Family Tax Policy in a Model with Endogenous Fertility à la Barro-Becker

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Discussion Paper 2016-10

Institut de Recherches Économiques et Sociales
de l'Université catholique de Louvain

Family Tax Policy in a Model with Endogenous Fertility à la Barro-Becker

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Abstract

This paper assesses quantitatively the effect of family fiscal policies on fertility, labour supply and parental childcare using a general equilibrium model with dynastic households. The introduction of time allocation decisions in the original Barro-Becker framework allows to reconcile the conclusion of the micro-econometric literature on pro-nativist fiscal policies, where such policies have a small effect on fertility, and the theoretical macroeconomic literature, where fertility is deemed to be elastic with respect to macroeconomic shocks. The use of indirect inference for calibrating the elasticity of fertility to fiscal subsidies enables the model to reproduce what observed in US data over the period 1905-2005.

1 Introduction

Over the last century, many countries have adopted pro-nativist fiscal policies either directly, giving families financial incentives related to the number of children, or indirectly, subsidizing childcare services. In both cases, as noted since Becker (1960), such policies should increase the demand for children of not voluntary childless households (Gobbi, 2013), by reducing their cost in terms of goods or time.[1]

Empirical studies have generally found a positive but relatively small impact of tax incentives on fertility suggesting that, even if tax subsidies are not the main determinant underpinning fertility decisions, on average families respond to such incentives. Whittington et al. (1990) estimates the effect of the personal exemption for dependent children in the United States, using data from 1913 to 1984. Fertility is modeled as a function of both the personal exemption and other economic and demographic variables. They find a marginal effect of the value of the tax

[*]This research is part of the ARC project 09/14-018 on "sustainability" (French speaking community of Belgium). I thank for their comments the discussants at the 14th International Meeting of the Association for Public Economic Theory (APET) and at the 2013 Overlapping Generations Days Workshop. Special thanks are due also to David de la Croix, Frédéric Docquier, Tim Kehoe, John Knowles, Fabio Mariani, Ellen Mc Grattan, Victor Rios Rull, Alice Schoonbroodt, .

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[1]As shown by Gobbi (2013) and Baudin et al. (2015) households may voluntary choose not to have children. Hence pro-nativist fiscal policies would have no effect on voluntarily childless households, as these kind of households do not have a positive demand for children.

exemption on the fertility rate ranging between 0.121 and 0.236, suggesting that rising by $100 the value of the personal exemption per dependent child increases the general fertility rate by 12 to 24 births per 1000 women. These results correspond to estimated elasticities of fertility with respect to the personal exemption ranging from 0.127 to 0.248. Crump et al. (2011) have revisited the analysis of Whittington et al. (1990), extending the time dimension of the sample and addressing the concerns about possible spurious regression results. In their work the elasticity of fertility with respect to a fiscal subsidy is lower, being equal to 0.077 - when the personal exemption per dependent child is the only measure taken into account - or 0.052 - when the personal exemption per dependent child is coupled with the child tax credit.[2] As far as other countries than the US are concerned, the fertility response to fiscal subsidies remains positive but small. Gauthier and Hatzius (1997) find a benefit elasticity equal to 0.16 for family allowances across OECD countries. Milligan (2005) finds a value equal to 0.107 calculating the elasticity of fertility for Quebecker families with respect to the allowance for newborn children benefits. Similarly, Cohen et al. (2013) exploit changes in Israel's child subsidy and identify a benefit elasticity equal to 0.192, which is very close to the value 0.2 estimated by Laroque and Salanie (2008) for France.[3]

By contrast, in quantitative theoretical papers using the model developed in Becker and Barro (1988) and Barro and Becker (1989) fertility strongly responds to macroeconomic shocks. For instance, Greenwood et al. (2003) argue that an increase in family size may counterbalance and even reverse the welfare gains that child benefits should bring to families, once fertility is considered as an endogenous variable in papers dealing with family decisions. In addition, Jones and Schoonbroodt (2010a) and Jones and Schoonbroodt (2010b) have recently reproduced the US demographic transition over the last century and the baby boom and bust following the second world war. The quantitative analysis performed by Jones and Schoonbroodt (2010b) shows that fertility is elastic with respect to aggregate shocks and, in particular, that the contemporaneous elasticity of fertility to productivity shocks lies between 1 and 1.7. Such large values of the elasticity are at odds with the empirical evidence reviewed above. Indeed, the elasticities found by Jones and Schoonbroodt (2010b) looking at productivity shocks would imply a larger effect of fiscal policy on fertility.

This paper aims to provide a model able to reproduce the elasticity of fertility to fiscal subsidies provided by the empirical literature. We do so by setting up a general equilibrium overlapping generations model where: adult households live for three periods and have altruistic

[2]Crump et al. (2011) does not explicitly report the value of the elasticities. However, these can be calculated on the basis of the regression coefficients reported in the paper and the fertility and fiscal subsidies time series used by the authors. The value of the elasticities reported in the text are calculated as the percentage change in fertility that a 1% increase in the tax benefit generates, taking average values for the fertility and subsidy time series as reference point.

[3]Other papers like Whittington (1992) and Whittington (1993) estimate the effect of tax subsidies on the probability of having a child. See Gauthier (2007) for a review of papers linking family tax policies and fertility in industrialized countries.

preferences like in Becker and Barro (1988) and Barro and Becker (1989), the productive sector is represented by a neo-classical firm, and the public sector is made up by a government keeping balanced its budget. We assume households to be able not only to decide about consumption, savings, fertility and transfers to children as in the standard Barro-Becker framework, but also to optimize their time use in terms of work, leisure and child care. In other words, we transform the Barro-Becker framework into a real business cycle model with endogenous fertility.

The elasticity of the households' fertility to tax subsidies is gauged through an exercise of indirect inference. On the basis of the model built, we simulate how fertility changes following variations in the personal exemption per dependent child and in the child tax credit. We use US data for the period 1905-2005 to match the results of our simulations with the empirical estimates of the fertility response to fiscal subsidies provided by Crump et al. (2011).

The combined use of indirect inference and the introduction of time allocation decisions in the standard Barro-Becker framework allow us to bring near the results of the empirical literature with the results of the theoretical literature. Indeed, time allocation decisions curb the fertility impulse response function of young households to a change in pro-nativist fiscal subsidies. At the same time, the calibration of the inter-temporal elasticities of substitutions of the households' utility function, including the one attached to fertility, allow to pin down the value of the theoretical impulse response function for fertility. Moreover, the introduction of a balanced budget rule further affect the response of fertility to an increase in pro-nativist fiscal subsidies. As the tax rate increases in order to compensate for the rise in pro-nativist fiscal subsidies, the effect of these latter is smaller on the net income of young households and negative for middle-aged households. An increase in fertility is hence no longer compatible with an increase of households' consumption or time spent out of work, leading households to choose to increase their consumption, at the cost of decreasing their level of fertility and increasing the share of time spent at work.

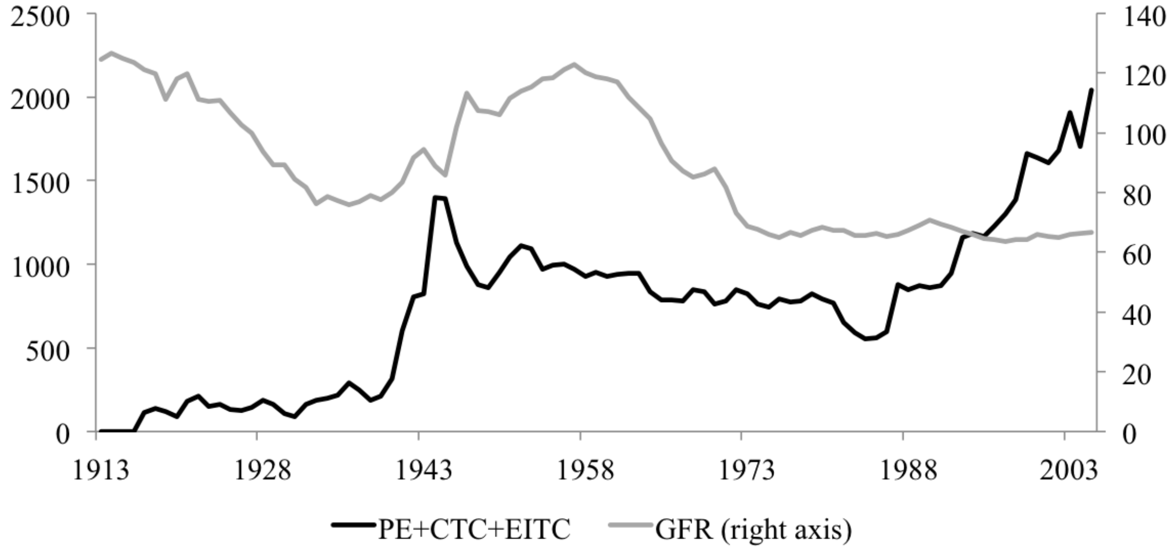
The structure of the paper is as follows. Section 2 briefly describes the main pro-nativist fiscal policies adopted in the US over the twentieth century. Section 3 develops the model underpinning the results in the rest of the paper. Section 4 provides the calibration for the parameters and variables of the model. Section 5 assesses the effects of different fiscal policies on fertility. Section 6 study the sensitivity of the fertility reaction function to a change in child subsidies with respect to some specific features of the model. Section 7 concludes.[4]

[4]The paper is complemented by two appendices, available under request. Appendix A gives additional details concerning the optimization problem of the households and provides a summary of the model, while Appendix B illustrates analytically why we chose to set the elasticity of the households' fertility to tax subsidies through an exercise of indirect inference.

2 Pro-nativist policies in the US

Over the last fifty years, many developed countries have adopted pro-nativist fiscal policies as means to reverse declining birth rates. The World Population Policies Report of the United Nations offers a comprehensive overview on the population policy situations for 200 countries (United Nations, 2013). In the US, in particular, there are three main types of pro-nativist fiscal benefits, namely the personal exemption per dependent child (PE), the child care tax credit (CCTC) and the child tax credit (CTC). Figure 1 shows the evolution over the last century of their total value, measured in 2005 US dollars, and of the general fertility rate.[5]

Figure 1: Subsidy per child in 2005 US dollars and general fertility rate between 1917 and 2005.



Source: Crump et al. (2011)

1. *Personal exemption for dependent child*: the exemption for dependents is an allowance that depends on the number of children had by an household. For this allowance, children must be less than 19 years old, or 24 years old if they are enrolled in a university as full-time student. Since its introduction in 1917, this allowance has permitted to deduce from the gross income of the family a fixed amount per year per dependent person claimed. In nominal terms, the statutory value of the allowance increased from $200 in 1917 to $3'800 in 2012. The actual benefit granted on average to US households per each child, however, is the result of the product between the marginal personal income tax rate, the real statutory value of the personal exemption and the number of children. This benefit increased from $112.91 in 1917 to $732.80 in 2012, with a peak of $1398.17 in 1944.

2. *Child care tax credit*: introduced in the 1970s, the child and dependent care tax credit is a credit that working parents can claim against their tax bill, whenever they have paid

[5]See the website of the Internal Revenue Service for more details, www.irs.gov.

childcare expenses in order to be able to work or look for a work. The percentage of childcare expenditures that can be credited depends on the gross income earned by the parents during the year. For the year 2011, the credit rate varied between 20% for people earning \$43'000 or more per year and increases up to 35% for families whose income is equal or lower than \$15'000 per year.

3. *Child tax credit*: the child tax credit was introduced in 1997 by the Taxpayer Relief Act. Initially families were given the possibility to credit against their federal income tax \$400 for each child younger than 17. This credit was extended already in 1999 and brought to \$500, then to \$600 by the Economic Growth and Tax Relief Reconciliation Act of 2001, and finally to \$1'000 in 2003 by the Jobs Growth and Tax Relief Reconciliation Act. These increases, which were initially meant to be only temporary, were confirmed up to 2012 by the Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act of 2010 and then made permanent by the American Taxpayer Relief Act of 2012 (Cordes et al., 2005). Differently from the personal exemption per dependent child, the actual benefit perceived by US households does not depend on the value of the marginal personal income tax rate, but only on the value of the credit in 2005 US dollars and the number of children.

4. *Others*: Other two tax subsidies may also influence family behavior, namely the earned income tax credit, as its value also depends on the number of children had by an household, and tax-favored savings instruments that encourage families to save for sending their children to college. The ultimate goal of these two subsidies, however, is not purely linked to fertility. The former was introduced with the scope to increase income for low income families and is thus a fiscal instrument targeted to fight poverty rather than low fertility. The latter, instead, relates to educational decisions and to the weight that parents attach to education in their preferences.

As in this paper we want to isolate the effects of pro-nativist fiscal policies from other possible fiscal policies, we focus our attention only on the first three fiscal policies described in this section.

3 Model

3.1 Households

As stated in the introduction, the aim of the paper is to have a theoretical paper based on the framework developed by Becker and Barro (1988) and Barro and Becker (1989), which can be calibrated in order to produce quantitatively sounding results for the pro-nativist policies at stake. In Becker and Barro (1988) and Barro and Becker (1989), the authors assume that households are altruistic and derive utility from the utility of their descendants. Following this assumption, the utility of an agent can be written as

$$U_t = V_t + \beta\phi n_t^{1-\epsilon} U_{t+1} \tag{1}$$

where U_t is the utility at period t of an household, which is composed by her life-time utility V_t and the utility of her descendants U_{t+1}. The number of descendants is indicated with n_t, β is the time discount factor, while ϕ is a parameter capturing the degree of parental altruism. As in the original framework proposed by Becker and Barro (1988) and Barro and Becker (1989), we assume that the altruism function $g(n) = \phi n_t^{1-\epsilon}$ is characterized by a constant elasticity with respect to the number of children.[6]

Replacing the expression for the utility of the agents' descendants, $U_{1,t+1}$, and iterating this substitution up to time T, we have that

$$\begin{aligned} U_t &= V_t + \beta\phi n_t^{1-\epsilon}[V_{t+1} + \beta\phi n_{t+1}^{1-\epsilon} U_{t+2}] \\ &= V_{1,t} + \beta\phi n_t^{1-\epsilon} V_{t+1} + (\beta\phi)^2 (n_t n_{t+1})^{1-\epsilon}[V_{t+2} + \beta\phi n_{t+2}^{1-\epsilon} U_{t+3}] \\ &= \ldots \\ &= \sum_{s=t}^{T-1} (\beta\phi)^s \left(\prod_{s=t}^{T-1} n_{s-1}^{1-\epsilon} \right) V_s + (\beta\phi)^T \left(\prod_{s=t}^{T} n_{s-1}^{1-\epsilon} \right) V_T. \end{aligned}$$

In addition, indicating with N the number of adult households living at each period t, we can use the following laws of motion for population,

$$\begin{aligned} N_{t+1} &= n_t N_t, \\ N_0 &= 1, \end{aligned}$$

so that $N_t = \prod_{s=-1}^{t-1} n_s$ and write the utility at time $t = 0$ of the head of a dynasty as follows:

$$U_0 = \sum_{t=0}^{T-1} (\beta\phi)^t N_t^{1-\epsilon} V_t + (\beta\phi)^T N_T^{1-\epsilon} V_T. \tag{2}$$

If the limit condition $\lim_{T\to\infty} (\beta\phi)^T N_T^{1-\epsilon} V_T = 0$ is satisfied, then (2) simplifies as

$$U_0 = \sum_{t=0}^{\infty} (\beta\phi)^t N_t^{1-\epsilon} V_t.$$

We assume that adult agents leave for three periods $a = \{1, 2, 3\}$, with a probability to survive to the next period of life equal to 1 for all periods. When young ($a = 1$), agents decide how much to consume, save and enjoy leisure. At the same time, they decide how many

[6]Alternative formulations for the altruism function have been proposed by Cordoba (2015).

children to have and how much time to spend with them, other than how much to leave them as inter-generational transfer. When agents become middle-aged ($a = 2$), they keep choosing their consumption, savings and leisure. However, they no longer take decisions regarding their children as these latter have become independent young adults. When old ($a = 3$), agents only consume what saved in the previous period of their life. So the life-cycle utility of parents can be written as

$$V_t = \sum_{a=1}^{3} \beta^{a-1} \Big\{ u_c(c_{a,t+a-1}) + \zeta u_{ld}(l_{a,t+a-1}, d_{a,t+a-1}) + A \Big\},$$

where $c_{a,t+a-1}$ indicates the level of consumption of an adult for each period of its adult life. Other than consuming, adults can either work or enjoy leisure or spend time with their children. Thus $l_{a,t+a-1}$ and $d_{a,t+a-1}$ are respectively the time that adults devote to leisure and the time they spent with their children. The parameter ζ represents the relative weight associated to time variables in the life-time utility of an adult and A is a constant we use to pin down the marginal benefit of an additional descendant in the quantitative exercise of the next section.

As explicit formulation for the utility functions of consumption and time, we adopt standard CRRA functions. For simplicity, we assume that agents can have children only the first period of their adult life and consequently they can spend time with their children only when they are aged $a = 1$. Setting $d_{a,t+a-1} = 0$ for $a > 1$ and $l_{3,t+2} = 1$, the utility of the head of the dynasty at $t = 0$ can be re-written as

$$U_0 = \sum_{t=0}^{\infty} (\beta\phi)^t N_t^{1-\epsilon} \Big\{ \frac{c_{1,t}^{1-\sigma}}{1-\sigma} + \zeta \frac{(l_{1,t} d_{1,t}^{\rho})^{1-\psi}}{1-\psi} + \beta \left(\frac{c_{2,t+1}^{1-\sigma}}{1-\sigma} + \zeta \frac{l_{2,t+1}^{1-\psi}}{1-\psi} \right) + \beta^2 \frac{c_{3,t+2}^{1-\sigma}}{1-\sigma} + A \Big\}. \tag{3}$$

where σ is the inverse of the inter-temporal elasticity of substitution for consumption and ψ is the inverse of the Frisch elasticity for leisure. Moreover, as adults with children share their non-working time between leisure and activities with children, we assume that leisure and time with children are not perfect substitutes using a Cobb-Douglas function, where the parameter ρ takes value 0 if $a = 1$.

At period t, the head of the dynasty maximizes (3) under both budget and time constraints. The budget constraints for a young household at age $a = 1$ is equal to

$$c_{1,t} + s_{1,t} + (1 - \xi_t)(1 - d_{1,t})\pi_t n_t + q_{t+1} n_t = h_{1,t} w_t - [(h_{1,t} w_t - \chi_t n_t)\,\tau_t - \omega_t n_t] + R_t q_t,$$

where s indicates savings, π is the child care cost that young households have to pay when they cannot personally take care of their children (in order to work or to enjoy leisure), q is the inter-generational transfer, χ is the personal exemption for dependent child that intervenes in the tax bill of the household before the imputation of the tax rate τ, ξ is the child care tax credit reducing the cost of child care, while ω is the child tax credit that is not influenced by the tax rate. w and R are the prices regulating the labor and capital markets of the economy, that is wage and the gross interest rate. The time that a young adult devotes to work is indicated by $h_{1,t}$, which is given by the following time constraint where the total amount at disposal of agent is standardized to 1 for each period of the life:

$$h_{1,t} = 1 - l_{1,t} - d_{1,t}. \tag{4}$$

In the next period of life, the budget constraint for middle-aged households is

$$c_{2,t+1} + s_{2,t+1} = h_{2,t+1} w_{t+1}(1 - \tau_{t+1}) + R_{t+1} s_{1,t}, \tag{5}$$

where the time spent at work is given by

$$h_{2,t+1} = 1 - l_{2,t+1}. \tag{6}$$

In the last period of their life, households live out of their savings so that the budget constraint for old agents is

$$c_{3,t+2} = R_{t+2} s_{2,t+1}. \tag{7}$$

Solving the optimization problem of the head of dynasty at time $t = 0$, we obtain two Euler conditions: one regulating the choice between present and future consumption for young adults,

$$c_{1,t}^{\sigma} = \frac{c_{2,t+1}^{\sigma}}{\beta R_{t+1}}, \tag{8}$$

and one regulating the same choice for middle-aged adults,

$$c_{2,t+1}^{\sigma} = \frac{c_{3,t+2}^{\sigma}}{\beta R_{t+2}}. \tag{9}$$

Moreover, two conditions regulate the decision of young adults in terms of leisure and child care,

$$\zeta l_{1,t}^{-\psi} d_{1,t}^{\rho(1-\psi)} = \tilde{\lambda}_t w_t (1 - \tau_t), \qquad \zeta \rho l_{1,t}^{1-\psi} d_{1,t}^{\rho(1-\psi)-1} = \tilde{\lambda}_t \left[w_t(1 - \tau_t) - (1 - \xi_t)\pi_t n_t \right], \tag{10}$$

while only one determines the share of leisure enjoyed by middle-aged households,

$$\beta \zeta l_{2,t+1}^{-\psi} = \tilde{\lambda}_t \frac{w_{t+1}(1 - \tau_{t+1})}{R_{t+1}}. \tag{11}$$

In both conditions, $\tilde{\lambda}_t = N_t^{-\epsilon} c_{1,t}^{-\sigma}$ is the Lagrangian multiplier representing the shadow value for consumption. Finally, two last conditions regulate the household's decision concerning inter-generational transfers,

$$\beta \phi \tilde{\lambda}_{t+1} R_{t+1} n_t^{-\epsilon} = \tilde{\lambda}_t, \tag{12}$$

and number of children,

$$\beta\phi n_t^{-\epsilon}\left[(1-\epsilon)V_{t+1}+\tilde{\lambda}_{t+1}\left(h_{1,t+1}w_{t+1}(1-\tau_{t+1})+\frac{h_{2,t+2}w_{t+2}(1-\tau_{t+2})}{R_{t+2}}\right)\right]$$
$$=\tilde{\lambda}_t\left[(1-\xi_t)(1-d_{1,t})\pi_t-\chi_t\tau_t-\omega_t\right]+\beta\phi n_t^{-\epsilon}\tilde{\lambda}_{t+1}\left(c_{1,t+1}+\frac{c_{2,t+2}}{R_{t+1}}+\frac{c_{3,t+3}}{R_{t+1}R_{t+2}}\right). \quad (13)$$

The first order condition underpinning fertility decisions of households require them to compare the marginal benefits and the marginal costs of having an additional child. The marginal benefit (left-hand-side of equation 13) is constituted by the marginal utility and the future labour income of a child. The marginal cost instead is made up by the sum of the child care cost that parents have to pay when they do not spend time with their children, minus the fiscal subsidy that parents receive per child, and the additional descendant's future consumption.

3.2 Firms

Producing firms maximize their profits choosing the quantity of labor to use in their productive process, that is

$$\max_{L_t}\Pi_t=F(K_t,L_t)-w_tL_t-r_tK_t,$$

where w_t is the wage rate, while K_t and L_t are respectively the stock of capital and labor at the beginning of period t. The labor demand associated to (14) can be retrieved from the first order condition of this latter, which states that the marginal productivity of labor equals the wage rate

$$F_L'(K_t,L_t)=w_t.$$

We assume a Cobb-Douglas production function, $F(K_t,L_t)=z_tK_t^{\alpha}L_t^{1-\alpha}$, so that the wage rate is equal to

$$w_t=z_t(1-\alpha)k^{\alpha}.$$

where $k=\frac{K_t}{L_t}$ represents capital per worker and z_t is the total factor productivity.

The real interest rate r_t is equal to the marginal productivity of capital, that is

$$r_t=F_K'(K_t,L_t)=z_t\alpha k^{\alpha-1},$$

under the assumption of a Cobb-Douglas production function. Households, instead, receive on their capital $R_t=r_t+(1-\delta)$ because part of the capital depreciates. Investments are in fact equal to

$$I_t=K_{t+1}-(1-\delta)K_t.$$

At equilibrium, the clearing conditions for the capital and labor market require

$$K_{t+1}=s_{1,t}N_t+s_{2,t}N_{t-1}+q_{t+1}N_{t+1},\qquad L_t=h_{1,t}N_t+h_{2,t}N_{t-1}.$$

3.3 Government

The budget constraint of the government is

$$G_t = \left[(h_{1,t}w_t - \chi_t n_t)\,\tau_t - \omega_t n_t - \xi_t(1-d_{1,t})\pi_t n_t\right] N_t + h_{2,t}w_t\tau_t N_{t-1},$$

where G_t represents a fixed amount of unproductive (e.g. military) public spending. In order to have a balanced budget at any point in time, the government is assumed to adjust the tax rate τ_t. We make an exception to this general equilibrium rule in the following section, where we calibrate the parameters of the model. Indeed, the indirect inference exercise that we use for the calibration of the model requires to work in a partial equilibrium environment, keeping constant the level of the tax rate τ_t. In Section 4, as a result, an increase in pro-nativist fiscal subsidies is supposed to be not compensated by an increase in the tax rate of the government. In Section 6.2, by contrast, we study the effects of the same increase in pro-nativist fiscal subsidies once the balanced budget rule is assumed to hold.

4 Calibration

We calibrate the model described in Section 3 at steady state, using 2005 data. In what follows, we first review the requirement that any possible calibration should meet, given the characteristics of the model. Then, we describe the three calibration methods adopted for the four different categories of parameters contained in the model.

4.1 Requirements to be met by calibration

Given the characteristics of the model, any acceptable calibration must fulfill some preliminary conditions. First, utility must be increasing and concave in all arguments. Second, the utility of the dynastic head in (1) must satisfy the d'Alambert criterion for the convergence of a series, that is

$$\lim_{t\to\infty} \frac{(\beta\phi)^{t+1} N_{t+1}^{1-\epsilon} V_{t+1}}{(\beta\phi)^t N_t^{1-\epsilon} V_t} < 1,$$

which implies that at steady state

$$\beta\phi n_{ss}^{1-\epsilon} < 1.$$

Third, if households are altruistic, for a given number of children, an increase in the utility of children must increase the utility of the parents:

$$\beta\phi n_{ss}^{1-\epsilon} > 0.$$

Fourth, if parents like having children, increasing the number of children must increase the utility of parents, for any given level of the life-cycle utility that descendants will have. Using the utility of the dynastic head as written in (3), this last condition requires that

$$\frac{\partial U_0}{\partial N_t}\mid_{N_t V_t}=\left(\frac{\sigma-\epsilon}{1-\sigma}\right)\left[c_{1,t}^{1-\sigma}+\beta c_{2,t+1}^{1-\sigma}+\beta^2 c_{3,t+2}^{1-\sigma}\right]+\zeta\left(\frac{\psi-\epsilon}{1-\psi}\right)\left[\left(l_{1,t}d_{1,t}^{\rho}\right)^{1-\psi}+\beta\left(l_{2,t+1}\right)^{1-\psi}\right]-\epsilon A>0.$$

In accordance with the first requirement, also the increase in the benefit of having more people in a generation must be subject to diminishing returns. Contrarily to Jones and Schoonbroodt (2010a) and Jones and Schoonbroodt (2010b), the introduction of a constant in the life-cycle utility function, A, allows to relax some of the requirements to be fulfilled by ϵ for given values of σ and ψ, while respecting this fourth requirement. Indeed, for values of σ and ψ larger than 1, ϵ no longer needs to be larger than σ and ψ and, for values of σ and ψ smaller than 1, ϵ no longer needs to be smaller than σ and ψ, as long as increasing the number of children increases the utility of the dynastic head for any given level of the children life-cycle utility. Hence, the introduction of a constant in the life-cycle utility function, A, allows to have the necessary room for manoeuvre to calibrate the value of ϵ by indirect inference, while keeping constant the values of σ and ψ.

4.2 Parameters set according to the literature

Concerning the calibration of the parameters taken from the literature, the inverse of the Frisch elasticity for the time that adult households spend out of work, ψ, is calibrated in line with the existing literature. It is set equal to 2 in order to have a corresponding Frisch elasticity equal to $\frac{1}{2}$; non-worked hours result hence to be relatively inelastic to variations in the wage rate, given a constant marginal utility of wealth. Similarly, the inter-temporal elasticity of substitution (IES) is fixed in line with existing literature. As starting point, we set the inverse of the IES, σ, equal to 1 so that adult households derive a logarithmic utility from consumption. A robustness check of these assumptions is then performed before the conclusion of the paper (see Section 6).

4.3 Parameters set on the basis of macroeconomic data

As regards exogenous variables, Table 1 summarizes the imputed values. We use Internal Revenue Service data to set the variables representing fiscal subsidies. In particular, the personal exemption per dependent child, χ, is fixed to \$64000 as the yearly value of the exemption in 2005 was equal to \$3200 per child and the length of a generation we use in the model is 20 years. For the child tax credit, ω, we choose the value corresponding to the average income of a US household in 2005, that is \$1000 per year for each child of the household. We set the child care tax credit rate, ξ, at 20% as in 2005 the average income per worker fell in the last gross income bracket of the child tax credit scheme. The child care cost π is set equal to \$190.98 thousand for the whole period of 20 years when children are assumed to be dependent from their parents, following the statistics reported by the United States Department of Agriculture

(2005). This cost corresponds to an annual cost of \$9549. We set the government public expenditure using national accounts data. Out of the total public expenditure, we select only the part used as military spending. This latter can be considered as unproductive public spending, thus allowing to abstract from the possible link existing between public spending and firms' production. The ratio between military spending and our reconstructed GDP (see Section 4.4) amounted to 5.10% in 2005.

Table 1: Value of exogenous variables, 2005

Variable	Value (yearly)
Personal exemption	$\chi = \$\,3200$
Child tax credit	$\omega = \$\,1000$
Child care tax credit	$\xi = 20\%$
Child cost	$\pi = \$\,9549$
Military spending/GDP	$\frac{G}{Y} = 5.10\%$

4.4 Parameters exactly identified with empirical moments

Table 2 summarizes the parameters that are exactly identified by matching a series of empirical moments. The first moment we match is the real interest rate. We calculated the average of the yearly interest rate on 20-years treasury bonds starting from 2005 monthly data. We use the value so obtained, 4.65%, to set the time discount factor β equal to 0.8776. Gross fixed investments as percentage of GDP are used to pin down the value of the depreciation rate. Using national accounts we sum up the values of consumption, investments and military spending, in order to reconstruct a value for the GDP that can fit into the notion of domestic production used in the model of section 3. We obtained an investment to GDP ratio of 21.19% corresponding to $\delta = 0.7924$. In addition, the capital to GDP ratio and the productivity per worker from the Penn World Tables are used to attribute a value to the two parameters of the production function. We set respectively the capital share $\alpha = \frac{1}{3}$ and the total factor productivity constant $z = 2.3127$.

For what concerns the utility function, the relative weight of time spent out of work, ζ, and the share of total time young households spend with their children relative to that spent as leisure, ρ, are defined using American Time Use data. Selecting individuals aged between 20 and 40 years having a child at least, we calculate the average time that young adults spend enjoying leisure and taking care of children. We obtain that young adults spent on average 57.88% of their time in working related activities, 35.67% enjoying leisure and the remaining 6.45% taking care of their children. On the basis of these results, we set $\zeta = 0.2697$ and $\rho = 0.1478$.

The altruism factor ϕ is paired off with inter-vivos transfers. We use bequest data coming from Gale and Scholz (1994). On the basis of the 1986 Survey of Consumer Finances (SCF), they report inter-vivos transfers to be equal to 0.32% of total wealth and 2.84% of average income. This coincides with a value of ϕ equivalent to 0.9680. The constant of the life-cycle utility function, A, is calibrated to have the number of children in the model corresponding, at steady state, to a yearly fertility rate of 0.007. To take into account the generation length, we set $n = 1.1497$ and thus $A = -26473.1315$.

Table 2: Matching parameters and matched moments, 2005

Matching parameter	Value	Matched Moment	Value (yearly)
Discount factor	$\beta = 0.8776$	20-years interest rate	$r = 4.65\%$
Depreciation rate	$\delta = 0.7924$	Investment-GDP ratio	$\frac{I}{Y} = 21.19\%$
Capital share	$\alpha = 1/3$	Capital share of labor	$w\frac{L}{Y} = 2/3$
TFP constant	$z = 2.3127$	Production per worker	$y = \$\,83400$
Utility relative weight	$\zeta = 0.2697$	Leisure	$l_1 = 35.67\%$
Leisure-childcare ratio	$\rho = 0.1478$	Time spent with children	$d_1 = 6.45\%$
Altruism factor	$\phi = 0.9680$	Bequests-income ratio	$\frac{qn}{h_1 w} = 2.84\%$
Utility constant	$A = -26473.1315$	Number of children	$n = 0.007$

4.5 Parameters calibrated by indirect inference

The elasticity of the altruism function with respect to the number of children, ϵ, is calibrated through indirect inference in order to match the effect of fiscal policies on fertility over the period 1905-2005. The empirical results we took as benchmark are those shown in Crump et al. (2011).

We perform this exercise of indirect inference varying both regression method, as in Crump et al. (2011), and number of moments, j. In all settings, we minimize the same objective function,

$$\min_{\mu} \sum_{j=\{1,2\}} Q_j(\mu, m) = \sum_j \nu_j(\mu_j - m_j)^2,$$

where Q is a quadratic function of the weighted distance between μ and m. μ is the vector of coefficients obtained from the empirical analysis performed by Crump et al. (2011). m is the vector of coefficients obtained thanks to the auxiliary model, which we use to run the same regressions as in Crump et al. (2011) but with simulated data. As weights, ν_j, we use the inverse of the standard errors attached to the coefficients of the auxiliary model.

Table 3: Indirect inference results

	Empirical moments	Simulated moments	Value of ϵ
OLS, 1 moment	$\eta_{OLS} = 0.0774$	$\hat{\eta}_{OLS} = 0.0775$	$\epsilon = 1.77$
OLS, 2 moments	$\eta_{OLS} = 0.0774$ $\widetilde{\eta}_{OLS} = 0.0520$	$\hat{\eta}_{OLS} = 0.0582$ $\hat{\widetilde{\eta}}_{OLS} = 0.0143$	$\epsilon = 2.59$
ADL, 1 moment	$\eta_{ADL} = 0.0340$	$\hat{\eta}_{ADL} = 0.0416$	$\epsilon = 2.24$
ADL, 2 moments	$\eta_{ADL} = 0.0340$ $\widetilde{\eta}_{ADL} = 0.0241$	$\hat{\eta}_{ADL} = 0.0421$ $\hat{\widetilde{\eta}}_{ADL} = 0.1447$	$\epsilon = 1.69$

The regressions we run are as follows. In the simplest case, we use the ordinary least squares method (OLS) to estimate the impact of the personal exemption per dependent child only on fertility. In particular, we regress the general fertility rate of young adults constructed from simulated data, $GFR_t = 2 * n_t * \frac{20}{80} * 1000$, on the level of the personal exemption per dependent child, $PE_t = \tau_t \chi_t$, and the level of TFP, z_t:

$$GRF_t = \beta_0 + \beta_1 PE_t + \beta_2 z_t + \upsilon_t. \tag{14}$$

The source of uncertainty introduced in the model to generate random paths, υ_t, comes from the auto-regressive model of first order (AR1) used to generate 100 TFP paths over the period 1905-2005, whose coefficients are calculated from the actual TFP data constructed by Chari et al. (2007).

The moment we match by indirect inference is the elasticity obtained on the basis of the coefficient β_1, that is $\eta = \beta_1 \frac{\bar{PE}}{G\bar{F}R}$, where $\bar{PE} = \tau\bar{\chi}$ is the average value of the personal exemption per dependent child and $G\bar{F}R = 2 * \bar{n} * \frac{20}{80} * 1000$ is the average level of the general fertility rate over the period 1905-2005. Note that the value of the tax rate is considered to be constant because, as explained in Section 3.3, the government is assumed to not adjust the tax rate in order to compensate for increasing pro-nativist fiscal subsidies. This assumption in necessary when performing the exercise of indirect inference, as it allows to have only exogenous variables in the right-hand side of equation (14). When we use more than one moment to identify ϵ, we accompany regression (14) with

$$GRF_t = \widetilde{\beta}_0 + \widetilde{\beta}_1 (PE_t + CTC_t) + \widetilde{\beta}_2 z_t + \widetilde{\upsilon}_t, \tag{15}$$

where $CTC_t = \omega_t$ is the amount of child tax credit received per child by the households with dependent children. The two moments that we use for evaluating the objective functions are then the two elasticities, η_{OLS} and $\widetilde{\eta}_{OLS}$, calculated respectively using β_1 and $\widetilde{\beta}_1$.[7]

As alternative setting, we follow Crump et al. (2011) in running an auto-regressive distributive lag (ADL) regression model. We replace regressions (14) and (15) by the following regressions, containing the lag of both endogenous and exogenous variables:

$$\begin{aligned} GRF_t &= \beta_0 + \beta_1 PE_t + \beta_2 z_t + \beta_3 GRF_{t-1} + \beta_4 PE_{t-1} + \beta_5 z_{t-1} + \upsilon_t, \qquad (16) \\ GRF_t &= \widetilde{\beta}_0 + \widetilde{\beta}_1(PE_t + CTC_t) + \widetilde{\beta}_2 z_t + \widetilde{\beta}_3 GRF_{t-1} + \widetilde{\beta}_4(PE_{t-1} + CTC_{t-1}) + \widetilde{\beta}_5 z_{t-1} + \upsilon_t. \end{aligned}$$

The two coefficients β_1 and $\widetilde{\beta}_1$ are then transformed in the two corresponding elasticities, η_{ADL} and $\widetilde{\eta}_{ADL}$, to be respectively matched with the values provided in Crump et al. (2011).

Table 3 reports the results we obtain in the different settings described above. Across all settings, the value of ϵ is always larger than 1 and ranges between 1.69 and 2.59. Moreover, the OLS method generates a lower value of the distance function when using two moments, instead of only one, in the exercise of indirect inference. In this case, a value of ϵ equal to 2.59 minimizes the distance between the vector of coefficients obtained from the empirical analysis performed by Crump et al. (2011) and the vector of simulated coefficients obtained from our auxiliary model. Henceforth, we will perform the policy experiments of the next session taking this value of ϵ as reference.

5 Policy experiments

In this section we describe the results of two different policy experiments. First, we study the effects of an increase in the personal exemption per dependent child, the child care tax credit and the child tax credit. Second, we evaluate the outcome of changing the current allocation of public spending among the three subsidies, concentrating all resources in only one of them.

In the first policy experiment, we raise the value of each subsidy by an equal amount corresponding to 1% of the initial amount of GDP per worker. All the subsidies increase fertility in the first period following the increase in their value, because they decrease the relative cost of having a child (see Figure 2). Transforming the results in terms of general fertility rate, we obtain that increasing the personal exemption per dependent child or the child tax credit by \$100 increases fertility by 5.93 children per 1000 women in the period following the policy shock, in line with the results of the empirical literature.[8] The effect of the child care tax

[7] We compare elasticities rather than the regression coefficients in order to avoid possible issues related to different scales used for simulated and empirical data.

[8] The personal exemption per dependent child and the child tax credit have the same effect on fertility because the government does not vary the value of the tax rate to keep the budget balanced in each period of time, as it has been assumed for the indirect inference exercise in Section 4. Indeed, due to the way in which the two subsidies are imputed in the tax bill of the households, the impact of a change in the exemption per dependent

credit results to be slightly stronger, increasing fertility by 5.96 children per 1000 women. The difference in the effect of the subsidies on fertility is due to the fact that the child care tax credit, decreasing the cost of external child care services for young adults with children, allows such households to have a higher fertility rate while renouncing to a smaller share of their time spent at work (see Figure 3).

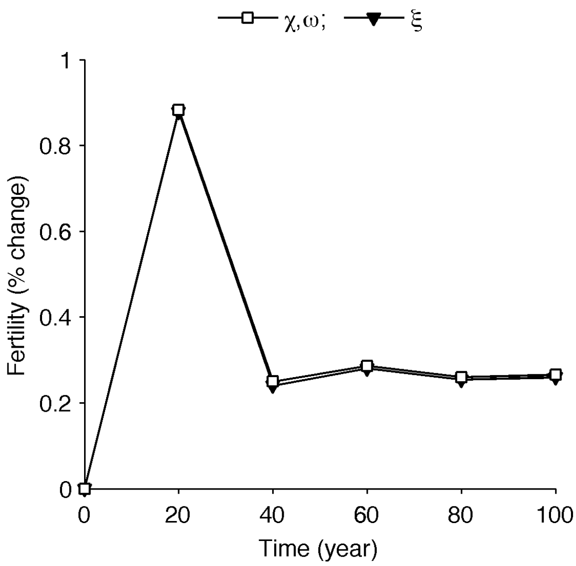


Figure 2: Fertility impulse reaction function to different pro-nativist fiscal incentives

All subsidies produce a positive income effect for agents that translate not only into higher fertility, but also into lower working hours and hence in favor of leisure and time spent with children. The change in the allocation of time by young households influences middle-aged households, who also decrease the amount of time they dedicate to work for enjoying more leisure from one period after the shock onwards (Figure 5). However, the initial positive effect of pro-nativist fiscal policies on both fertility and time spent out of work is, respectively, reverted or reduced when prices begin reacting to the variation of subsidies (Figure 4). Indeed, the effective labor force decreases due to the decrease in the working hours of young and middle-aged households, which overcompensates the increase in the active population caused by the higher fertility rate. The ratio between capital and the effective labor force, k_t, increases leading to an increase in the wage rate and a decrease in the interest rate. In turn, the increase in the wage rate causes an increase in working hours for young adults, compensated by a decrease in leisure, time spent with children and fertility, while a similar increase in working hours and a decrease in the share of time dedicated to leisure takes place for middle-aged households in the next period.

The just mentioned changes in the allocation of time following the increase of pro-nativist

child can be distinguished from that of a change in the child tax credit only if the tax rate is left free to adjust for balancing the budget (see below, Section 6.2).

fiscal subsidies invert the predictions of the Barro-Becker original framework where no time allocation decision is considered. Indeed, in the original Barro-Becker framework, an increase in a pro-nativist fiscal subsidy would strongly increase fertility and consumption for all young, middle-aged and old households. Contrarily to when time decisions can adjust in response to a change in fiscal subsidies, the ratio between capital and effective labor would decrease starting one period after the fiscal shock, due to an increase in fertility no longer compensated by a decrease in working hours. Households would then raise their savings and so diminish their consumption, under the influence of an increasing interest rate, while the wage rate would decrease led by the increase in the labour force due to the higher level of fertility. As a result, if the time allocation of households was given, wage and interest rate dynamics would have reinforced the initial effect of pro-nativist fiscal subsidies on fertility.

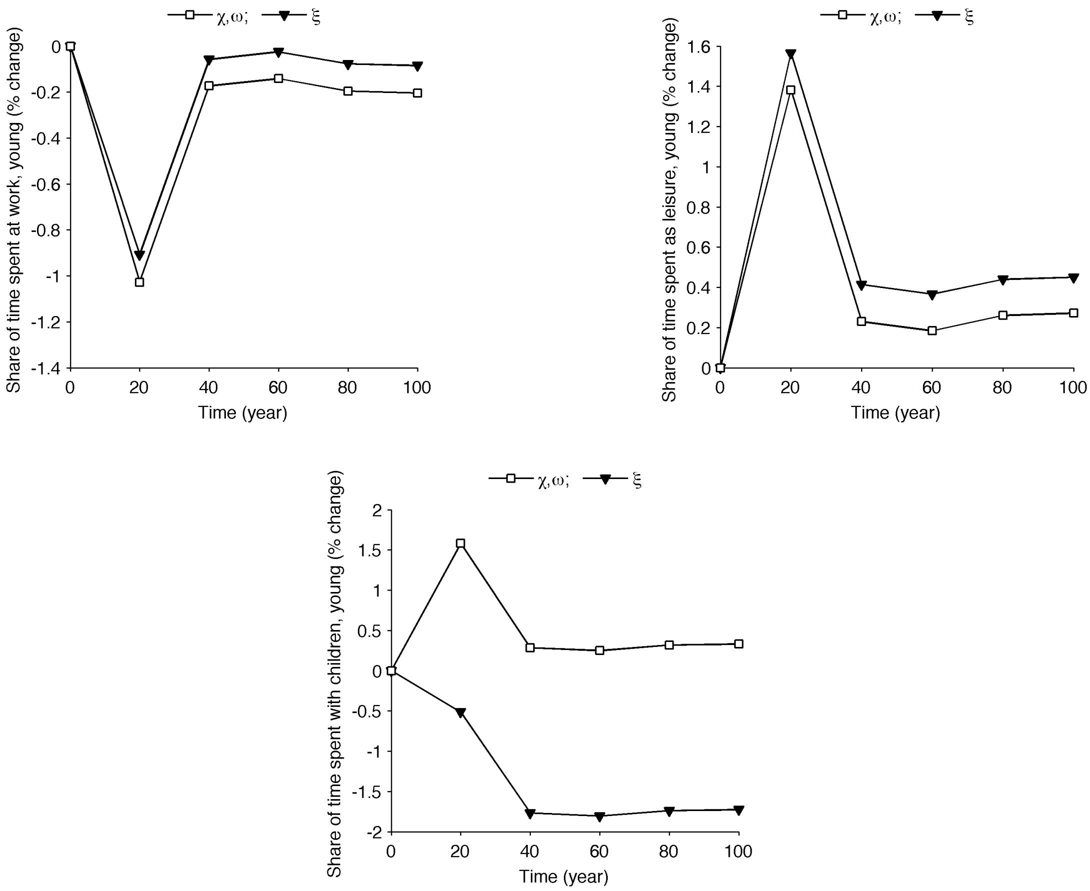


Figure 3: Effects of different pro-nativist fiscal incentives on the time allocation of young households

Concerning the interest rate, its decrease affects the savings decisions of all households and the inter-vivos transfer decisions of young adults. Indeed, the decrease of the interest rate in turn decreases the return from savings and the inter-generetional transfers, leading households to increase their present consumption and save a smaller portion of their income either for their own future consumption or for the consumption of the following generation. Lower savings and

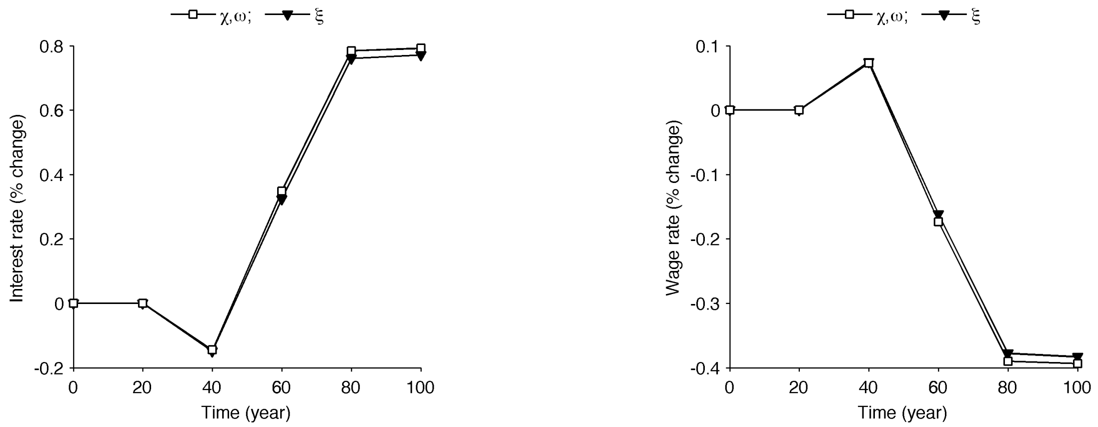


Figure 4: Effects of different pro-nativist fiscal incentives on the interest and wage rate

inter-generetional transfers lead to a decrease of investments in capital (Figure 6).

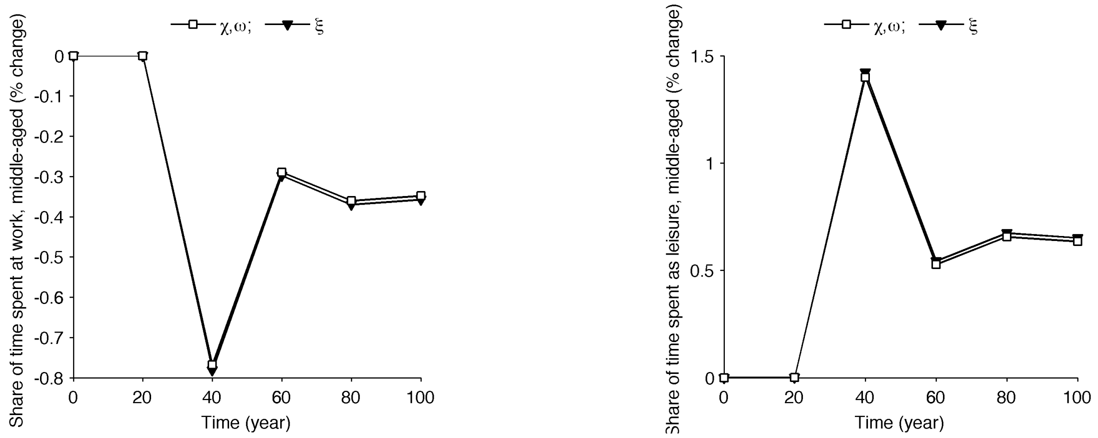


Figure 5: Effects of different pro-nativist fiscal incentives on the time allocation of middle-aged households

Consumption per capita increases for all generations of households. When pro-nativist fiscal subsidies increase, young households raise their level of consumption. Such increase is transmitted to middle-aged households in the next period and then to old households starting from two periods after the shock in pro-nativist fiscal subsidies. The dynamics of the wage rate described above curtail the initial increase in consumption enjoyed by each generation of households and lead such variable towards its new equilibrium value, below the level reached just after the increase of pro-nativist fiscal subsidies.

In the second policy experiment, we study the effect of transforming all subsidies in child care tax credit. Reducing to zero the personal exemption per dependent child and the child tax credit, while compensating this reduction through a higher value of the child care tax credit, has almost no overall effect on fertility. As expected, fertility reduces only by 0.005 percent

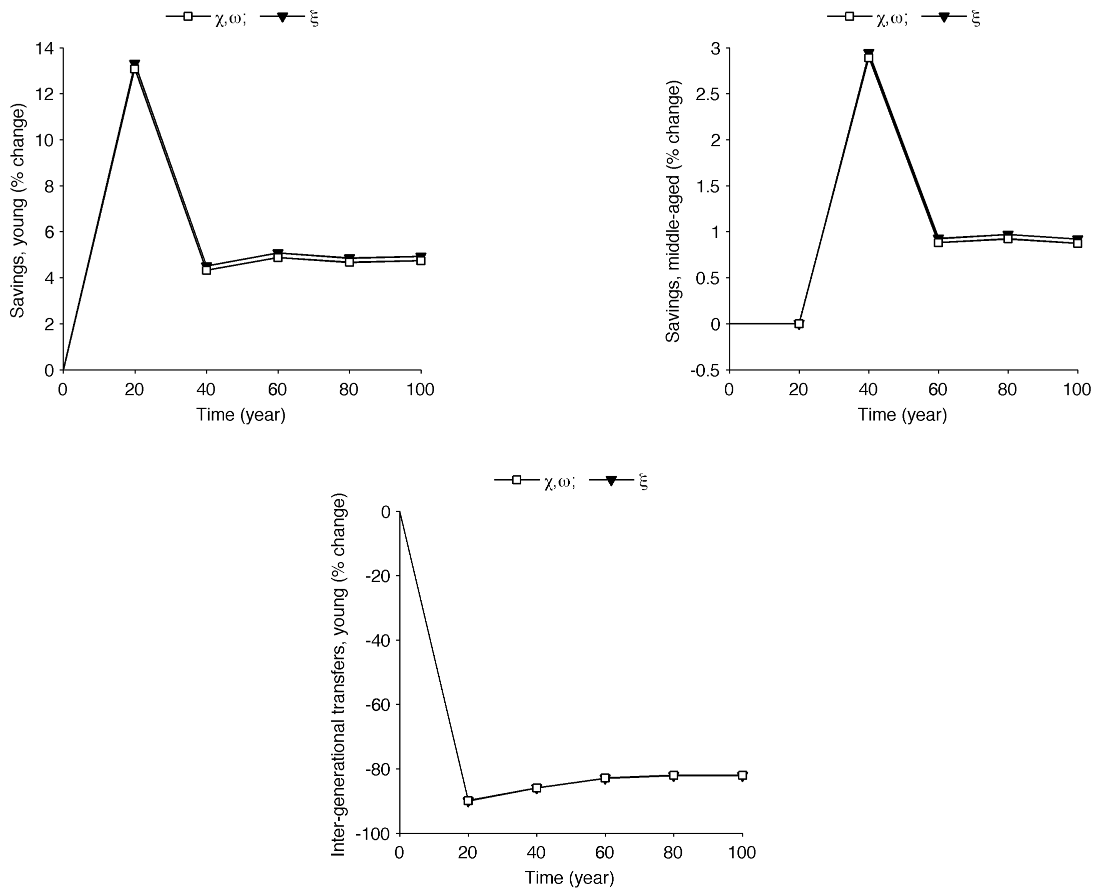


Figure 6: Effects of different pro-nativist fiscal incentives on savings and inter-generational transfers

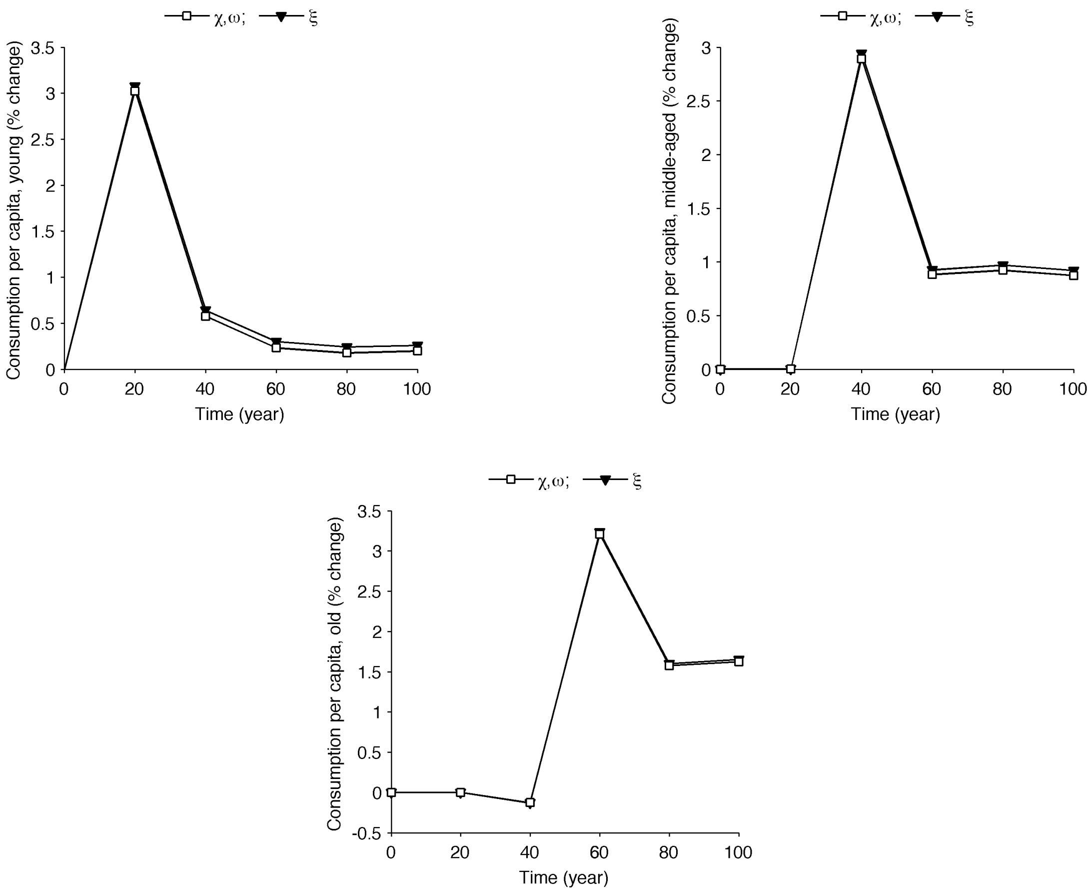


Figure 7: Effects of different pro-nativist fiscal incentives on consumption decisions

from its value at the initial steady state (see Figure 8), given that the first policy experiment revealed a very similar impact on fertility of each of the three subsidies. By contrast, the shift of subsidies towards the child care tax credit, has a positive effect on the share of time allocated to work and to leisure. This latter increases respectively by 0.22% and 0.36%. It is compensated by a decrease in the share of time that parents spend with children; given the reduction in the cost of external childcare services due to the increase in the child care tax credit, parents substitute part of the time they spend with children with external childcare. As a result, parental childcare decreases by 3.94% with respect to its value at the initial steady state.

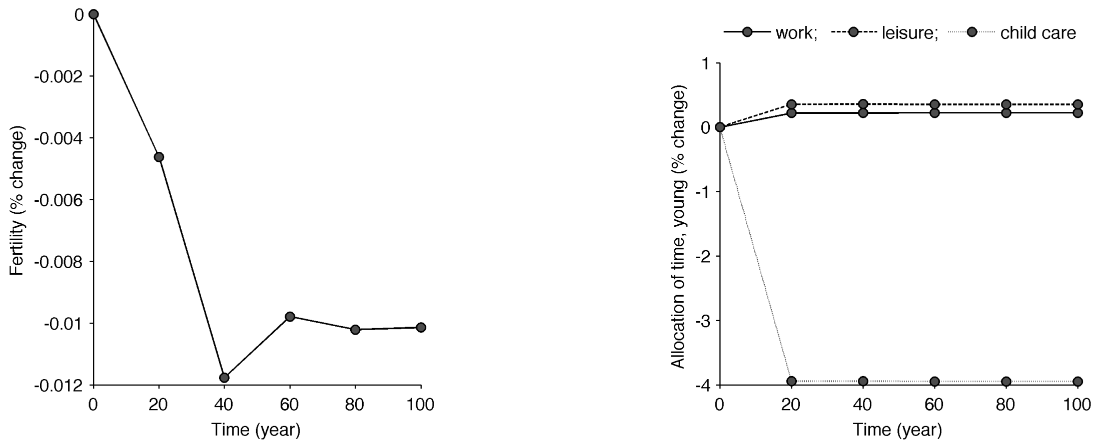


Figure 8: Percentage change in fertility and time allocation following a shift of subsidies in favor of the child care tax credit.

6 Robustness checks

6.1 Assessing the role of ϵ, σ and ψ

The results described in Section 5 have been obtained for given value of the three inter-temporal elasticities of the head of a dynasty utility function (equation 3). In this section we dig further into the role these play in shaping the impulse response function of fertility with respect to pro-nativist fiscal subsidies.

The role of ϵ. In Section 4.2 we used an exercise of indirect inference to set the value of ϵ. Indeed, as shown in Figure 9 the value of such variable influences the impulse response function of fertility, both affecting the inter-temporal preferences of dynasty heads and the life-time preferences of adult households. Higher values imply that an adult household that is at the head of a dynasty attributes lower value to the utility of future generations. This implies that pro-nativist fiscal subsidies are used for increasing fertility of the present rather than future generations. That is, a higher value of ϵ implies that the marginal benefit of giving birth to an additional children today is higher than the marginal benefit of having an additional children tomorrow, with the result that adult households have more children following an increase in pro-nativist fiscal subsidies, for given values of ψ and σ.

Higher values of ϵ imply also a larger elasticity of substitution between children and the other components of the life-time utility of adult households. In the same vein as what underlined in the previous paragraph, higher values of ϵ imply that households are more keen to vary fertility decisions, rather than consumption or time allocation decisions, when pro-nativist fiscal subsidies increase. As a result, the value of the fertility impulse response function at the time of the pro-nativist subsidy shock is higher the higher the value of ϵ.

The role of σ and ψ. Also σ and ψ, similarly to ϵ, represent at the same time the intertemporal elasticity and the elasticity of substitution of, respectively, consumption and the time spent out of work.

Higher values of σ lead to a smaller reaction of fertility following the increase in pro-nativist fiscal policies (see Figure 10), due to increased preferences for present consumption (see equation 8) and a lower elasticity of consumption to income shocks. In this respect, the role played by σ is the same as in the original Barro-Becker model.

Concerning ψ, for a given value of the variables representing leisure and child care, an increase in the value of ψ decreases the response of time that adults spend out of work to changes in the value of present and future income. As households tend to stick more strongly to their initial allocation of time, an increase in pro-nativist fiscal subsidies has a smaller effect on the share of time spent out of work, allowing households to use such increase in pro-nativist fiscal subsidies for raising more their level of consumption and fertility. Given the importance of time allocation variables - working time hours in particular - in determining the change in the ratio between capital and effective labor, larger values of ψ imply also a larger fall in fertility after its initial increase following the rise in a pro-nativist fiscal subsidy (see Figure 11).

6.2 Assessing the role of the balanced budget rule

The respect of the balanced budget rule equally plays a role in determining the fertility response of households to pro-nativist fiscal subsidies. If the government decides to keep constant the level of public expenditures over time and to increase the tax rate to respect the balanced budget rule, fertility is negatively affected by an increase of pro-nativist fiscal subsidies (see Figure 12). Moreover, as the tax rate is left free to adjust the government budget, the fertility response to an increase in the personal exemption per dependent child can be distinguished from the effect of an increase in the child tax credit. The effect in the first case is stronger than the latter because the adjustment of the tax rate, in order to balance the budget, increases the

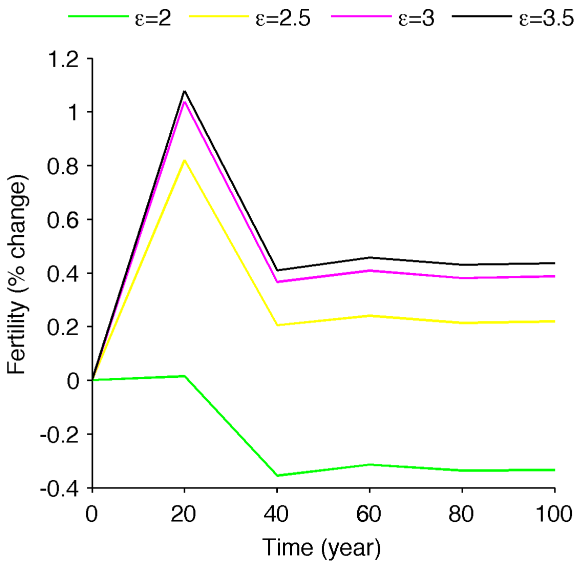


Figure 9: Effects of a change in the personal exemption per dependent child for different values of ϵ.

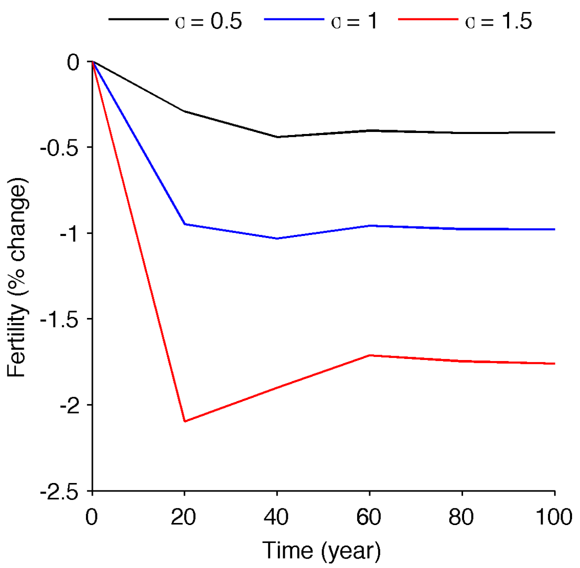


Figure 10: Effects of a change in the personal exemption per dependent child for different values of σ.

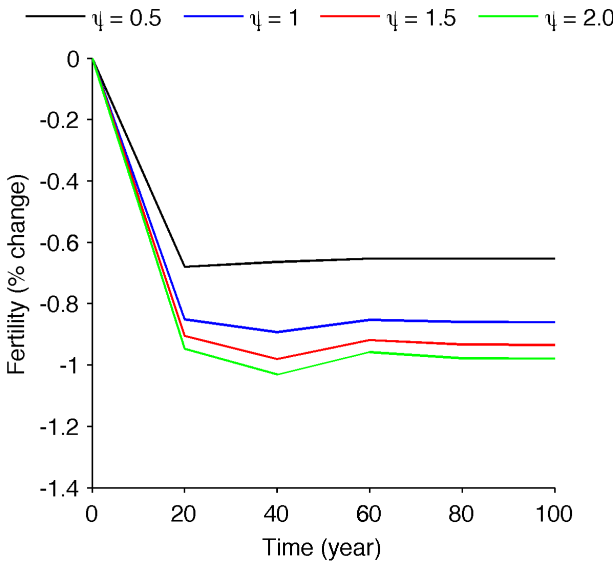


Figure 11: Effects of a change in the personal exemption per dependent child for different values of ψ.

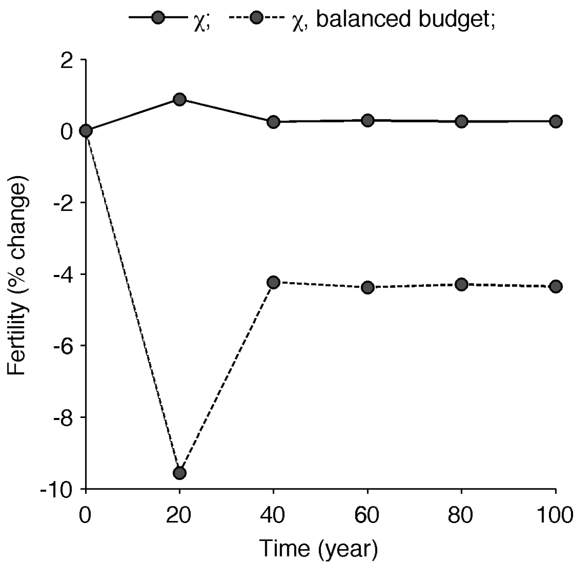


Figure 12: Increase in the exemption per dependent child, with and without balanced budget rule.

value of the personal exemption per dependent child, but not of the child tax credit.

The decrease in fertility is accompanied by an increase in the working time of young adults, compensated by a decrease in leisure and time spent with children. These changes in the time allocation decisions of young workers are limited by the increase in the wage rate resulting from the reduction of the labor force following the decrease in fertility. Middle-aged workers also increase their share of time spent at work and consequently decrease leisure, in order to compensate for the loss in disposable income caused by the increase in the tax rate.

Consumption per capita increases for young workers, whilst it remains constant for middle-aged workers and decreases for old households. Inter-generational transfers left by young workers to their children decrease, while savings held by young and middle-aged workers increase to smooth consumption over households' lifetime. This increase in savings is, in fact, necessary to counterbalance both the decrease in the interest rate, due to the increase in the capital per worker realized after the decrease in fertility, and the increase in the tax rate, which both tend to drag down consumption.

7 Conclusions

In this paper we have studied the effect of pro-nativist fiscal subsidies on fertility. We have developed a Barro-Becker model, where adult households live for three periods and have altruistic preferences. Departing from the standard Barro-Becker framework developed by Becker and Barro (1988) and Barro and Becker (1989), we have assumed that adult households are able to optimize their time use in terms of work, leisure and child care, beyond deciding upon consumption, savings, fertility and transfers to children. The transformation of the original Barro-Becker framework into a real business cycle model with endogenous fertility has allowed us to reconcile the conclusion of the micro-econometric literature on pro-nativist fiscal policies, where such policies have a small effect on fertility, and the theoretical macroeconomic literature, where fertility is deemed to be elastic with respect to macroeconomic shocks. Indeed, the introduction of time allocation decisions for adult households helps limit the fertility impulse response function of young households to a change in pro-nativist fiscal subsidies.

The elasticity of households' fertility to tax subsidies has been gauged through an exercise of indirect inference. On the basis of the model built, we simulated how fertility changes following variations in the personal exemption per dependent child and in the child tax credit. We considered both a change in the three subsidies and a shift in the allocation of public spending among the three subsidies. We use US data for the period 1905-2005 to match the results of our simulations with the empirical estimates of the fertility response to fiscal subsidies provided by Crump et al. (2011). Moreover, in Section 6 we have provided some sensitive analysis to the calibration obtained through indirect inference, showing how the three inter-temporal elasticities present in the model affect the impulse response function of fertility following a shock in the value of pro-nativist fiscal subsidies. Finally, in the same Section we have also discussed the role played by the introduction of a balanced budget rule. This contributes to further lower the response of fertility to an increase of pro-nativist fiscal subsidies, transforming it from positive into negative.

We have left open for further research a better understanding of the possible link existing between fiscal policy, inter-generational transfers and fertility. In particular, in this paper we assumed that agents are heterogeneous in terms of age, but not in terms of personal wealth. By contrast, different levels of wealth may lead to different choices in terms of fertility and inter-generational transfers, with the implication that fiscal policies affecting wealth may equally have an impact on inter-generational transfer decisions and fertility.

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ISSN 1379-244X D/2016/3082/10