# War debt and the baby boom

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**Abstract**

In this paper, I argue that an important cause of the postwar baby boom in the US was the dramatic reduction in government debt (via income taxation) in the two decades following WWII. A reduction in government debt (via income taxation) increases fertility by changing the tax burden of different generations. A higher current income tax increases fertility by lowering after-tax wage and therefore the opportunity cost of child-rearing (when the cost of child-rearing involves parental time). A lower government debt level implies a lower tax burden on children in the future and thus a higher lifetime utility for them, which also increases current fertility if parents have Barro-Becker type preferences (the children's utility is included in the parents' utility function). The United States government accumulated a large amount of debt from WWII. The debt-GDP ratio peaked at 108% in 1946, and the debt level was reduced significantly (via taxation) in the following two decades. The debt-GDP ratio was only 35% in 1966. In a quantitative Barro-Becker model with government debt, I show that a reduction in government debt (financed by income taxation) such as the one experienced by the postwar US can generate a significant increase in fertility, which in magnitude accounts for 48% of the postwar baby boom in the US.

**Keywords:** Fertility, Baby boom, Government debt, WWII.
**JEL** Classifications:

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# 1 Introduction

The United States experienced a massive baby boom during the two decades following the Second World War. 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 increased to 3.2 for the cohort of women born in 1931-1935 (who completed most of their fertility by the 1960s).[1] Simultaneously, the government debt-GDP ratio dropped dramatically, from 108% in 1946 to 35% in 1966. Both patterns are demonstrated in Figure 1.

What impact does the government's debt policy have on fertility? Is there a role for the postwar US debt policy in accounting for the postwar baby boom in the US? I ask these questions in this paper. To answer them, I develop a general equilibrium and overlapping-generation model with endogenous fertility and heterogeneous agents. 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 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 (1988), Becker and Barro (1989)). 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 old-age savings. In the benchmark model, the children and old-age agents make no economic decisions. There exist government debt and labor income tax in the economy, and a change in government debt affects agents' behaviors by changing the labor income tax rates through the government's budget constraint. For simplicity, I assume that the parents have no ability to change their children's utility in the benchmark model (through bequest or human capital investment), and a standard Cobb-Douglas production technology on the production side.

I find that a reduction in government debt (via income taxation) in the model can significantly increase fertility. The mechanisms are twofold. First, a reduction in debt (financed by income tax) increases fertility by changing the tax burden of different generations. A higher current income tax rate increases fertility as it reduces the after-tax wage and thus the opportunity cost of child-rearing (when the cost of child-rearing involves parental time). A lower debt level implies a lower tax burden on children in the future and thus a higher lifetime utility for them, which also increases fertility if parents have Barro-Becker type preferences (the children's utility is included in

[1] A similar pattern is observed in the data for total fertility rate. The total fertility rate was 2.5 in 1945, and it rose to 3.8 in 1957 (see the dot line in Figure 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.

the parents' utility function). Second, the reduction in government debt also increases fertility via general equilibrium effects. As pointed out by Diamond (1965), government debt (internal debt) has a crowding out effect on aggregate capital stock. Therefore, a reduction in government debt can boost the aggregate capital stock of the economy, which in turn implies higher wage rates and lower interest rates in the next period. Higher wages in the future raise children's utility, thus they also increase fertility in the same way as a lower future tax burden.

To assess the quantitative importance of the above-described mechanisms, I conduct the following quantitative exercise. First, I calibrate the model such that the initial stationary equilibrium matches some moments of the US economy prior to the baby boom. Then, I shock the stationary equilibrium by temporarily raising the labor income tax rate to pay back a part of the existing debt and drive down the debt-GDP ratio to the post-baby boom level.[2] I compare the transition path with the postwar baby boom in the US. I find that the transition path generated by the policy shock mimics the postwar baby boom in the US. The fertility rate jumps immediately when the policy shock hits, and then drops in the following period, as in the baby boom in the US during the two decades after WWII and the baby bust directly following it. Quantitatively, the magnitude of the baby boom generated in the model accounts for 48% of that observed in the data.

An important assumption adopted in this paper is that the government imposed higher income tax rates on people after WWII to drive down the debt-GDP ratio.[3] Is it true that the US government taxed people heavily after the war in order to drive down the debt level? Some supporting evidence 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 and to be reasonably prepared against contingencies. ..."

[2]Note that a higher labor income tax rate is not the only reason that the debt-GDP ratio goes down. The GDP growth also drives down the debt-GDP ratio even the tax rates are constant. In this quantitative exercise, I also take into account the effect of growth on the debt-GDP ratio over this period.

[3]Note that here I mean the postwar income tax rates are higher compared to the prewar tax rates. The income tax rates during the war could be extremely high for other reasons (paying for the direct cost of the war, etc.).

——————**President Harry S. Truman, April 1, 1948**

<<***Truman's Veto of the Income Tax Reduction Bill***>>

From this letter, it is clearly seen that President Truman favored on debt reduction over tax cuts after the war was over. This reflects that the postwar US government did want to drive down the debt level by keeping the income tax rates at relatively high levels. Figure 2 plots the US federal income tax rates (top and bottom income brackets).[4] As can be seen, after WWII the income tax rates did not go back to the prewar levels, instead they remained high for the following two decades. Especially, the top bracket rate, which was below 30% in 1930, jumped above 90% at the end of WWII and remained at around 90% throughout the whole baby boom period. The bottom tax rate also demonstrated a similar pattern. Figure 3 plots the effective income tax rate for the median income family in the US, which showed a similar pattern with the marginal income tax rate. The effective income tax rate for the median income family was below 5% before 1940. It jumped above 20% during WWII and kept above 20% afterwards.

An important implication of the theory is that the income tax rates should go down after the baby boom. As can be seen in Figure 2, the top rate started to fall after the 1960s and it went down to around 30% again by the 1990s. A similar pattern is observed for the bottom tax rate. As shown in Figure 3, the drop in the effective income tax rate is also clear. The effective income tax rate (for the median income family) first experienced a significant drop in the middle of the 1960s and then another big drop at the beginning of the 1970s. Since then, the effective income tax rate has been around 15% for the median income family in the US.. Figure 3 shows that the median income family in the US faces a significantly lower tax burden after the baby boom than before. Note that, the welfare state has expanded dramatically in the last several decades in the US (see Figure 4). Therefore, if I only consider the tax rates attributed to the financing of government debt, the drop in income tax rate would be even larger after the baby boom.

Recently, there has been a growing literature that tries to account for the baby boom using quantitative macroeconomic models.[5] Several interesting explanations of the baby boom have been proposed. Greenwood, Seshadri, and Vandenbroucke (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

[4] Since the realistic income tax system is fairly complicated, and involves many income brackets and the number of income brackets varies over time, I only present the tax rates for the first income bracket and the top income bracket.

[5] Greenwood, Seshadri, and Vandenbroucke (2005), Doepke, Hazan, and Maoz (2007), Simon and Tamura (2007), etc.

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, Hazan, and Maos (2007). They argue that WWII produced a large number of women with work experience. Assuming that 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 emphasize 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. The difference is that Doepke et al. (2007) focus on how a more competitive labor market reduces the cost of child-rearing by lowering the market wage rates. I argue that what really matters is the after-tax wage rate and therefore focus on how government taxation reduces the after-tax wage rates and the cost of child-rearing. I also point out that the drop in the government debt-GDP ratio changes the parents' expectations about their children's utility in the future, another possible force causing the baby boom.

This paper is also related to Wildasin (1990), and Lapan and Enders (1990). Both papers study the role of government debt in a model with endogenous fertility, and demonstrate theoretically that a decrease in government debt can bolster fertility. However, they do not further quantify the effect of government debt on fertility, and they also do not relate their theories to the baby boom. To the best of my knowledge, this paper is the first to quantitatively investigate the effects of government debt on fertility and its explanatory power for the postwar baby boom in the US.

## 2 Cross-country Evidence

The baby boom phenomenon was not unique to the United States. Most 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 experienced a larger reduction in the debt-GDP ratio should have had a larger baby boom. Here I investigate whether this implication holds true in the data.

I investigate two groups of industrialized countries: 1) allied countries that did not fight on their own soil, and 2) neutral countries. [6] Figure 5 plots the time series of the debt-GDP ratio for the first group of countries (the United States, Canada, and Australia).[7] Figure 6 plots the time series of the debt-GDP ratio for the second group of countries (Sweden, Switzerland, and Portugal). All in the first group experienced a large reduction in the debt-GDP ratio after the war, while all in the second group did not. The model implies that the first group should have a larger baby boom than the second group. Figures 7 and 8 plot the time series of completed fertility rate by cohort for both groups of countries. I find that the first group of countries had a much larger baby boom than the second group, which is consistent with the model implication. It is worth mentioning that the cross-country evidence does not distinguish the explanation proposed here from other explanations which also emphasize the role of WWII in accounting for the postwar baby boom, such as the explanation proposed in Doepke et al. (2007).

# 3 The Model

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 $\epsilon$ and is endowed with one unit of time which can be used to work or rear children. The middle-aged agent chooses her fertility, middle-age consumption, and old-age saving. No decisions are made in childhood, and the old-age agent only consumes what she saves from the middle age. For simplicity, I assume that the parent does not have the ability to change the children's utility in the benchmark model (through bequest or human capital investment).[8]

Assume that the agent has Barro-Becker type preferences (the children's utility is included in her utility function). The following is the lifetime utility function of the agent with productivity, $\epsilon$,

$$u(c_m) + \beta u(c_o') + \beta\gamma n^{\theta} E[V'(\epsilon') \mid \epsilon] \tag{1}$$

with

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}. \tag{2}$$

[6]Here I exclude the countries that fought on their own soil during WWII for the following reason: besides the government debt problem, these countries also needed to deal with postwar reconstruction, which has similar effects on fertility as government debt, according to the theory. This reconstruction problem may distort the true correlation between government debt and fertility among these countries

[7]New Zealand is not included because of the lack of data.

[8]I extend the model to include intergenerational transfers in the appendix.

The first term represents the utility from middle-age consumption which is denoted by $c_m$. The second term represents the utility from old-age consumption $c_o'$. The third term represents the parent's altruism toward her children. Note that $n$ is the number of children, $V'(.)$ is the value function of children, and $\epsilon'$ is the children's productivity which is unknown to the middle-age parent. Note that $\gamma$ is the weight on altruism, and $\theta$ is the curvature on the number of children. The agent faces the following budget constraints:

$$s + c_m = (1-\tau)\epsilon w(1-bn), \tag{3}$$

$$c_o' = (1+r')s, \tag{4}$$

where $\tau$ is the labor income tax, and $s$ is the saving for old age. The wage and interest rate are represented by $w$ and $r'$ respectively. The cost of rearing a child is $b(1-\tau)\epsilon w$, a fraction, $b$, of the parent's lifetime earnings. A natural interpretation of $b$ is that child-rearing needs parental time, therefore the cost of child-rearing is the forgone earnings.[9]

The middle-age agent's problem (P1) can be written as a Bellman equation,

$$V(\epsilon) = \max_{n,s} u(c_m) + \beta u(c_o') + \beta\gamma n^{\theta} E[V'(\epsilon') \mid \epsilon] \tag{5}$$

s.t.

$$s + c_m = (1-\tau)\epsilon w(1-bn),$$

$$c_o' = (1+r')s,$$

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

$$Y = K^{\alpha}(AL)^{1-\alpha}. \tag{6}$$

Let $\alpha \in (0,1)$, and let capital depreciate at a rate of $\delta$. The firm chooses capital $K$ and labor $L$ by maximizing profits $Y - wL - (r+\delta)K$. The labor-augmented technology $A$ is assumed to grow at a rate of $g$.

The productivity shock $\epsilon \in \{\epsilon_1, \epsilon_2, ..., \epsilon_m\}$, is governed by a Markov chain with transition matrix $\pi(i,j) = Prob(\epsilon' = \epsilon_j | \epsilon = \epsilon_i)$. The Markov chain is approximated from the log-normal

[9] 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.

AR(1) process

$$\ln \epsilon' = \rho \ln \epsilon + u', u' \sim N(0, \sigma_u^2), \tag{7}$$

where $\rho$ is the intergenerational persistence coefficient.

Denote the distribution of the middle-age generation by the density function $\Phi(\epsilon)$. The market clearing conditions are:

$$K = \frac{N_{-1}}{N} \sum_{i=1}^{m} \Phi_{-1}(\epsilon_i) f_{-1}^{s}(\epsilon_i), \tag{8}$$

and

$$L = \sum_{i=1}^{m} \Phi(\epsilon_i)\epsilon_i(1 - bf^n(\epsilon_i)). \tag{9}$$

Here $f^s(.)$ and $f^n(.)$ represent the agent's decision rules for saving and fertility. The law of motion for the population measure of each generation, $N$, is as follows:

$$N' = N \sum_{i=1}^{m} \Phi(\epsilon_i) f^n(\epsilon_i), \tag{10}$$

and the law of motion for the density function $\Phi(\epsilon)$ is,

$$\Phi'(\epsilon_j) = \frac{N}{N'} \sum_{i=1}^{m} \Phi(\epsilon_i) f^n(\epsilon_i)\pi(i,j), \forall j \in \{1, 2, ..., m\}. \tag{11}$$

I assume that there exists government debt in the economy, which is denoted by $B$ (per middle-age person). The government's budget constraint (per middle-age person) can be written as follows,

$$(1 + r)B = \frac{NB'}{N'} + w \sum_{i=1}^{m} \Phi(\epsilon_i)\epsilon_i(1 - bf^n(\epsilon_i))\tau. \tag{12}$$

I assume that the government's debt policy at the stationary equilibrium is to keep the government debt-GDP ratio constant, and the labor income tax rate is the only tax tool available to the government.[10] It is easy to see that this policy implies that the amount of government debt per middle-age person is also constant in the stationary equilibrium, $(1 + g)B = B'$. The government's

[10] I abstract from capital income tax in this paper for simplicity. However, it would be interesting to think about the effect of capital income tax on fertility. For example, capital income tax does not reduce the parents' child-rearing cost, but it may encourage the parents to substitute old-age savings for children.

budget constraint (per middle-age person) becomes,

$$\left[1 + r - (1+g)\frac{N}{N'}\right] B = w \sum_{i=1}^{m} \Phi(\epsilon_i)\epsilon_i(1 - bf^n(\epsilon_i))\tau. \tag{13}$$

**Definition 1** *A* ***competitive equilibrium*** *consists of a set of prices* $(r, w)$*, a set of government policy parameters* $(\tau, B)$*, laws of motion for* $K$*,* $L$*,* $N$*, and* $\Phi$*, the agent's value functions* $V(.)$*, and policy functions* $f^n(.)$*, and* $f^s(.)$*, such that:*

1. *given the prices and government policy parameters, the value function* $V(.)$ *and the policy functions* $\{f^n(.), f^s(.)\}$ *solve the agent's problem (P1);*

2. *the firm's choices maximize its profits;*

3. *the prices* $w$ *and* $r$ *clear the markets, i.e. conditions (8) and (9) are satisfied;*

4. *the population of each generation,* $N$*, evolves according to (10) ; and the distribution evolves according to (11);*

5. *the government budget constraint* (12) *is satisfied.*

When the equilibrium is stationary, the following should be true: 1) $r$, $\frac{K}{AL}$, $\tau$, $\Phi$, and $f^n(.)$ are constant; 2) $B$, $w$, and $f^s(.)$ grow at the rate of $g$; 3) $L$ and $N$ grow at a constant rate that is equal to the population growth rate; 4) the value function $V(.)$ evolves according to $V'(.) = (1+g)^{1-\sigma}V(.)$.

# 4 Theoretical Analysis

In this section, I derive two propositions in a simplified version of the model to provide some intuition about how a change in government debt affects fertility via income tax rates and general equilibrium effects.

I simplify the model in two ways: 1) individual heterogeneity is assumed away, and agents are identical within each generation; and 2) the prices $r_t$ and $w_t$ are exogenously determined. In this simplified model, each middle-age agent in period t faces the following problem.

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

s.t.

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

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

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

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

where $c_t^m = \frac{(1-\tau_t) w_t (1 - n_t b)}{\beta^{1/\sigma}(1+r_{t+1})^{(1-\sigma)/\sigma} + 1}$.

Using $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, and after some algebra,

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

Equation (17) states how the current fertility decision $n_t$ is determined. It can be seen that $n_t$ is a function of $w_t$, $\tau_t$, $r_{t+1}$, and $V_{t+1}$

**Proposition 1**: *When $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, the following two statements are true:*

1. $\tau_i \downarrow \Rightarrow V_{t+1} \uparrow$, *for any* $i \geq t + 1$.

2. $w_{t+1} \uparrow \Rightarrow V_{t+1} \uparrow$.

**Proof**: These two statements directly follow from the fact that $u'(c) > 0$.

**Proposition 2**: *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**: All three statements can be derived from equation (17). The first statement follows from the fact that the left-hand side (LHS) of equation (17) is increasing in $\tau_t$, and the RHS of equation (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 $n_t$.

Proposition 1 and 2 together give us the following two statements:

- The current income tax rate is positively correlated with fertility: $\tau_t \uparrow \Rightarrow n_t \uparrow$. Future income tax rates are negatively correlated with fertility: $\tau_i \downarrow \Rightarrow n_t \uparrow$, for any $i \geq t + 1$.

- The wage rate in the next period is positively correlated with fertility: $w_{t+1} \uparrow \Rightarrow n_t \uparrow$.

Recall that a reduction in government debt financed by income tax raises the current income tax rate and lowers the income tax rate in the future, thus causing fertility to rise (according to the first statement above). The second statement shows how general equilibrium effects cause fertility to rise. As argued in Diamond (1965), government debt (internal debt) has crowding out effect on aggregate capital. Therefore, a reduction in government debt boosts the aggregate capital stock of the economy, which in turn implies higher wage rates in the next period. According to the second statement above, this change in wage should also cause fertility to rise. The intuition behind is as follows: higher wages raise children's utility, thus also increasing fertility.

# 5 Quantitative Analysis

## 5.1 The Benchmark Calibration

In the remainder of the paper, I turn to numerical techniques and study to what extent the postwar US debt policy accounted for the postwar baby boom in the US. The quantitative strategy is as follows. First, I calibrate the initial stationary equilibrium so that it mimics the US economy right before the baby boom, i.e. the US economy in 1946, in which the government debt-GDP ratio was 108%. Then, I shock the stationary equilibrium by temporarily raising the labor income tax for one period to drive down the government debt-GDP ratio to 35%, which is the US debt level in 1966.[11] I compare the fertility time series on the transition path in the model with the postwar baby boom in the US.[12]

The length of a model period is assumed to be 20 years, which roughly represents the time gap between two generations in the real economy. There are in total 10 model parameters (see Table 1). I use the following calibration strategy to determine their values. I predetermine the values of some standard parameters based on the existing literature. Then I *simultaneously* choose the rest parameter values to match some empirical moments.

Based on the existing macroeconomics literature, I set the capital income share, $\alpha$, to 0.3, the yearly capital depreciation rate to 0.12 ($\delta = 1 - (1 - 0.12)^{20}$), and the yearly time discount rate

[11]Note that though I assume that the government temporarily raised income tax rates to drive down the debt-GDP ratio in the model, what really happened in the data is that the income tax rates were raised to an extremely high level during WWII, and after the war the US government kept the high income tax rates for the following two decades to drive down the debt-GDP ratio instead of cutting the income tax rates to the prewar level immediately (see Figures 2 and 3).

[12]Here I implicitly assume that the US economy in 1946 was in a stationary equilibrium, and it was chosen as the initial equilibrium. In the section of sensitivity analysis, I evaluate how sensitive the main results of this paper are to the choice of the initial equilibrium by conducting an alternative quantitative exercise.

to 0.97 ($\beta = 0.97^{20}$). Following Doepke (2005), I set the value of $\sigma$ to 0.5. I also explore other values of $\sigma$ in the sensitivity analysis. The intergenerational persistence coefficient, $\rho$, is assumed to be between zero and one, which means that earning ability is mean-reverting over generations. This assumption is supported by a large amount of empirical evidence,[13] and it gives us the result that in this model the poor tend to have more children than the rich, which is a well-observed fact in the fertility data.[14] I set $\rho$ to 0.667 based on the empirical estimation by Zimmermann (1992). The time cost of child-rearing, b, is set to 0.075 according to Haveman and Wolfe (1995).[15]

The altruism weight, $\gamma$, 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 standard deviation, $\sigma_\mu$, 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 after WWII, which is 0.22 (Friesen and Miller (1983)).

As is standard in the Barro-Becker model, the curvature on the number of children, $\theta$, is assumed to be between zero and one, which means that the quality and the quantity of children are complementary.[16] Note that $\theta$ is a very important parameter in this model, since its value directly determines the size of the baby boom generated in our model. When $\theta$ 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 debt policy shock. When $\theta$ is closer to zero, the opposite is true. To the best of my knowledge, there is no empirical estimate of $\theta$ in the existing literature. Since $\theta$ also affects the magnitude of differential fertility (by income), in the benchmark calibration I choose the value of $\theta$ to match the actual magnitude of differential fertility by income among the cohort of women born between 1911-1915.[17] The benchmark calibration results in a value of 0.52

[13] Solon (1992), Zimmerman(1992), and Solon (2002).

[14] The reason why the poor tend to have more children in this model is as follows. Poor parents tend to have more children because they expect their children will have a relatively higher earnings ability than themselves and a higher utility. Furthermore, poor parents face a low opportunity cost of child-rearing because of the low price of their time. See Zhao (2011) for detailed explanation of the driving forces behind differential fertility. Jones, Schoonbroodt, and Tertilt (2008) provide a complete survey of the literature on differential fertility.

[15] 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.

[16] Jones and Schoonbroodt (2009) propose an alternative hypothesis, in which they assume that $\theta$ is larger than one. Therefore, the quality and quantity of children are substitutable. In their model, the mechanisms proposed in this paper would run in the opposite direction.

[17] Here we use the income elasticity of fertility as the measurement of differential fertility by income. The income elasticity of fertility is -0.35 among the cohort of women born between 1911 and 1915.

for $\theta$. In the sensitivity analysis, I try different calibration strategies for $\theta$. I choose the amount of government debt per middle-age person $B$ so that the debt-GDP is 108% in the initial stationary equilibrium, which matches the data in 1946.

As I argued earlier, economic growth reduces the debt-GDP ratio. Therefore, it is a key element in the model. I calibrate the growth rate of $A$, the labor-augmented technology, to match the post-WWII economic growth in the US. Figure 13 plots the post-WWII log real GDP in the US and its counterpart in the model. As we can see, the magnitude of economic growth in the model is consistent with the data. This calibration results in an annual growth rate of 1.6 percent for $A$ in the model, which is within the range of empirical estimation. As documented in Greenwood, Seshadri, and Vandenbroucke (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).

All the parameter values are summarized in Table 1. This set of parameter values give us a (yearly) interest rate of 5% in the initial equilibrium and 4% in the post-baby boom equilibrium. Table 1 summarizes the results of the benchmark calibration.

Table 1: Benchmark model calibration

| Parameter | Interpretation | Value |
|---|---|---|
| $\alpha$ | Capital share | 0.3 |
| $\delta$ | Capital depreciation rate | 0.12 (annual) |
| $\sigma$ | Elasticity of substitution | 0.5 |
| $\beta$ | Time discount factor | 0.97 (annual) |
| b | Time cost of children | 0.075 |
| $\rho$ | Intergen. persistence of the earning ability | 0.667 |
| $g$ | the rate of technological progress | 1.6% (annual) |
| $\sigma_\mu$ | Stand. dev. of the log of earnings ability | 0.32 |
| $\gamma$ | Altruism weight | 0.121 |
| $\theta$ | Curvature of utility of children | 0.52 |

## 5.2 The Main Results

The main results of the quantitative exercise are demonstrated in Figure 9. It can be seen that the model produces very good qualitative results under the benchmark calibration. The fertility rate rises immediately in the period when the policy shock hits, which mimics the baby boom.

Furthermore, the fertility rate drops quickly in the following period, mimicking the baby bust directly following the baby boom in the data. The magnitude of the baby boom generated in the model is 48% of the one observed in the data (the fertility numbers are reported in Table 2). Table 2 also reports the income tax rates on the transition path. It is clear that the labor income tax rate does increase dramatically in the period of policy shock. It jumps from 11.8% to 20% immediately and then drops to 2.4% in the following period. This pattern is also observed in the postwar data. However, the drop in the labor income tax rate after the baby boom is smaller in the data. This may be due to the fact that the size of the welfare state dramatically expanded after the 1960s, which drives the labor income rate in the opposite direction (see Figure 4). It is worth mentioning that I do not attempt to match the actual income tax rates in the data since part of the income taxes are attributed to the government services and welfare programs and the magnitude of these services and programs vary significantly over time.

Table 2: Characteristics On the Transition Path

| | Period 1 (pre-the baby boom) | Period 2 (hit by the policy shock) | Period 3 |
|---|---|---|---|
| fertility (data) | 2.41 | 3.20 | 2.05 |
| fertility (benchmark) | 2.41 | 2.79 | 2.53 |
| $\tau$ (benchmark) | 11.8% | 20.0% | 2.4% |
| fertility ($\theta = 0.88$) | 2.41 | 3.20 | 2.73 |
| fertility ($\theta = 0.1$) | 2.41 | 2.66 | 2.48 |

### 5.3 Cross-sectional Properties

One interesting cross-sectional property of the baby boom is that its size was larger among richer households. As demonstrated in Figure 10(a) the size of the baby boom was 0.79 children for the whole population. However, the women in the bottom half of the income distribution only had a baby boom 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 magnitude of the baby boom is measured by fertility increase in percentage. As demonstrated in Figure 10(b), while the completed fertility rate increases by 33% for the whole population, it only increases by 27% for the poor, and by 40% for the rich. This is due to the fact that the fertility of the rich was much lower than the poor before the baby boom. Because of the differential magnitudes of the baby boom by income, the fertility differential between the rich and the poor shrinks over the baby boom period, which is one of the main findings in Jones and Tertilt (2008).

The model can also generate results that are consistent with this cross-sectional property as long as the income tax rate is assumed to be progressive. The logic is as follows. A progressive income taxation system implies that the rich share a proportionally larger part of the tax burden. Therefore, the reduction in the debt-GDP ratio benefits the children of the rich more than those of the poor (if children of the rich are assumed to be also relatively rich). This means that the utility of children of the rich will increase by more, which gives the rich parents greater incentive to increase fertility. Furthermore, the progressivity of labor income tax implies that the rich pay proportionally more to finance the drop of the debt-GDP ratio. Thus, the opportunity cost of child-rearing drops more for the rich, which also gives them greater incentive to increase fertility.

Figure 11(a) demonstrates the magnitudes of the baby boom (by income) generated in the benchmark model, in which the labor income tax is not progressive. It is clear that the baby boom among the poor half of the households is as big as that among the rich half of the households. Figure 11(b) demonstrates the results from a computational experiment, in which the labor income tax is assumed to be progressive.[18] As we can see, the rich do have a larger baby boom than the poor when the labor income tax is progressive. When the debt policy hits, the rich increase their fertility by 19% while the poor's fertility only rises by 11%. Note that the progressivity of the labor income tax does not significantly change the magnitude of the baby boom at the aggregate level.[19] The comparison between Figure 11(a) and 11(b) clearly show that a progressive income tax can generate the differential magnitudes of the baby boom (by income) which are observed in the data (Jones and Tertilt (2008)).

Overall, the model can generate very good qualitative results. However, it is also obvious that the model cannot account for the entire baby boom in the US. The baby boom generated in this model is approximately 48% of the one observed in the data. Clearly, there is more than just my story behind the baby boom. In the next section, I do sensitivity analysis to examine the robustness of the results.

[18]To capture the progressivity of the labor income tax, I assume that agents with $\epsilon_i$ face a tax rate 20% higher than those with $\epsilon_{i-1}$ , for all $i = 2, 3, .., m$. That is, $\tau_i = (1+20\%)\tau_{i-1}$, for all $i = 2, 3, .., m$. $\tau_1$ is endogenously determined through the government's budget constraint. The reason why I do not quantitatively match the progessivity of income tax with the data here is because the progressivity of income tax is hard to measure and it varied significantly in the post-WWII period.

[19]This point is important since it shows that the assumption of a flat income tax in the benchmark model is a valid one and it does not significantly affect the main results of this paper. See the previous footnote for the reason for assuming a flat income tax instead of a progressive income tax.

## 6 Sensitivity analysis

The curvature on the number of children, $\theta$, is a key parameter in the model. 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 $\theta$ so that the model can match the income elasticity of fertility among the cohort of women born between 1911 and 1915. In this section, I try different calibration strategies for $\theta$. An alternative calibration strategy is to choose the value of $\theta$ to match the entire baby boom observed in the data (the fertility increase from the 1911-1915 cohort to the 1931-35 cohort.) This calibration strategy results in a value of 0.88 for $\theta$. I also try a value of 0.1 for $\theta$ as robustness check. The fertility time series on the transition path from these two exercises are plotted in Figure 9 (the numbers are reported in Table 2).[20] As can be seen in Figure 9, the value of $\theta$ is positively correlated with the magnitude of the baby boom, which is consistent with the model prediction. Furthermore, even when the value $\theta$ is set to be as low as 0.1, the model can still generate a baby boom as large as 32% of the postwar baby boom in the US. This strengthens the argument that the drop in the debt-GDP ratio after WWII was an important factor causing the postwar baby boom in the US.

Another important parameter is $\sigma$, the elasticity of substitution. There is no consensus on the value of $\sigma$ in the fertility literature, while most studies in the fertility literature choose a value between zero and one for $\sigma$ ($\sigma \in (0, 1)$).[21] In the benchmark calibration, I set $\sigma$ to be 0.5 following Doepke (2005). In this section, I also try the values of 0.25 and 0.75 for $\sigma$ as robustness check.[22] The results are shown in Figure 12. As can be seen, the results do not change dramatically as the value of $\sigma$ changes.

In the main quantitative exercise, I assume that the US economy was in a stationary equilibrium in 1946. People may argue that this assumption is not realistic. The US experienced several significant events in the 30s and 40s, i.e. the Great Depression and WWII, which suggest that the US economy during that period may not be at steady state. However, the nature of the quantitative exercise conducted in this paper determines that I have to choose an initial stationary equilibrium to start with. In order to evaluate how sensitive the main results of this paper are to the choice of the initial equilibrium, I conduct the following quantitative exercise here as sensitivity analysis:

[20] For each value of $\theta$, I recalibrate the model to match all the targets used in the benchmark calibration except the income elasticity of fertility.

[21] This assumption guarantees a positive utility function. Jones and Schoonbroodt (2009) study the case with the value of $\sigma$ above one.

[22] Again, for each value of $\sigma$, I recalibrate the model to match all the targets used in the benchmark calibration.

I calibrate the initial stationary equilibrium so that the debt-GDP ratio was 44% (which mimics the year of 1940). The initial economy is hit by a war shock (WWII) at the beginning of the period (before the production takes place), which drives up the debt-GDP ratio to 108%. Then the government immediately raises the income tax rate to pay back part of the debt within the same period so that the debt-GDP ratio drops down to 35% in the next period. Then I compare the transition path with the postwar baby boom in the US. I find that with this alternative strategy, the results are only slightly different from the benchmark results. With this alternative strategy, the model explains 45% of the postwar baby boom in the US.[23]

# 7 Conclusion

In this paper, I study the role of government debt policy in generating the postwar baby boom in the United States. I find that the dramatic reduction in the government debt-GDP ratio after WWII was an important cause of the baby boom in the US. A reduction in government debt (financed by income tax) changes the tax burden of different generations: it raises the current income tax rate and implies a lower tax burden on children in the future. A higher current income tax rate raises fertility by lowering the after-tax wage and therefore the opportunity cost of child-rearing (when the cost of child-rearing involves parental time). A lower tax burden on children in the future raises the children's lifetime utility, which also raises current fertility if the parent has Barro-Becker type preferences.

Furthermore, the reduction in the debt-GDP ratio also affects people's fertility choice through general equilibrium effects. Government debt (internal debt) has a crowding out effect on aggregate capital (see Diamond (1965)). Therefore, the reduction in government debt boosts the aggregate capital level, which in turn implies higher wage rates in the next period through general equilibrium effects. Higher wage rates in the future raise children's utility, thus also increasing fertility.

The quantitative exercise shows that, with reasonable parameter values, the model accounts for around a half of the postwar baby boom in the United States. Furthermore, the model also matches an interesting cross-sectional property of the baby boom: the size of the baby boom was much larger among richer households (documented in Jones and Tertilt (2008)). I argue that the progressivity of the US income tax system may be an important reason for this cross-sectional property of the baby boom.

[23] The detailed results are available from the author upon request.

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# 8 Appendix 1: A Model with Intergenerational Transfer

In this appendix, I show that the main qualitative results remain after adding bequest into the model. Now consider an economy in which parents are allowed to leave intergenerational transfers to their children. For simplicity, I assume away the old-age period. In other words, agents only live for two periods: childhood and adulthood. Now each adult in period t faces the following problem.

$$V_t = \max_{c,n} u(c_t) + \beta n_t^{\theta} V_{t+1} \tag{18}$$

s.t.

$$c_t + n_t b w_t(1-\tau_t) + n_t a_{t+1} = w_t(1-\tau_t) + (1+r_t)a_t, \tag{19}$$

where $a$ is the intergenerational transfer, which could be either bequest or human capital investment.

Following Barro and Becker (1989), I reformulate the problem as a dynastic problem.

$$V_0 = \max_{c,n} \sum_{t=0}^{\infty} \beta^t (N_t)^{\theta} u(c_t) \tag{20}$$

s.t

$$c_t + n_t b w_t(1-\tau_t) + n_t a_{t+1} = w_t(1-\tau_t) + (1+r_t)a_t, \forall t, \tag{21}$$

where $N_t = \prod_{i=0}^{t-1} n_t$ for $t = 1, 2, ...(N_0 = 1)$ is the number of adults in period t. The standard first order conditions are as follows,

$$\frac{u'(c_t)}{u'(c_{t+1})} = \beta(1+r_{t+1})n_t^{\theta-1}. \tag{22}$$

$$(\theta+\sigma-1)u(c_t) = u'(c_t)[bw_{t-1}(1-\tau_{t-1})(1+r_t) - w_t(1-\tau_t)]. \tag{23}$$

Assuming $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, and equation (22) can be rewritten as,

$$c_t = \frac{1-\sigma}{\theta+\sigma-1}[bw_{t-1}(1-\tau_{t-1})(1+r_t) - w_t(1-\tau_t)]. \tag{24}$$

Combining (21) and (23),

$$\frac{bw_{t-1}(1-\tau_{t-1})(1+r_t) - w_t(1-\tau_t)}{bw_t(1-\tau_t)(1+r_{t+1}) - w_{t+1}(1-\tau_{t+1})} = (\beta(1+r_{t+1}))^{-1/\sigma} n_t^{(1-\theta)/\sigma} \tag{25}$$

Equation (25) tells us that how the current fertility is determined. The following proposition states how the tax rates affect the current fertility decision in the model with intergenerational transfer.

**Proposition 3**: *Under the standard assumptions of the Barro-Becker model: 1)* $0 < \theta < 1$*; 2)* $0 < \sigma < 1$*; 3)* $\theta + \sigma > 1$*; 4) children are a net financial burden to altruistic parents, the following two statements are true:*

1. $\tau_t \uparrow \Rightarrow n_t \uparrow$
2. $\tau_{t+1} \downarrow \Rightarrow n_t \uparrow$.
3. $w_{t+1} \uparrow \Rightarrow n_t \uparrow$.

**Proof**: The proofs for these three statements are similar with the proofs for proposition 2.

Proposition 3 shows that the main qualitative results of this paper remain after I add intergenerational transfer into the model. However, it is worth noting that the intergenerational link may affect the quantitative results. The quantitative importance of intergenerational link would be largely depend on how it is modeled, e.g. how strong the parent's altruistic motive is, how effective the parent can affect her children's human capital.

# 9 Appendix 2: Government Debt and Fertility in A Historical Perspective

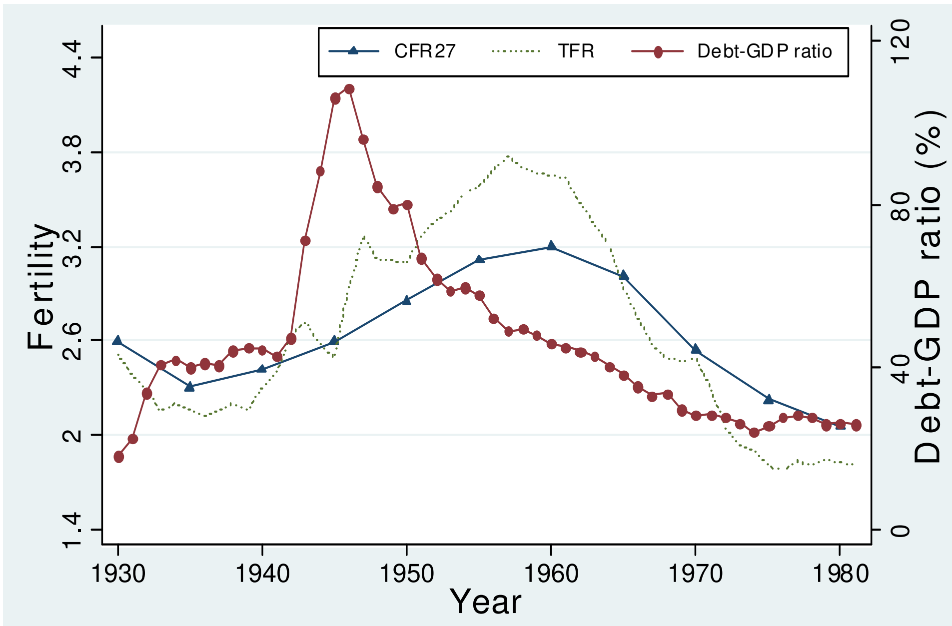
It is also interesting to examine whether the correlation between government debt and fertility holds true in other time periods. Figure 14 plots the federal government debt-GDP ratio in the US since 1849. It can be seen that the other two significant reductions in the debt-GDP ratio happened after the 1860s (civil war) and the 1910s (WWI), respectively. Using the HP filter to detrend the US time series of completed fertility rate, I find that fertility positively deviated from the trend in both time periods (see Figure 14). This suggests that my theory also holds in other time periods.[24]

Caution needs to be taken when applying this model to other time periods: if the variation in government debt is not caused by exogenous shocks (such as war), the effect of government debt on fertility can be ambiguous because people's expectations on the government's behaviors in

[24] Note that I do not mean to explain all the fertility variations happened after the civil war and WWI by the changes in the debt-GDP ratio, since some other elements may also affect fertility, i.e. mortality and economic growth.

the future may be ambiguous. Furthermore, if the government debt is used to finance for public education or any other public programs that affect future generations, the effect of government debt on fertility is also ambiguous.

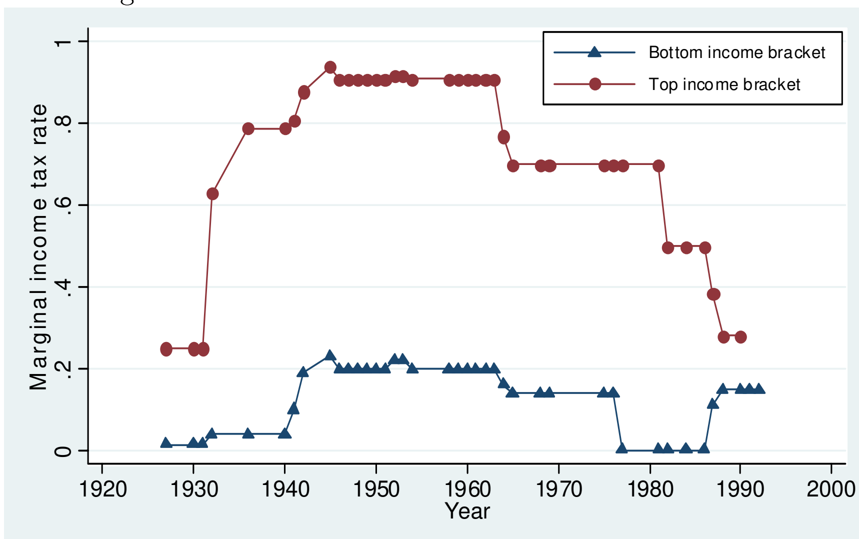
Figure 1: The debt-GDP ratio and cohort fertility in the US..




Note: CFR27 is completed fertility rate by cohort (shifted to right by 27 years from birth year), TFR is total fertility rate.

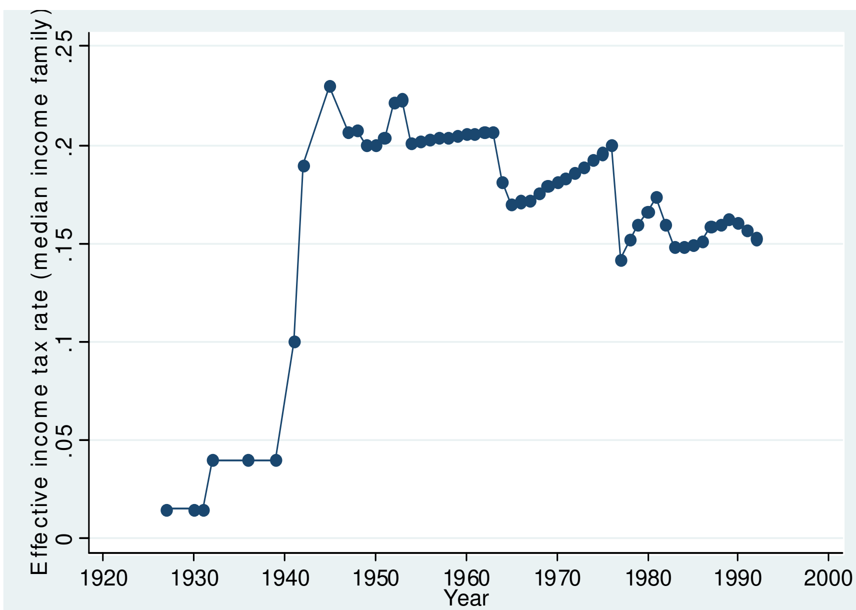
Data source: 1. debt-GDP ratio: OMB/Budget of the US Government (since 1940), derived by the author from the data provided by US Bureau of the Census and http://www.measuringworth.org (before 1940); 2. completed fertility rate: Jones and Tertilt (2008).

Figure 2: Labor income tax rate in the US:1913-2007.



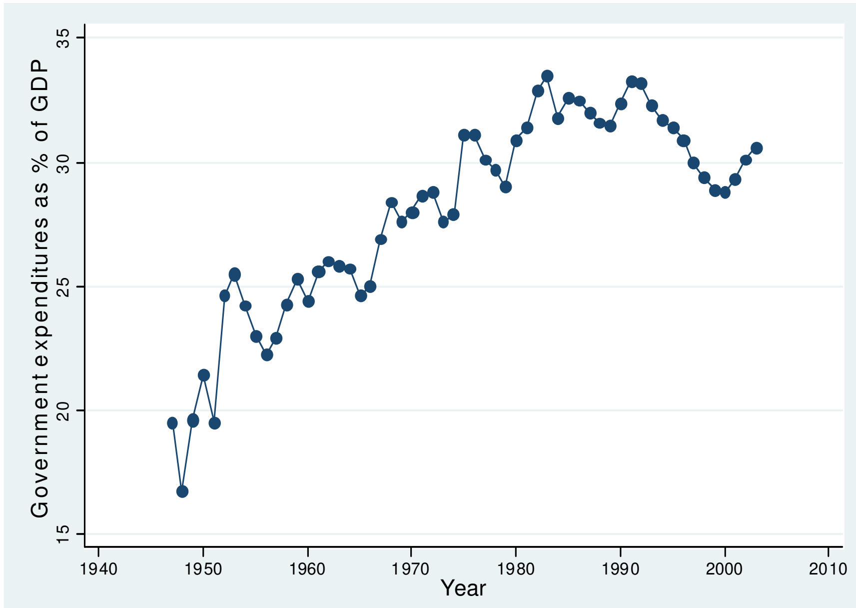

(Data source: Census (1913-1970), Internal Revenue Service (1971-2007))

Figure 3: Effective income tax rate for the median income family in the US.



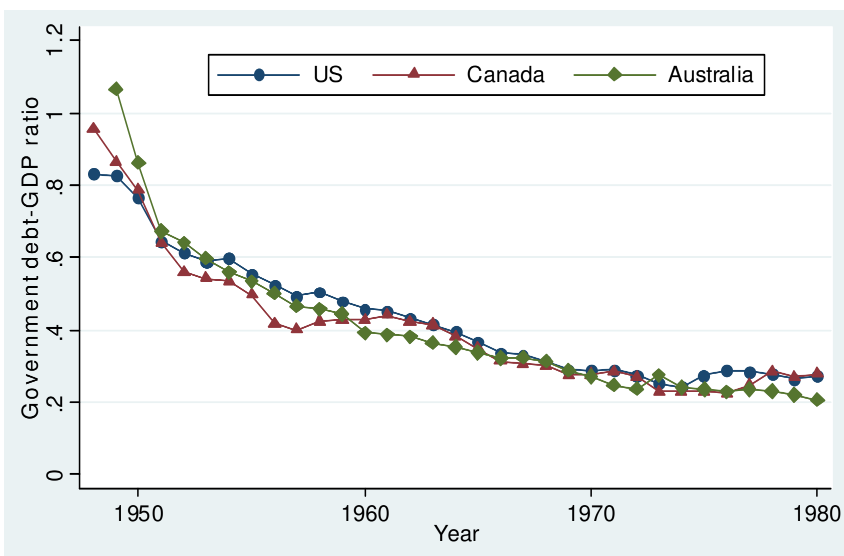

(Data source: 1. median income: US Census Bureau; 2. income tax rates: the Tax Foundation.

Figure 4: Government expenditures as % of GDP in the US.



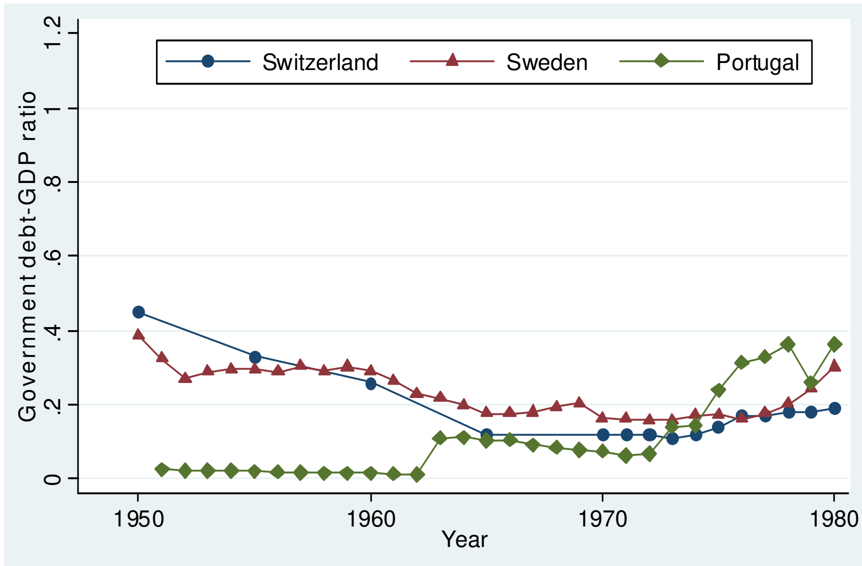

(Data source: US Census Bureau)

Figure 5: The government debt-GDP ratio in the first group of countries



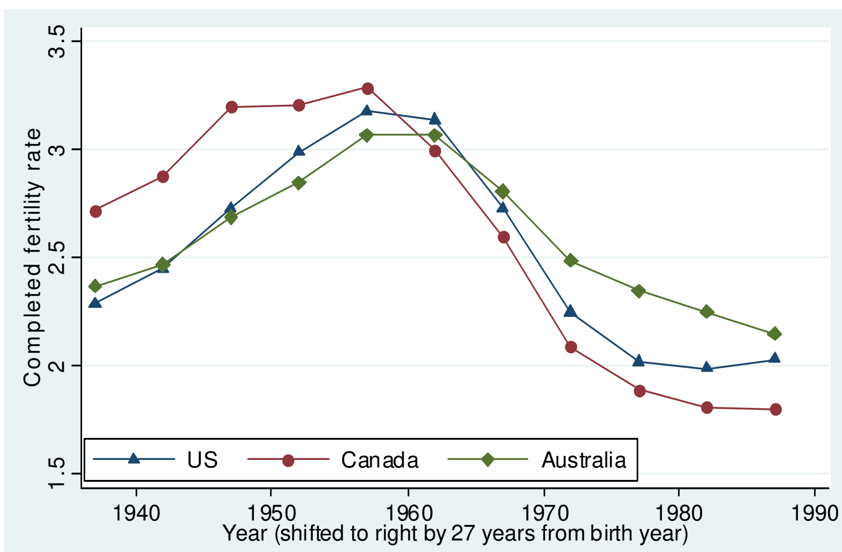

(Data source: Robert Franzese(2002))

Figure 6: The government debt-GDP ratio in the second group of countries



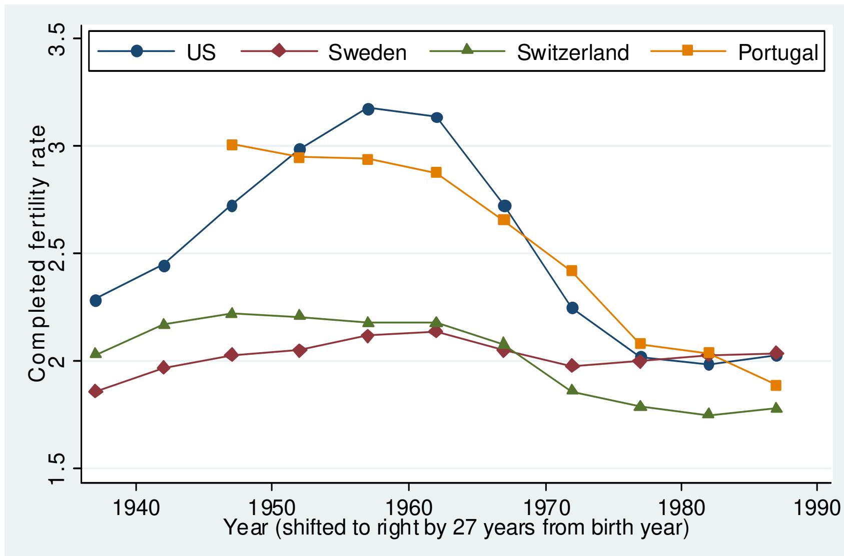

(Data source: Robert Franzese(2002))

Figure 7: Completed fertility rate in the first group of countries



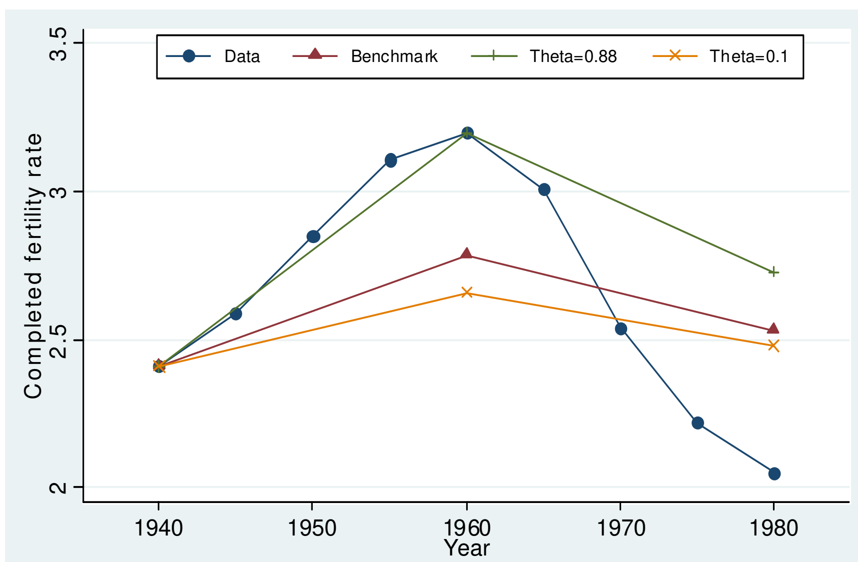

(Data source: Doepke, Hazan, and Maoz (2007))

Figure 8: Completed fertility rate in the second group of countries



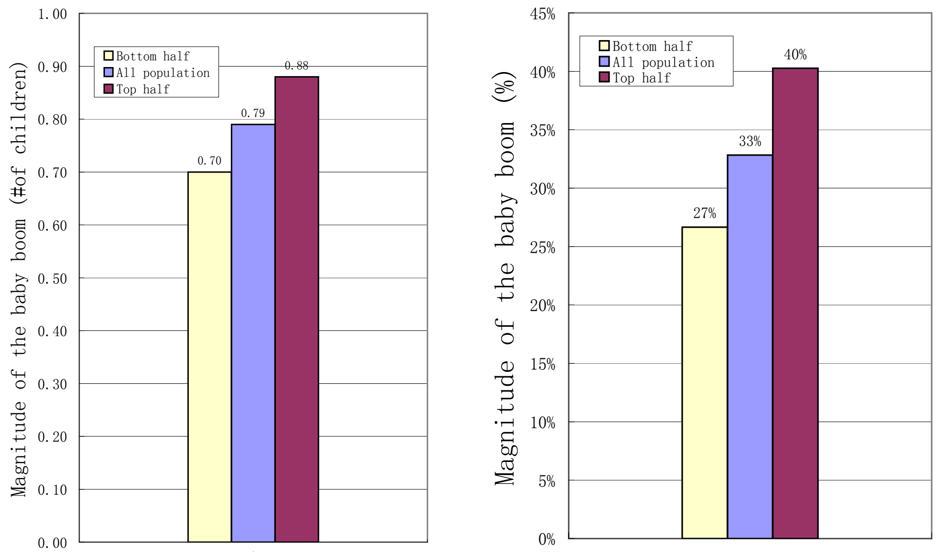

(Data source: Doepke, Hazan, and Maoz (2007))

Figure 9: The fertility rates on the transition path (the main results)




(Data source: Jones and Tertilt (2008))

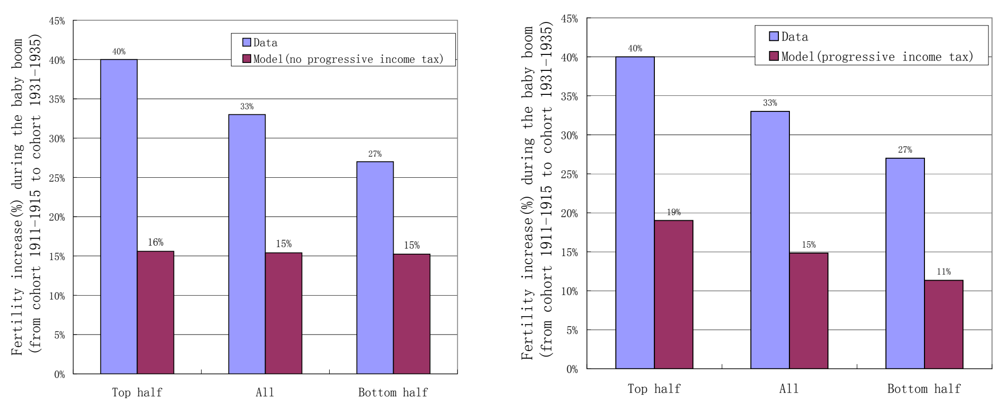
Figure 10: Cross-sectional properties of the baby boom




(a) (b)

(Data source: Jones and Tertilt (2008))

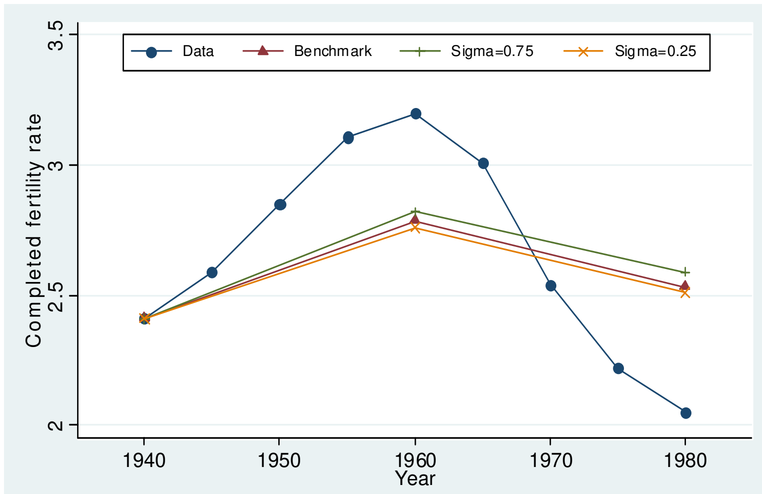
Figure 11: Cross-sectional properties of the baby boom: model vs data




(a) (b)

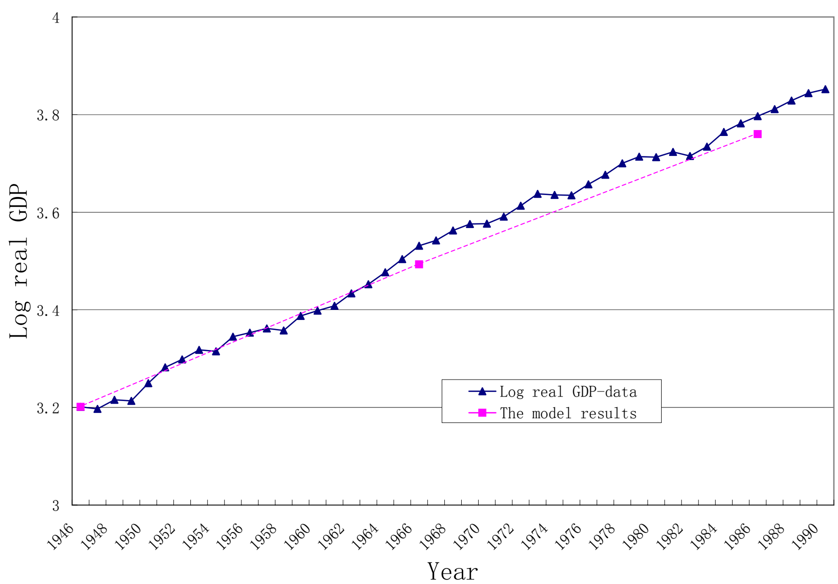
(Data source: Jones and Tertilt (2008))

Figure 12: Baby boom w. r. t. different values of $\sigma$



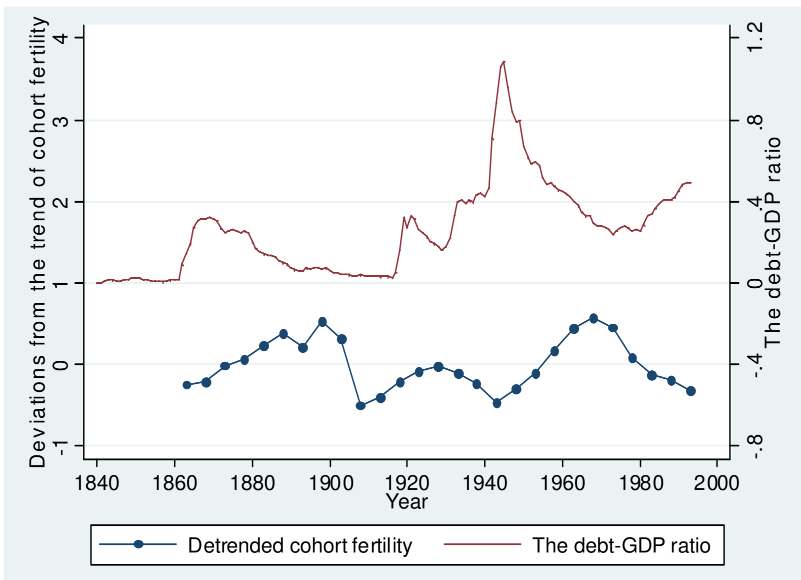

(Data source: Jones and Tertilt (2008))

Figure 13: Data VS. Model: the log real GDP.




(Data source: http://www.measuringworth.org.)

Figure 14: The debt-GDP ratio and detrended lifetime fertility in the US(since 1840).




(Data source: 1. debt-GDP ratio: OMB/Budget of the US Government (since 1940), derived by the author from the data provided by US Bureau of the Census and http://www.measuringworth.org (before 1940); 2. cohort fertility: Jones and Tertilt (2008).)