, it only increased by 27% for the poor half, and by 40% for the rich half.

[4] Note that the poor had much more children than the rich prior to WWII in the US. As a result, a more pronounced baby boom among richer households reduced the fertility gap between the poor and the rich.

[5] For example, de la Croix and Doepke (2003, 2004), Zhao (2011).

[6] Greenwood et al. (2005), Doepke et al. (2012), Jones and Schoonbroodt (2011), Simon and Tamura (2012), etc.

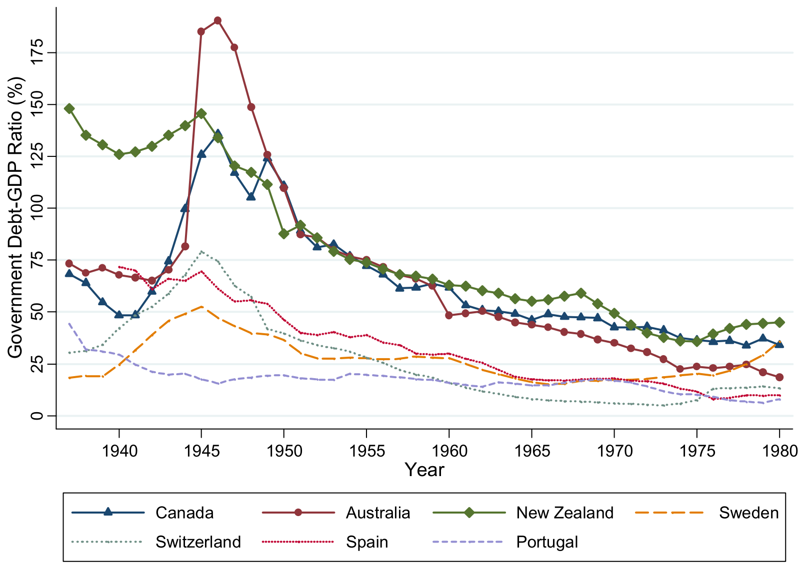

Fig. 3. The government debt–GDP ratio in other countries. Data source: Reinhart and Rogoff (2009).

as it changes parents' expectation about their children's utility in the future, another possible force causing the baby boom. It is worth noting that Doepke et al. (2012) also include a fiscal policy channel in their analysis, but they find that the fiscal channel in their model is relatively unimportant compared to the female labor supply channel.

Among other explanations proposed in the literature, the one from Jones and Schoonbroodt (2011) is in particular interesting. In a model combining features of a stochastic growth model with a Barro–Becker model of fertility choice, they show that the large aggregate income shocks over the 20th century can account for a large part of the fertility fluctuations over the same period. For instance, they show that the Great Depression was an important cause of the baby bust in the 1930s and the following baby boom.

1.1. *Cross-country evidence*

The baby boom phenomenon was not unique to the United States. Many industrialized countries also experienced a baby boom roughly around the same period. Is international evidence consistent with the theory proposed in this paper? One implication of the theory is that countries that participated in WWII and thus experienced similar fiscal policy changes as the US should have had a larger baby boom. In this section I investigate whether this implication holds true in the data.

I study two groups of industrialized countries: (1) Allied countries that did not fight on their own soil (Canada, Australia, and New Zealand), and (2) neutral countries (Spain, Sweden, Switzerland, and Portugal).[7] The first group participated in the war and thus experienced similar fiscal policy changes as the US, while the second group did not fight in WWII and therefore their fiscal policies were less affected by the war. As shown in Fig. 3, the government debt–GDP ratio went up dramatically after the breakout of WWII among all three countries in the first group, and the ratio was above 100% for all of them at the end of the war. The debt–GDP ratio then dropped gradually and was below 50% by the end of the 1960s in them. On the other hand, the changes of debt–GDP ratio among the neutral countries were qualitatively similar but quantitatively much smaller over the same period (see Fig. 3). Fig. 4 plots the average marginal income tax rate series over this period. Similar with the US, the other Allied countries also experienced a dramatic increase in the marginal income tax rate immediately after the onset of WWII, while in neutral countries the marginal income tax rates remained stable over that period.[8]

Based on these differences, the model predicts that the first group will have a larger baby boom than the second group. Figs. 5 and 6 plot the time series of completed fertility rate by cohort for both groups of countries. The first group of countries had a much larger baby boom than the second group, which is consistent with the model implication.

In the rest of the paper, I present the model in Section 2. I calibrate the model and conduct the main quantitative exercise in Section 3. I provide further analysis in Section 4, and conclude in Section 5.

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[7] Here I exclude the countries that fought on their own soil during WWII for the following reason: besides the income taxation and government debt issues, these countries also needed to deal with postwar reconstruction, which may also affect fertility. The postwar reconstruction problem may distort the true correlation between other fiscal policy changes and fertility, but it differs across these countries and is very hard to model.

[8] Note that information on average marginal income tax rates is not available for Sweden, thus the median income tax rates for local taxes (including taxes at the municipal and county levels) are used for Sweden in the picture.

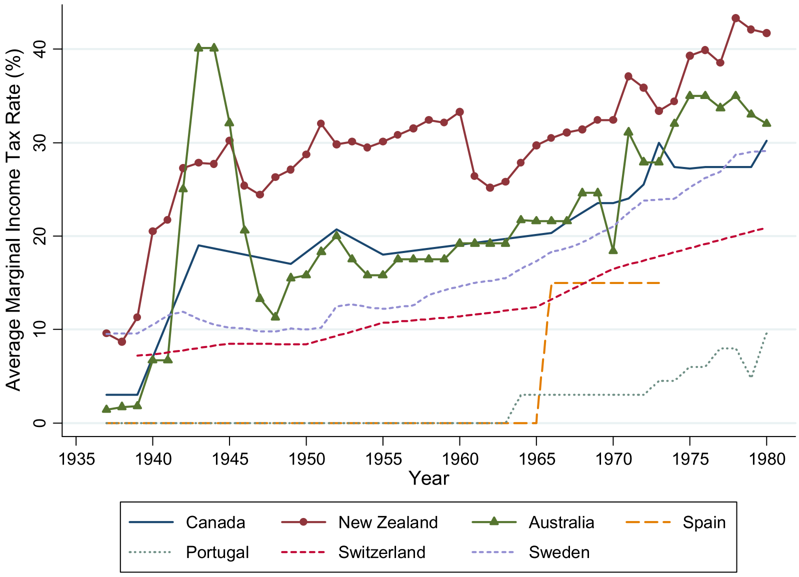

Fig. 4. Average marginal income tax rates in other countries. Data source: author's own calculation based on data from different sources.

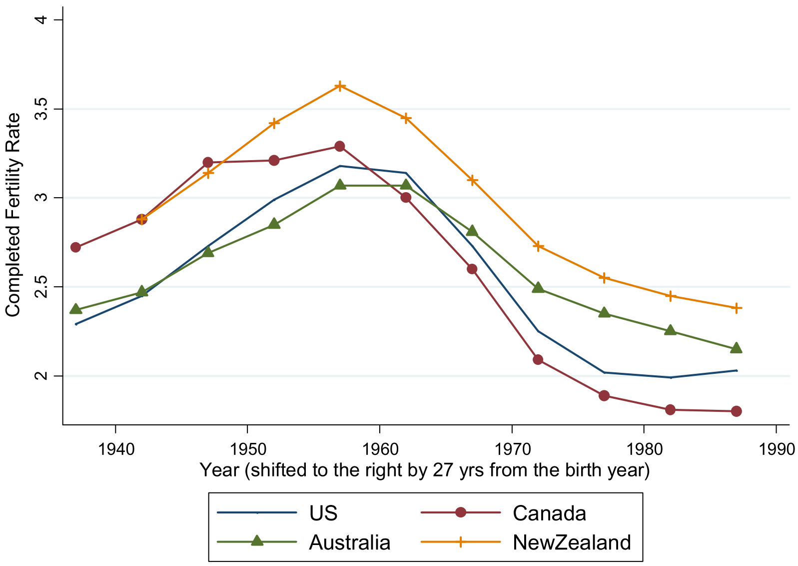

Fig. 5. Completed fertility rate in the first group of countries. Data source: Doepke et al. (2012).

2. The model

2.1. The agents

Consider an economy inhabited by overlapping generations of agents who live for three periods: childhood, middle age, and old age. At the beginning of the middle age, the agent receives a productivity shock ϵ and is endowed with one unit of time which can be used to either work or rear children. The middle-age agent has Barro–Becker type preferences (the children's utility is included in her utility function), and chooses her fertility, middle-age consumption, and saving for the old age to maximize her lifetime utility. No decisions are made in childhood, and in the old age the agent only consumes what she saves from the middle age. The following is the lifetime utility of the agent with productivity shock ϵ_t in period t,

$$u\left(c_t^m\right) + \beta u\left(c_{t+1}^o\right) + \beta\gamma n_t^\theta E\left[V_{t+1}(\epsilon_{t+1}) \mid \epsilon_t\right] + \nu(g_t) + \beta\nu(g_{t+1}). \tag{1}$$

The first term represents the utility flow from middle-age consumption c_t^m in period t. The second term represents the utility flow from old-age consumption c_{t+1}^o in the next period. Here I assume that the utility function takes the CRRA form,

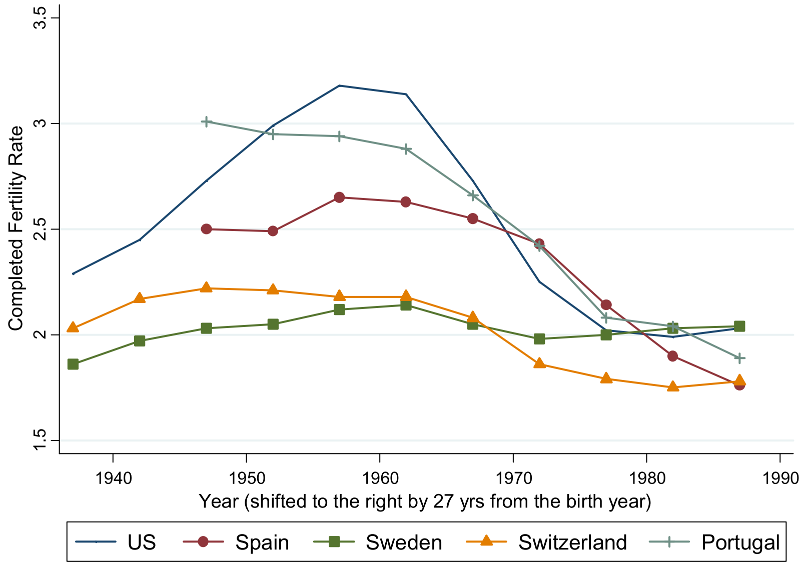

Fig. 6. Completed fertility rate in the second group of countries. Data source: Doepke et al. (2012).

$u(c) = \frac{c^{1-\sigma}}{1-\sigma}$. The third term represents the parent's altruism toward her children. Note that n_t is the number of children, and V_{t+1} is the value function of children in the next period with ϵ_{t+1} representing the children's productivity, which is unknown to the current middle-age parent.[9] Note that γ is the altruism weight, and θ is the curvature on the number of children. The last two terms, $\nu(g_t)$ and $\nu(g_{t+1})$, represent the utility flows derived from government expenditures (per person) in the middle age and old age, g_t and g_{t+1}. The functional form of $\nu(.)$ is assumed to be $\nu(g) = \zeta \frac{g^{1-\sigma}}{1-\sigma}$.

The agent faces the following budget constraints:

$$s_t + c_t^m = \epsilon_t w_t(1 - bn_t) - T_t\big(\epsilon_t w_t(1 - bn_t)\big), \tag{2}$$

$$c_{t+1}^o = (1 + r_{t+1})s_t, \tag{3}$$

where $T_t(.)$ is the labor income tax, which is a function of earnings, $\epsilon_t w_t(1 - bn_t)$, s_t is saving for the old age. The wage and interest rate are represented by w_t and r_t respectively. Rearing one child requires parental time, b. Therefore the opportunity cost of child-rearing is the forgone earnings.[10]

The productivity shock $\epsilon_t \in \{\epsilon_1, \epsilon_2, \dots, \epsilon_m\}$, is governed by a Markov chain with transition matrix $\pi(i, j) = Prob(\epsilon_{t+1} = \epsilon_j \mid \epsilon_t = \epsilon_i)$. The Markov chain is approximated from the log-normal AR(1) process

$$\ln \epsilon_{t+1} = \rho \ln \epsilon_t + u_t, \quad u_t \sim N\big(0, \sigma_u^2\big), \tag{4}$$

where ρ is the intergenerational persistence coefficient. Let Φ_t represent the distribution of middle-age agents over ϵ in period t. That is, $\Phi_t(\epsilon_i)$ measures the percentage of agents with productivity ϵ_i in the cohort, for all $i \in \{1, 2, \dots, m\}$.

In period t, the middle-age agent's problem (P1) can be written as a Bellman equation,

$$V_t(\epsilon_t) = \max_{n_t, s_t} u\big(c_t^m\big) + \beta u\big(c_{t+1}^o\big) + \beta\gamma n_t^\theta E\big[V_{t+1}(\epsilon_{t+1}) \mid \epsilon_t\big] + \nu(g_t) + \beta\nu(g_{t+1}) \tag{5}$$

subject to Eqs. (2), (3).

Let $f_t^n(.)$ represent the agent's decision rules for fertility, and $f_t^s(.)$ represent the decision rules for saving. Then, the average fertility rate in period t is given by $\bar{n}_t = \sum_{i=1}^m \Phi_t(\epsilon_i) f_t^n(\epsilon_i)$. Assuming that N_t represents the population measure of the middle-age cohort in period t, the law of motion for N can be simply represented by:

$$N_{t+1} = \bar{n}_t N_t. \tag{6}$$

[9] Here I assume that children within the same family have the same productivity.

[10] It is worth mentioning that the child-rearing cost in this model can also be interpreted as goods cost, as long as the goods cost is positively related to the parent's lifetime earnings.

2.2. The firm

On the production side, a standard Cobb–Douglas production technology is assumed. Production is undertaken in a competitive firm in accordance with

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}. \tag{7}$$

Here $\alpha \in (0,1)$, capital depreciates at a rate of δ, and A_t is the labor-augmented aggregate productivity. The firm chooses capital K_t and labor L_t by maximizing profits $Y_t - w_t L_t - (r_t + \delta)K_t$, which implies

$$w_t = (1-\alpha)A_t\left(\frac{K_t}{A_t L_t}\right)^{\alpha}, \tag{8}$$

$$r_t = \alpha\left(\frac{K_t}{A_t L_t}\right)^{\alpha-1} - \delta. \tag{9}$$

The aggregate productivity A_t is assumed to grow at a constant rate g_A in each period:

$$A_{t+1} = (1+g_A)A_t.$$

2.3. The government

There exist government expenditures G_t in period t, which can be financed through either government debt B_{t+1} or income tax revenue. This can be seen in the following government budget constraint,

$$(1+r_t)B_t + G_t = B_{t+1} + N_t \sum_{i=1}^{m} \Phi_t(\epsilon_i) T_t\big(w_t \epsilon_i\big(1 - b f_t^n(\epsilon_i)\big)\big). \tag{10}$$

Note that the measure of the whole population in period t is $N_{t-1} + N_t$, thus the government expenditure per person, g_t, is simply given by $g_t = \frac{G_t}{N_{t-1}+N_t}$.

2.4. Market clearing

The market clearing conditions are:

$$K_t = N_{t-1} \sum_{i=1}^{m} \Phi_{t-1}(\epsilon_i) f_{t-1}^s(\epsilon_i) - B_t \tag{11}$$

and

$$L_t = N_t \sum_{i=1}^{m} \Phi_t(\epsilon_i)\epsilon_i\big(1 - b f_t^n(\epsilon_i)\big). \tag{12}$$

The law of motion for the distribution of middle-age agents Φ, is

$$\Phi_{t+1}(\epsilon_j) = \frac{1}{\bar{n}_t} \sum_{i=1}^{m} \Phi_t(\epsilon_i) f_t^n(\epsilon_i)\pi(i,j), \quad \forall j \in \{1,2,\ldots,m\}. \tag{13}$$

Definition. Given a sequence of government policies $\{T_t, B_t\}_{t=1}^{\infty}$ and initial conditions $\{K_1, \Phi_1, N_0, N_1\}$, a *competitive equilibrium* is sequences of functions $\{V_t, f_t^n, f_t^s; r_t, w_t; K_t, L_t, N_t; G_t, \Phi_t\}_{t=1}^{\infty}$ such that for all t, the following hold.

1. Given prices, government policies, and initial conditions, the individual functions $\{V_t, f_t^n, f_t^n\}$ solve the agent's problem (P1).
2. The prices satisfy conditions (8) and (9).
3. The government budget constraint (10) is satisfied.
4. The markets clear, i.e. conditions (11) and (12) are satisfied.
5. The distribution Φ evolves according to (13), and the population measure N evolves according to condition (6).

To define a steady state equilibrium, I assume that the government policies at steady state are to keep the government debt–GDP ratio and the income tax rates constant. This assumption implies that the government debt per person and the government expenditure per person at steady state should be growing at the same rate as the aggregate productivity, i.e. g_A. The stationary equilibrium (steady state equilibrium) can be defined as follows.

Definition. A *stationary equilibrium* (steady state equilibrium) is a competitive equilibrium in which the following hold. (1) r, $\frac{K}{AL}$, Φ, and $\bar{n}$ are constant; (2) w, g, and $\frac{B}{N_{-1}+N}$ grow at a constant rate g_A; and (3) L and N grow at a constant rate $\bar{n}$.

Since analytical results are not obtainable, numerical methods are used to solve the model.

3. Quantitative analysis

In this section, I quantitatively evaluate to what extent the fiscal policy changes following WWII can account for the postwar baby boom in the US. I take the following quantitative strategy. I calibrate the model so that it mimics the US economy prior to WWII (the initial stationary equilibrium). Then, I shock the stationary equilibrium by introducing the fiscal policy changes, and compute the transition path along which the economy eventually converges to a new stationary equilibrium. To assess the quantitative importance of the effect of the fiscal policy changes on fertility, I simply look at how fertility behaviors change on the transition path, and compare them with the US fertility data during the postwar baby boom period.

3.1. The benchmark calibration: the initial stationary equilibrium

The length of a model period is assumed to be 20 years, which roughly represents the time gap between two generations in the economy. To calibrate the model parameters, I take the following strategy. I predetermine the values of some standard parameters based on the existing literature, and then *simultaneously* choose the values of the remaining parameters to match some empirical moments (calculated from the US economy prior to WWII).

Based on the existing macroeconomics literature, I set the capital income share, α, to 0.3, the yearly capital depreciation rate to 0.12 ($\delta = 1-(1-0.12)^{20}$), and the yearly time discount rate to 0.97 ($\beta = 0.97^{20}$). Following Doepke (2005), I set the value of σ to 0.5. I also explore other values of σ in the sensitivity analysis. The intergenerational persistence coefficient, ρ, is assumed to be between zero and one, which means that the earning ability is mean-reverting over generations.[11] I set ρ to 0.4 based on the empirical estimate provided in Solon (1992). The time cost of child-rearing, b, is set to 0.075 according to Haveman and Wolfe (1995).[12]

The altruism weight, γ, is chosen to match the completed fertility rate of the cohort born between 1911 and 1915, which is 2.4 (Jones and Tertilt, 2008). The weight on utility derived from government expenditures, ζ, is calibrated such that the marginal utility of private consumption is equal to the marginal utility of government expenditures in the initial stationary equilibrium. In other words, I assume that the level of government expenditures is optimal in the initial stationary equilibrium. The resulting value of ζ is 0.18, which also implies that the marginal utility of government expenditures in the final stationary equilibrium (after the baby boom) is slightly lower than half of the marginal utility of private consumption. The variance of earning shock, σ_μ^2, directly affects the lifetime earnings inequality in the economy. Thus, I calibrate it to match the Gini coefficient of lifetime earnings in the US economy around the WWII period, which was 0.22 (in 1947) according to Friesen and Miller (1983). The resulting value of σ_μ^2 is 0.15.

As is standard in the Barro–Becker model, the curvature on the number of children, θ, is assumed to be between zero and one. Note that θ is an important parameter in this model, since its value directly determines the size of the baby boom generated in our model. When θ is closer to one, the marginal utility of having an extra child would diminish more slowly, therefore the model economy would respond with a larger baby boom to the fiscal policy changes. When θ is closer to zero, the opposite is true. To the best of my knowledge, there is no empirical estimate of θ in the existing literature. Since θ also affects the magnitude of differential fertility (by income), I calibrate the value of θ to match the income elasticity of fertility, which is -0.35 among the cohort of women born between 1911–1915 (Jones and Tertilt, 2008). The benchmark calibration results in a value of 0.1 for θ. The assumption $\theta \in (0,1)$ is also worth a discussion here. An important implication of this assumption is that the quality and the quantity of children are complementary in the model. Jones and Schoonbroodt (2010) propose an alternative hypothesis, in which they assume that θ is larger than one. As a result, the quality and quantity of children are substitutable in their model. In that case, some mechanisms mentioned in this paper would work differently.[13]

I choose the value of B, the amount of government debt, such that the debt–GDP is 30% in the initial stationary equilibrium, which is approximately the average value in the two decades prior to WWII. Economic growth reduces the debt–GDP ratio, thus it is also important in the model. I calibrate the rate of technological progress, g_A, so that the model matches the post-WWII growth rate of GDP per capita in the US. The resulting value of g_A is 2.0 percent (per year).[14]

[11] This assumption is supported by a large amount of empirical evidence, e.g. Solon (1992) and Zimmerman (1992).

[12] Haveman and Wolfe (1995) find that rearing a child takes about 15% of the parent's time. I assume that children live with the parent for 15 years and the parent's working career is 30 years. Thus, the time cost of rearing a child should be two thirds of Haveman and Wolfe's estimate, which is 0.075. de la Croix and Doepke (2003) use the same method to calibrate the time cost of child-rearing.

[13] The effect of income tax on fertility should remain the same as in this model, but the effect of government debt would run in the opposite direction. That is, when children's expected lifetime utility increases (as less debt is left to the future), parents would like to have fewer children.

[14] The rate of technological progress in the model is slightly on the upper side of the empirical estimates in the literature. As documented in Greenwood et al. (2005), the annual rate of technological progress was 1.41 percent between 1900 and 1948 (US Bureau of the Census, 1975, Series W6), and it jumped up to 1.68 percent between 1948 and 1974 (Bureau of Labor Statistics).

Table 1
Benchmark model calibration.

Parameter	Interpretation	Value
α	Capital share	0.3
δ	Capital depreciation rate	0.12 (annual)
σ	Elasticity of substitution	0.5
β	Time discount factor	0.97 (annual)
b	Time cost of children	0.075
ρ	Intergen. persistence of the earning ability	0.4
g_A	Rate of technological progress	2.0% (annual)
σ_μ^2	Variance of log earning shock	0.15
γ	Altruism weight	0.47
θ	Curvature in the altruism function	0.10
ζ	Weight on government expenditures	0.18

Table 2
Key statistics in the initial stationary equilibrium.

Statistics	Model	Data
Interest rate	4.1%	...
Cohort fertility rate	2.40	2.41
Income elasticity of fertility	0.36	0.35
Gini of lifetime earnings	0.23	0.22
GDP (per capita) growth rate	1.9%	2.1%

Though the US income taxes prior to WWII contained some progressivity, most American households were in fact facing a flat rate of 4%, which was the rate for the lowest income bracket, since the next income bracket was more than three times of the average income. Based on this, I simply assume that the tax function $T(y)$ takes the form $T(y) = 0.04y$ in the initial stationary equilibrium, that is, agents face a flat income tax rate, 4%.

All the parameter values are summarized in Table 1. This set of parameter values generates a (yearly) interest rate of 4.1% in the initial stationary equilibrium and 4.9% in the post-baby boom stationary equilibrium. Table 2 summarizes some key statistics in the initial stationary equilibrium.

3.2. The fiscal policy changes

After the beginning of WWII, the US experienced dramatic changes in fiscal policy, which are summarized in Table 3. As can be seen, the average marginal income tax rate was 4% on average in the two decades before the war, and it jumped to 22% during 1941–1960 and kept around this level in the following two decades. On the other hand, the government debt–GDP ratio jumped from approximately 30% on average in the two decades before WWII to 68% on average during 1941–1960, and then dropped to 30% again during 1961–1980. It is worth noting that the progressivity of US income taxation also changed dramatically following WWII. Prior to the war, most Americans face a flat rate, 4%, but it was not the case after the beginning of WWII. Most Americans faced progressive income taxes since WWII and throughout the following decades. To capture the progressivity of US income taxes after WWII, I follow Gouveia and Strauss (1994), and assume that the tax function switches to the following form immediately after the war,[15]

$$T(y) = \kappa_0\big(y - \big(y^{-\kappa_1} + \kappa_2\big)^{-1/\kappa_1}\big).$$

I set κ_0 to 0.479 and κ_1 to 0.817 based on the empirical estimates provided in Gouveia and Strauss (1994), and assume that these values are constant along the transition path.[16] Following Conesa et al. (2009), I calibrate the value of κ_2 in each period along the transition path such that the average marginal income tax rates in the model match those observed in the postwar US data (see Table 3).

3.3. The main results

I shock the initial stationary equilibrium by introducing the fiscal policy changes described above. Specifically, I assume that at the beginning of a period (before the production takes place), the war occurs and then the government immediately

[15] Note that the flat tax rate can also be generalized by this class of tax functions. When κ_1 is set to zero and κ_2 is set to any positive number, the Gouveia and Strauss tax function collapses down to a proportional tax, i.e. $T(y) = \kappa_0 y$.

[16] I make this assumption for simplicity because the empirical estimates on parameters in Gouveia and Strauss tax function are not available for earlier years. Also, since the income brackets for marginal tax rates changed frequently after WWII and one period is 20 years in the model, it would be hard to measure the progressivity of income tax in each period.

Table 3
The fiscal policy changes following WWII.

	1921–1940	1941–1960 (following WWII)	1961–1980
Ave. marginal income tax rate	4%	22%	22%
Progressivity	Flat	Gouveia and Strauss tax function	Gouveia and Strauss tax function
The debt–GDP ratio	30%	68%	30%

Table 4
Characteristics on the transition path.

	Ini. stationary equilibrium	1st period (following WWII)	2nd period ...	New stationary equilibrium
Cohort fertility rate				
Data	2.41	3.20	2.70	
Benchmark exercise	2.40	2.72	2.72	2.71
Experiment 1 (no debt reduction)	2.40	2.64	2.64	2.63
Experiment 2 (flat tax rate)	2.40	2.63	2.72	2.71
Experiment 3 (no utility from g)	2.40	2.63	2.63	2.63
Experiment 4 (partial equi.)	2.40	2.72	2.72	2.71
Income elas. of fertility				
Data	−0.35	−0.17	−0.17	
Benchmark exercise	−0.36	−0.27	−0.27	−0.27
Experiment 2	−0.36	−0.38	−0.38	−0.38
Interest rate				
Benchmark exercise	4.1%	4.5%	5.0%	4.9%

adopts the new tax function and issues extra government debt so that the debt–GDP ratio rises to 68%.[17] In the next period, the tax function stays the same and but the debt–GDP ratio drops back to 30% to match the data during 1961–1980. Thereafter, the fiscal policies stay constant and the economy gradually converges to a new stationary equilibrium.

The main results of the quantitative exercise are demonstrated in Table 4. As can be seen, the average fertility rate increases significantly along the transition path after the fiscal policy changes are introduced. The magnitude of the fertility increase in the model is approximately 40% of the one observed during the postwar baby boom period in the US. This result shows that the fiscal policy changes following WWII may be an important reason why the fertility rate dramatically increased in the two decades after WWII in the US. However, since quantitatively there is still a large residual left unexplained in the model, it also suggests that there must be more than one force driving the postwar baby boom. As reviewed in the introduction, the other important causes of the baby boom include the technological progress in home production (Greenwood et al., 2005) and the competitive labor market for women after WWII (Doepke et al., 2012). It is worth noting that one limitation of this model is that it cannot generate a baby bust immediately following the baby boom as we observe in the data, which suggests that the baby bust was due to factors other than the fiscal policy changes. (See Fig. 7.)

3.4. Income taxes versus government debt

The income tax rate and the government debt both changed dramatically following WWII. As argued before, both may affect fertility choices in the model. A rise in the marginal income tax rate can increase fertility by reducing the opportunity cost of child-rearing, that is the after-tax wage. The government's debt policy also affects fertility choice in the model as government debt implies a tax burden on children in the future and thus affects their expected utility, which is an important determinant of fertility choice in the Barro–Becker model.[18] Therefore, it is interesting to understand which fiscal policy change is relatively more important for generating the baby boom.

To decompose the effects of these two policies on fertility, I run the following counterfactual experiment (Experiment 1), in which I redo the main quantitative exercise but keep the government-debt ratio constant after the first period on the transition path. That is, after the government-debt ratio rises to 68% in the first period following WWII, the government

[17] Here I model how the war changed the income tax rates and the debt levels, but do not explicitly model the war expenses. I think this strategy is appropriate here because of the following reasons. The war expenses may have other immediate effects on the government's budget. However, one model period here is 20 years and in the longer term the effects of the war on the government should be mainly through changing the tax rate and debt level. Furthermore, the peak of the baby boom was in late 1950s. Thus, the immediate effects of the war expenses may not be important for understanding the role of the war in the baby boom.

[18] Note that since I exogenously feed in the time series of taxes in the model, leaving more government debt to the future would simply affect children's utility by reducing future government expenditures via the government's budget constraint.

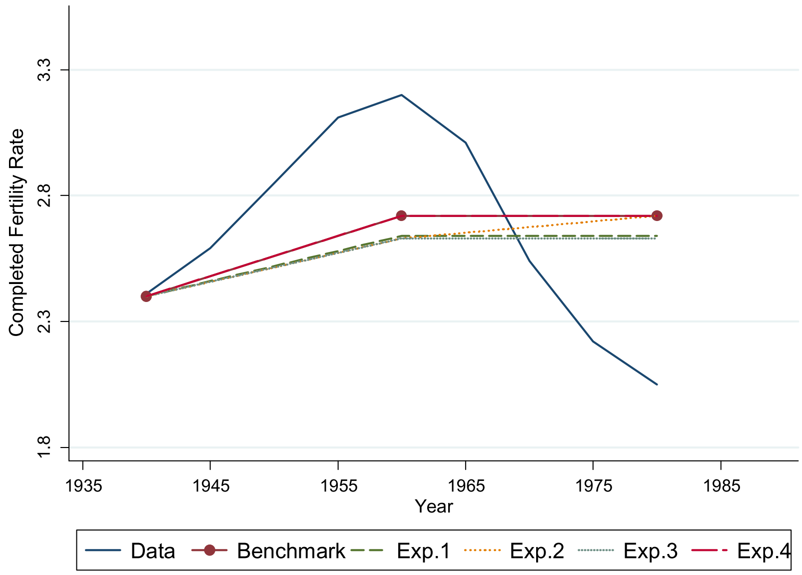

Fig. 7. The main results. Data source: Jones and Tertilt (2008).

chooses not to pay down the war debt and keeps the government-debt ratio at 68% thereafter. The results of this experiment are also reported in Table 4. As can be seen, the baby boom generated along the transition path is smaller than that in the benchmark exercise. Quantitatively, the magnitude of the baby boom in this experiment is 75% of that in the benchmark exercise, and is 30% of the one observed during the postwar baby boom period in the US. The reason for that is simple. When the government chooses not to pay down the war debt, the parents expect their children's utility in the future to be lower, and thus choose to rear fewer children, partially offsetting the positive effect of higher income tax rates on fertility.[19] This result means that if the government did not pay down the war debt immediately after WWII, the size of the baby boom would have been smaller than the one actually happened. This result also suggests that the change in income taxation was quantitatively much more important than the government debt policy in accounting for the baby boom.

3.5. *Cross-sectional properties*

As first documented by Jones and Tertilt (2008), there exists another interesting and related empirical observation over the postwar baby boom period. That is, richer households experienced a larger baby boom (see Fig. 9).[20] As a result, the fertility differential between the poor and the rich shrank significantly during the baby boom period, which was labeled as "the compression of fertility" by Jones and Tertilt (2008).[21] I argue that a successful theory about the baby boom should also be able to account for the simultaneous change in the fertility–income relationship. One way of measuring the change of the fertility–income relationship is to look at the change in income elasticity of fertility during the baby boom period. As shown in the bottom half of Table 4, the income elasticity of fertility in the US was −0.35 prior to WWII, but it became −0.17 after the baby boom. As can be seen, the model can also generate the change in income elasticity of fertility. In the benchmark exercise, the income elasticity of fertility changed from −0.36 to −0.27 during the baby boom period. Quantitatively, the change in income elasticity of fertility in the benchmark exercise is about 50% of that in the data. In other words, while the model can account over a third of the baby boom in the two decades following WWII, it can also account for half of "the compression of fertility" over the same period. Fig. 9 also demonstrates the size of the baby boom by income generated in the model. As can be seen in Fig. 9(b), while the fertility rate increased by 13% for the whole population, it increased by 11% for the poor and by 17% for the rich. This is consistent with the data.

The reason for this result is simple. As the US income taxes switched from a flat tax rate (for most Americans) to progressive income tax rates after the beginning of WWII, richer Americans experienced a larger increase in the marginal income tax rate, and thus had a larger baby boom. To further illustrate the importance of progressive income taxation in

[19] As explained in footnote 18, in this case the parents expect their children's utility in the future to be lower because the interest expenses on the debt will be higher and thus the future government expenditures will be lower.

[20] As shown in Fig. 9(a), women in the bottom half only had an increase of 0.70 children, while the women in the top half of the income distribution had 0.88 more children during the baby boom. This property would be even more evident if the size of the baby boom is measured by percentage change because the fertility rate among richer households was much lower before the baby boom. As demonstrated in Fig. 9(b), while completed fertility rate increased by 33% for the whole population, it only increased by 27% for the poor, and by 40% for the rich.

[21] This fact can be very important as existing studies have shown that differential fertility has important aggregate and distributional effects. For example, see de la Croix and Doepke (2003, 2004), Zhao (2011).

generating the cross-sectional feature of the baby boom, I conduct a counterfactual experiment (Experiment 2) in which everything else is the same as in the benchmark quantitative exercise except that the income tax rate changed from a flat rate of 4% to a flat rate of 22% following WWII. The results of this experiment are also reported in Table 4. As can be seen, when the income taxes were not progressive, the income elasticity of fertility (the absolute value) does not decrease during the baby boom, instead, it increases slightly.

4. Further analysis

4.1. Utility-increasing government expenditures

Government expenditures in this model are assumed to be utility-increasing, as such they can be interpreted as expenditures on things such as infrastructure. It is worth noting that some existing studies have assumed that government expenditures do not generate utility for simplicity.[22] I argue that when it comes to the Barro–Becker model of endogenous fertility, it is important to carefully capture the effect of government expenditures on individual utility. This is because the utility effect of government expenditures determines children's expected utility level, which is an important determinant of fertility choice in the Barro–Becker model. When government expenditures generate more utility, children's expected utility would be higher, and thus the parent would like to rear more children. To see this point more clearly, I run the following counterfactual experiment (Experiment 3), in which government expenditures are assumed to generate no utility. I recalibrate the relevant parameters using the same moments and redo the quantitative exercise. The results of this experiment are also reported in Table 4. As can be seen, the fertility increase along the transition path is smaller than in the benchmark exercise. Quantitatively, the magnitude of the fertility increase in this experiment is 72% of that in the benchmark exercise. The reason for that is as follows. When government expenditures do not generate utility, increasing the income tax rate and thus government expenditures means that more resources are wasted. This implies a lower utility level for children, which discourages the parent to rear children. This mechanism partially offsets the positive effect of a higher income tax rate on fertility.

4.2. Progressive income tax

As argued in Section 3.5, the progressive income tax was the reason why richer Americans experienced a larger baby boom. In fact, the progressive income tax does not only affect the distribution of fertility, but also affect the average fertility rate. As can be seen in Experiment 2 (in which the income tax is not progressive), the fertility rate increased only by 0.23 along the transition path, which in magnitude is only 72% of that in the benchmark exercise.

The reason for this result is related to the tradeoff between the price effect and the income effect of a higher income tax rate. A higher income tax rate has the income and price effects on fertility. The price effect is that a higher income tax rate reduces the opportunity cost of child-rearing and thus increases fertility. The income effect is that a higher income tax rate lowers disposable income and thus reduces the demand for children (fertility). The net effect is positive because usually the price effect is dominating in the Barro–Becker model with empirically relevant parameter values. If the income tax was flat, raising the income tax rate from 4% to 22% would reduce disposable income by more, and thus having a larger income effect on fertility. As a result, the net effect of raising the income tax rate on fertility becomes smaller than in the benchmark exercise.

4.3. General equilibrium effect

A higher average fertility rate reduces labor supply, and it may also change the population structure and thus affecting the capital–labor ratio.[23] On the other hand, as pointed out by Diamond (1965), government debt (internal debt) has a crowding out effect on aggregate capital. Therefore, the fiscal policy changes in the model may have general equilibrium effects. This point can be confirmed by looking at how the interest rate changes on the transition path in the benchmark exercise. As can be seen, the interest rate increases from 4.1% to 4.5% immediately after the fiscal policy changes are introduced, and it eventually rises to 4.9% in the new stationary equilibrium.

To understand whether the general equilibrium effects are important for obtaining the main result, in this section I conduct the counterfactual experiment (Experiment 4), in which I redo the main quantitative exercise in a partial equilibrium environment. That is, I fix the interest rate in the initial equilibrium (i.e. 4.1%), and then shock the economy by introducing the fiscal policy changes and compute the transition path along which the economy eventually converges to a new stationary equilibrium. The results are also reported in Table 4. As can be seen, the main results do not change significantly, suggesting that the general equilibrium effects are not the main reason why the main results are obtained.

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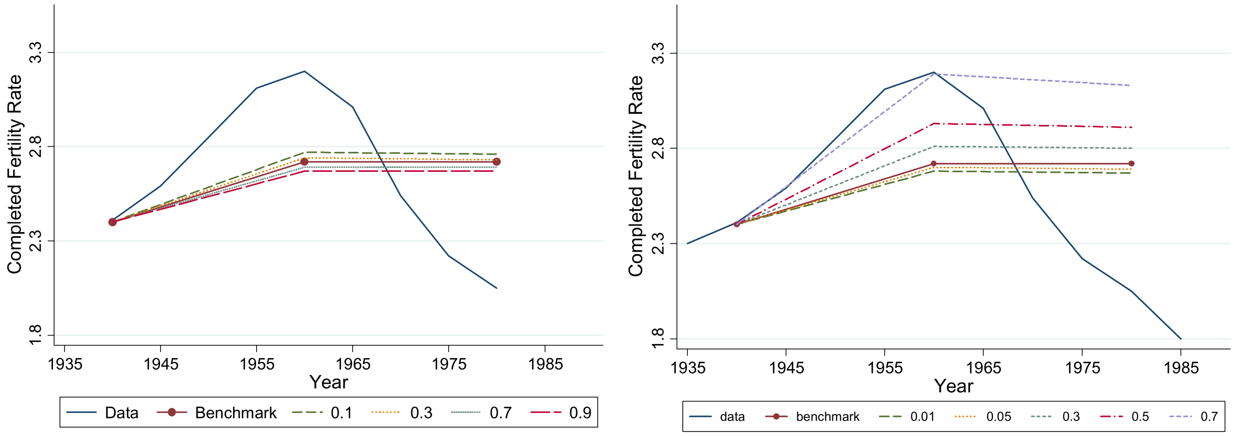
[22] Another reason for their assumption may be that empirical studies have found little substitutability between private consumption and government expenditures, and thus whether or not to include government expenditures into the utility function does not matter for agents' decisions.

[23] In the model, the capital is provided by the old-age cohort and the labor is from the middle-age cohort. Therefore, when the fertility rate increases, the population share of the old age decreases, and so does the capital–labor ratio.

Table 5
Sensitivity analysis results.

	Ini. stationary equilibrium	1st period (following WWII)	2nd period ...	New stationary equilibrium
Cohort fertility rate				
Data	2.41	3.20	2.70	2.05
$\sigma = 0.1$	2.40	2.77	2.76	2.76
$\sigma = 0.3$	2.40	2.74	2.73	2.73
$\sigma = 0.5$ (benchmark)	2.40	2.72	2.72	2.71
$\sigma = 0.7$	2.40	2.69	2.69	2.69
$\sigma = 0.9$	2.40	2.67	2.67	2.67
$\theta = 0.01$	2.40	2.68	2.67	2.67
$\theta = 0.05$	2.40	2.70	2.69	2.69
$\theta = 0.1$ (benchmark)	2.40	2.72	2.72	2.71
$\theta = 0.3$	2.40	2.81	2.80	2.80
$\theta = 0.5$	2.40	2.93	2.91	2.90
$\theta = 0.7$	2.40	3.19	3.13	3.12



(a) Sensitivity Analysis Results: σ (b) Sensitivity Analysis Results: θ

Fig. 8. The fertility rates on the transition path. Data source: Jones and Tertilt (2008).

4.4. Sensitivity analysis

The risk aversion parameter in the CRRA utility function, σ, is an important parameter in the model. There is no consensus on the value of σ in the fertility literature, while most studies in the fertility literature choose a value between zero and one for σ (i.e. $\sigma \in (0, 1)$).[24] In the benchmark calibration, I set σ to be 0.5 following Doepke (2005). Here I explore some other values (i.e. 0.1, 0.3, 0.7, and 0.9) for σ as robustness check. For each value of σ, I recalibrate the model to match the same moments used in the benchmark calibration, and redo the quantitative exercise. The results are shown in Table 5 and Fig. 8(a). As can be seen, the size of the baby boom generated in the model becomes smaller as the value of σ increases, but quantitatively the results do not change dramatically. Note that the negative relationship between the size of the baby boom and the value of σ is simply because the income effect of a higher income tax rate increases in the value of σ.

Another key parameter in the model is the curvature on the number of children, θ. It directly affects the size of the baby boom in this model. However, there is no empirical estimate for it in the existing literature. In the benchmark calibration, I calibrate the value of θ to match the income elasticity of fertility estimated in the data. In this section, I try alternative values for θ as robustness check. The results are shown in Table 5 and Fig. 8(b). As can be seen, the value of θ is positively correlated with the magnitude of the baby boom, which is consistent with the model prediction. Furthermore, even when the value of θ is set to be as low as 0.01, the model can still generate a significant baby boom.

5. Conclusion

In this paper, I study the role of the fiscal policy changes following WWII for understanding the postwar baby boom. I find that the dramatic increase in the marginal income tax rate was an important cause of the postwar baby boom in

[24] This assumption guarantees a positive utility function, which is necessary for the Barro–Becker model of endogenous fertility.

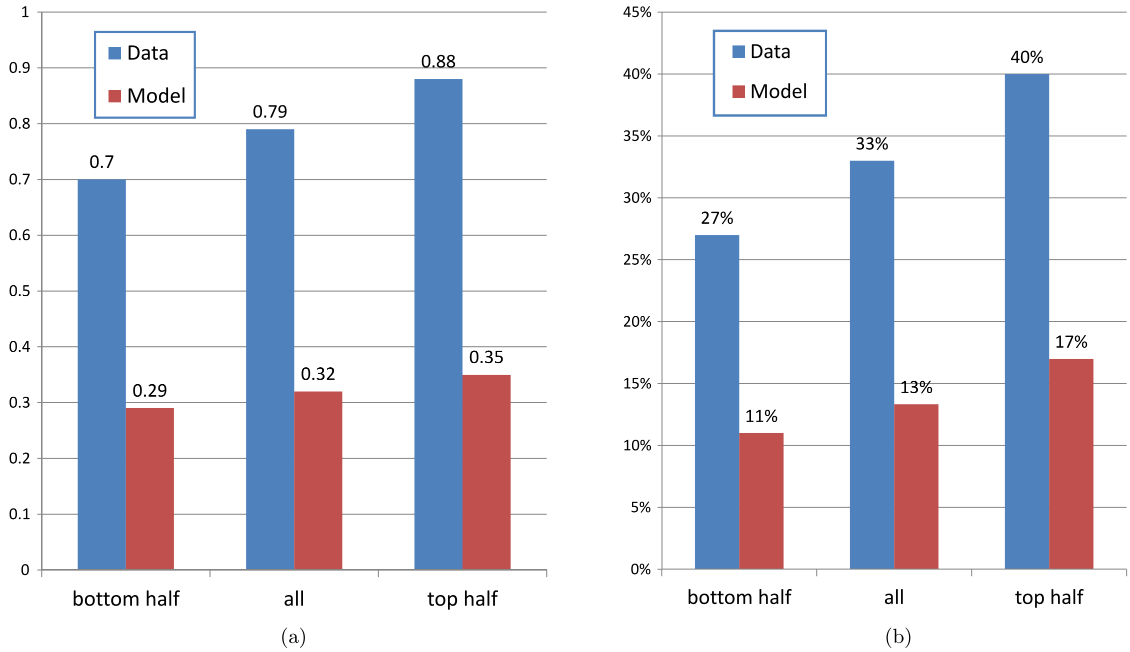


Fig. 9. Cross-sectional properties of the baby boom: model vs data. Data source: Jones and Tertilt (2008).

the US because it lowered the after-tax wage and thus the opportunity cost of child-rearing. I also find that the differential change in taxes by income was an important reason why the baby boom was more pronounced among richer households (as documented by Jones and Tertilt, 2008). Furthermore, I show that the government's debt policy also matters for understanding fertility choices because government debt implies a tax burden on children in the future and thus affects children's utility, which is a key determinant of fertility choice in the Barro–Becker model. The results of the quantitative exercises show that with reasonable parameter values, the model accounts for over a third of the postwar baby boom in the US, and it can also account for the fact that the baby boom was more pronounced in richer households.

Appendix A. Theoretical analysis

In this section, I derive some theoretical results in a simplified version of the model to provide the intuition about how fiscal policy changes affect fertility choices.

I simplify the model in three ways: (1) individual heterogeneity is assumed away, and agents are identical within each generation; (2) the prices r_t and w_t are exogenously determined; and (3) the labor income tax function $T(.)$ is simply assumed to be a proportional tax rate, τ. In this simplified model, each middle-age agent in period t faces the following problem:

$$V_t = \max_{c,n} u\left(c_t^m\right) + \beta u\left(c_{t+1}^o\right) + \beta n_t^\theta V_{t+1} + \nu(g_t) + \beta \nu(g_{t+1}) \tag{14}$$

s.t.

$$c_t^m + \frac{c_{t+1}^o}{1 + r_{t+1}} + n_t b w_t (1 - \tau_t) = w_t - T(w_t), \tag{15}$$

where V_{t+1} is the utility function of a representative child. Note that $\theta \in (0, 1)$ and the altruism weight γ is assumed to be one.

The following equation can be derived from the first order conditions,

$$u'\left(c_t^m\right) b w_t (1 - \tau_t) = \beta\theta n_t^{\theta-1} V_{t+1}, \tag{16}$$

where $c_t^m = \frac{(1-\tau_t) w_t (1-n_t b)}{\beta^{1/\sigma}(1+r_{t+1})^{(1-\sigma)/\sigma}+1}$. Substituting $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$ in the above equation, and after some algebra,

$$\frac{(\frac{\beta\theta V_{t+1}}{b})^{1/\sigma}[w_t(1-\tau_t)]^{1-1/\sigma}}{\beta^{1/\sigma}(1+r_{t+1})^{(1-\sigma)/\sigma}+1} = \frac{n_t^{(1-\theta)/\sigma}}{1-n_t b}. \tag{17}$$

Eq. (17) states how the current fertility decision n_t can be affected by other key variables, such as τ_t and V_{t+1}.

Proposition 1. *Under the standard assumptions of the Barro–Becker model*: (1) $0 < \theta < 1$; (2) $0 < \sigma < 1$, *the following two statements are true*:

1. $\tau_t \uparrow \Rightarrow n_t \uparrow$;
2. $V_{t+1} \uparrow \Rightarrow n_t \uparrow$.

Proof. The two statements can be simply derived from Eq. (17). The first statement follows from the fact that the left-hand side (LHS) of Eq. (17) is increasing in τ_t, and the RHS of Eq. (17) is increasing in n_t. The second statement is from the fact that the LHS of equation is increasing in V_{t+1}, and the RHS of equation is increasing in n_t. □

The first statement of Proposition 1 says that a rise in labor income tax rate increases fertility. The intuition for that is simple. A rise in labor income tax rate reduces the cost of child-rearing. The second statement of Proposition 1 says that parents would choose to have more children if they expect their children will live a better life. This is simply because under the standard assumptions of the Barro–Becker model, the quality of children and the quantity of children are complements. One implication of the second statement is that government debt policy may affect fertility via changing children's utility. Since government debt implies a tax burden on children in the future, leaving less debt to the future increases children's utility and thus encourage parents to have more children.

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