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Raising America's future: search for optimal child-related transfers

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Comparison of screening devices

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Abstract
The US differs from other OECD countries in terms of family policy size and composition. This study examines the welfare and macroeconomic effects of family policy reforms. I explore three policy instruments: child-related tax credits, child care subsidies, and child allowances. The children are merit good due to PAYG social security structure. I show that expanding family policy, similar to the American Rescue Plan, enhances welfare. I also characterize the optimal family policy for the US. It accounts for about 3\% of GDP, three times larger than the existing policy, and primarily focused on child-care subsidies. The structure of family policy is vital for welfare evaluation, as similar expenditure levels can lead to contrasting welfare outcomes depending on policy composition. This study underscores the importance of carefully designed family policies, highlighting the need for ongoing research and policy innovation to maximize societal benefits and promote equitable economic growth..

Keywords:
family policy, social security system, welfare, income risk

JEL Classification
D21, E62, H31, H55

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1 Introduction

Child-related transfers play a critical role in fostering intergenerational equity, supporting families, and promoting economic stability. As the United States grapples with an aging population, sluggish economic growth, and increasing income inequality, it becomes imperative to examine the efficacy of the nation's family policies in addressing these issues. This paper delves into the analysis of optimal child-related transfers in the United States, focusing on the macroeconomic and welfare implications of child-related transfers and identifying the optimal family policy mix that could deliver significant welfare gains. The study employs an overlapping generations model with endogenous fertility and idiosyncratic income risk to better capture the intricacies of intergenerational dynamics and household decision-making.

The United States operates a pay-as-you-go (PAYG) social security system, which, along with public healthcare or public debt, is linked to the positive externalities of raising children. Children contribute to societal well-being beyond the utility they provide to their parents by paying taxes in the future. This social externality is overlooked when individuals decide on their fertility rates, leading to a suboptimal private solution that warrants government intervention.

It is worth noting that the United States has historically diverged from its high-income peers in adopting family policies. The country's child-related transfers rank among the lowest in the OECD, heavily relying on tax credits and providing a disproportionately small share of transfers to the poorest households. Additionally, the US lags in adopting child-related instruments that are not work-related, as well as in providing adequate support for child care that could alleviate the career-family trade-offs parents face.

This paper makes several important contributions to the literature on child-related transfers and family policy. First, it examines the macroeconomic and welfare effects of family policy expansion in the United States, specifically focusing on the implications of the child tax credit expansion enacted under the American Rescue Plan Act of 2021. The increase in transfer size and its transformation into a universal allowance result in welfare gains equal to 9.5% under the veil of ignorance. Furthermore, the effects are positive for all households regardless of initial productivity levels. Two main factors drive these results: universal child allowance provides additional insurance, which is valuable given the presence of idiosyncratic income risk, and current family support in the US is lower compared to the optimal level, so increasing support size leads to welfare improvement.

Second, the paper characterizes the optimal family policy in terms of size and composition for the United States. Using a grid search method, it identifies the optimal family policy mix, which accounts for about 3.2% of GDP–three times larger than the current policy–and relies heavily on public child care. Public child care increases time endowment, leading to a higher labor supply. The policy also impacts the composition of the labor force, eliciting a stronger reaction among high-productivity households. Welfare gains associated with implementing optimal family policy are equivalent to 12.2%. Moreover, the results highlight the critical role of family policy structure in welfare evaluation, as nearly identical levels of family policy expenditures can produce either welfare gains or losses depending on policy composition. The study also decomposes these effects into tax, social security, and general equilibrium channels to provide a comprehensive understanding of the reform's impact.

As the United States continues to face demographic, economic, and social challenges, it is crucial to rethink its approach to family policy and child-related transfers. By examining the welfare and macroeconomic effects of policy reform and identifying the optimal family policy mix, this study offers valuable insights for policymakers to make more informed decisions in crafting equitable and effective family policies that can drive long-term societal benefits. The results gain further relevance in light of the cancellation of the extended support offered via the American Rescue Plan.

The paper is organized as follows. Section 2 presents a literature review. Section 3 presents transfer system in the US relevant for this analysis. Section 4 describes the stylized model with externalities related to fertility decisions. Section 5 presents the quantitative overlapping generations model with endogenous fertility decision and idiosyncratic income risk. In section 6 describes the calibration. Then, section 7 discusses the effect of the expansion of child-related transfers. Finally, section 8 concludes.

2 Related literature

Doepke et al. [2022], and Greenwood et al. [2017] provide recent and comprehensive literature reviews of family economics.[1] In the following section, I present three streams of the literature especially relevant for this paper. First, several papers analyze the **welfare consequence of family-policy reform in the US**. Shaefer et al. [2018] use microsimulation setting. In this paper, by using the life cycle model, I account for the labor market response. Guner et al. [2020] offer profound insight into the labor supply and welfare effect of a more generous child-related transfer system for the US. I build on that work by relaxing two assumptions. Namely, I account for the endogenous character of fertility and labor income risk. Income risk leads to lower fertility and reduces the demand for children. Fraser [2001], Ejrnæs and Jørgensen [2020], and Sommer [2016] support this finding. Ortigueira and Siassi [2022] analyze the consequence of the Family Security Act proposal using a structural microsimulation approach. They show that the plan would increase marriage rates and reduce child poverty but increase poverty among single-mother families and deep child poverty. My model, while compromising on household heterogeneity, accounts for general equilibrium effects and the efficiency linked to fertility-social security link. Ho and Pavoni [2020] and Kurnaz [2021] study optimal child care and child credits in an endogenous fertility set-up, respectively. This paper contributes by analyzing combinations of different child-related transfers.

Second, this paper draws on economic literature exploring the link between **social security**

[1] In Tables D.1 and D.2 in the Appendix D, I summarize the literature on modelling family structure, decision-making, and fertility in macroeconomic literature.

and optimal fertility.[2] Numerous cross-country studies show a negative correlation between size of social security system and fertility rates. For instance, Boldrin et al. [2015] demonstrate that the magnitude of the social security system explains 55-65% of the observed difference in fertility rates between the US and Europe. Similarly, Fenge and Scheubel [2017] show that the introduction of Bismarck's social security system negatively impacted fertility, and Billari and Galasso [2014] found that cutting social security benefits in Italy in the 1990s led to a rise in fertility rates. If social security relies on intergenerational transfer, the private optimum fertility rate is lower than the social optimum. The key mechanism is the lack of property rights for children's future income, see Schoonbroodt and Tertilt [2014]. Although social security on a pay-as-you-go basis completes the market by offering a contract between parents and unborn children, it forces born children to support retired parents, linking future generations' aggregate income to today's parents' social security benefits and resulting in children generating both private costs and public benefits. Fenge and Meier [2009] and Fenge and Von Weizsäcker [2010] show that the socially optimal fertility rate may be obtained by the mix of standard PAYG system and transfers related to individual fertility. Cipriani and Fioroni [2022] show that governments can realize the first-best allocation by introducing a child allowance scheme and a subsidy to incentivize the labor supply of older workers. Optimal family policy design is the subject of several studies. For instance, Cigno and Luporini [2011] demonstrate in a theoretical framework that providing credit to households during the child-rearing period brings the private fertility level closer to the optimal level. This paper builds on their work by adding a quantitative analysis of the welfare effects of family policies. The magnitude of optimal child-related transfers is increasing in longevity, saccording to van Groezen and Meijdam [2008], and the size of social security, as per Yasuoka and Goto [2011].

Third, this paper contributes to the growing stream of the **literature on the economic consequences of child-related transfers**. Hannusch et al. [2019], Rogerson [2007], Alon et al. [2020], Olivetti and Petrongolo [2017]. Child-related transfers can account for a considerable part of the employment gap between married women with and without children, see Hannusch et al. [2019], Alon et al. [2020]. Rogerson [2007] shows that high levels of female labor supply in Scandinavia are attributed to the scope and magnitude of child-related transfers. However, the effects of child-related transfers are complex, and the local context (economic, cultural, and political economy) is crucial Olivetti and Petrongolo [2017]. Thus, macro-simulation models offer an important contribution to the ex-ante evaluation and fiscal policy implications. This paper is closely related to the works of Fehr and Ujhelyiova [2013] who use the overlapping generations, general equilibrium model of Germany to study the impact of family policy on household labor supply and fertility decisions. Bucciol et al. [2017] study the redistributive effects of child-related transfers for France, Italy, and Sweden, and show that in the case of child care, life cycle redistribution could be negative since there is no obvious relationship between having children and life cycle disposable income. Several recent papers seek to estimate

[2]This link also applies to other intergenerational transfers such as Medicare, Medicaid, and public debt, as noted in Ishida et al. [2015] and Fanti and Spataro [2013].

how child-related transfers impact fertility, exploiting natural experiments in several countries. These papers find evidence consistent with a positive and significant price effect on overall fertility Luci-Greulich and Thévenon [2013], Gauthier [2007], González and Trommlerová [2023].[3] Not only the magnitude of child-related transfers but also the nature of those transfers affect fertility response Doepke and Kindermann [2019]. Furthermore, Wang and Xu [2020] show that labor market structures, such as the scale of gender discrimination, also affect the effectiveness of child-related transfers in supporting fertility.

3 Transfers in the US: social security, child related transfers and American Rescue Plan

3.1 Social security

The Old-Age, and Survivors, and Disability Insurance (OASDI) program offers monthly benefits to eligible retired and disabled individuals, their dependents, and the survivors of insured workers. Eligibility and benefit amounts are contingent on a worker's contributions to Social Security, with benefits displaying a progressive nature that favors low-income retirees through higher replacement rates. Operating on a Pay As You Go basis, the system channels revenue from social security contributions towards the U.S. Treasury to finance current benefit expenditures. Surplus funds, not allocated for immediate expenses such as benefits or administrative costs, are invested in interest-bearing Federal securities.[4] Social security constitutes a significant aspect of the government's budget. The Trustees' projections indicate that the annual cost of OASDI will rise from 5.2% of GDP in 2023 to 6.3% by 2076.[5] For many retirees, Social Security is their primary income source. The Social Security Administration's research, which combines survey and administrative data, revealed that in 2015 Social Security accounted for at least 50% of income for 4 out of 10 retirees and at least 90% for 1 out of 7 retirees, see Dushi and Trenkamp [2021].

3.2 Child related transfers

According to the OECD data total spending on child-related policies equals 1.1 percent of GDP in the US. This expenditure is split roughly equally between a child tax credits (CTC) and public childcare (PCC), see Figure 1.

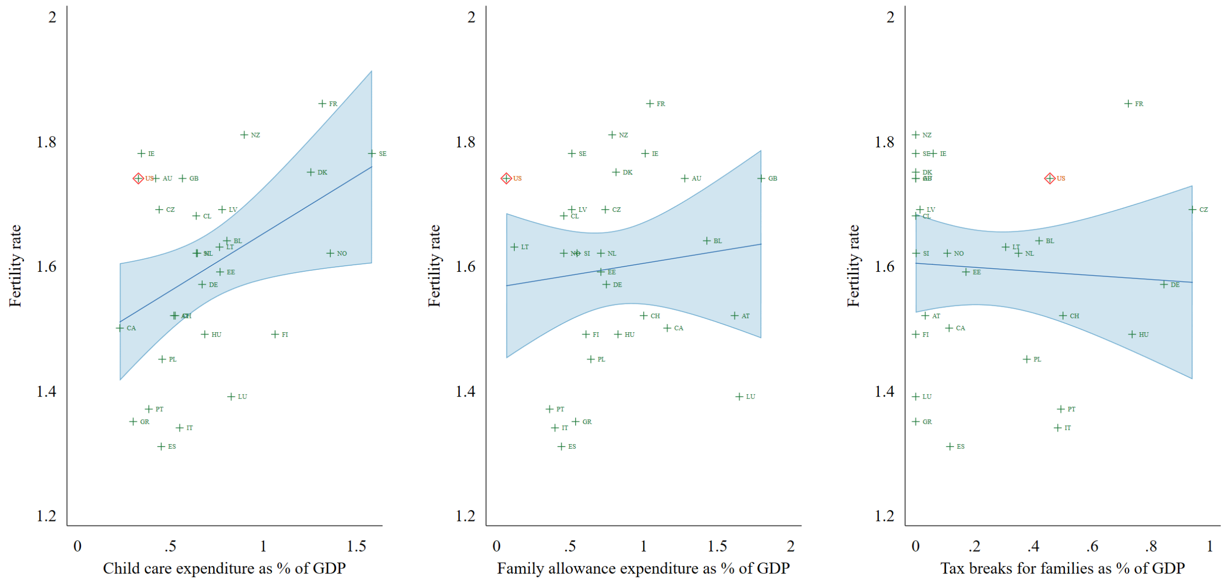
Public childcare (PCC) There are two instruments related to child-care: child care subsidies and childcare credits. The first one is addressed to low-income families and has a means-tested nature. The second one enables families to deduct childcare expenditure from

[3]In the model, children are treated as a normal good, so the same pattern applies.

[4]Annual Statistical Supplement to the Social Security Bulletin, accessed 30 March 2023.

[5]The 2023 annual report of the board of trustees of the federal old-age and survivors insurance and federal disability insurance trust funds, accessed 30 March 2023.

Figure 1: Expenditure on family policies and fertility rate



Note: OECD Social Expenditure database for Early Child Care Expenditure and Familly Allowance, OECD Table PF1.1.A for tax breaks, Fertility rate based on OECD data, data coresponds to 2017

taxable income. However, the latter is not refundable and thus serves predominantly high-income families.

Child tax credits (CTC) consists of two instruments: child tax credit and additional child tax credit. The former is not refundable, implying that if a household's tax liabilities fall short of the credit, the household can only claim it up to the taxes due. This makes the instrument effectively regressive, as high income households benefit more than low income households. The latter instrument is refundable as long as household income exceeds $10 750 [compare Guner et al., 2020], partially compensating for the regressivity of the first instrument. Admittedly, not all eligible families apply for either of the tax credits. This is more common among more impoverished families. As a result, 10 percent of children in the US do not receive a child-related tax credit, see Collyer et al. [2020]. Due to The American Rescue Plan Act of 2021, the child tax credit becomes – temporarily – a near-universal child allowance available to almost all families with children. For the evolution of child tax credit forms over time, see Crandall-Hollick [2021].

3.3 American Rescue Plan (ARP)

The COVID-19 pandemic has significantly impacted the health and economic wellbeing of the American workforce, prompting the introduction of the American Rescue Plan (ARP). The ARP aimed to provide immediate financial assistance to American families. One of the ARP component was expansion of the Child tax credits (CTC). In 2021, the CTC was amended in three ways: an increase in credits value, the introduction of full refundability, and an expansion of the credits' scope. Under the ARP, the CTC was raised from $2,000 to $3,000 per child, or $3,600 for children under six years of age. The credits was made fully refundable. By making the CTC fully refundable, low- income households will be entitled to receive the full credits benefit, as significantly expanded and increased by the American Rescue Plan. Moreover, credits' scope has been expanded and 17-year-olds were also considered eligible for the credits. Consequently, a typical family of four with two young children could receive an additional $3,200 to support child-rearing expenses. This policy change is anticipated to benefit the families of over 66 million children. In 2021, the majority of families obtained monthly payments of at least $250 per child without any required action.[6] Furthermore the APR increase the Earned Income Tax Credits for 17 million workers and expanded child care assistance. Families got back as a refundable tax credits as much as half of their spending on child care for children under age 13. The ARP was projected to alleviate poverty for more than 5 million children, reducing the overall child poverty rate by 52 percent, largely due to the expanded CTC, which by itself cut child poverty by 40 percent, see Wimer et al. [2022]. In 2022 the policy was reversed, leading to rebound of child poverty rate to pre-pandemic levels.[7]

4 The intuition behind family policy: stylized model

In this section, I explain the key mechanism behind the welfare improvement resulting from the expansion of family policies. In the US, the social security system operates on a Pay-As-You-Go basis, where the level of pension benefits depends on the aggregate fertility in the economy. However, parents do not consider the impact of their fertility choices on future pension benefits, which leads them to choose lower fertility levels than what the Constrained Social Planner would choose. The family policy affects the individual child-rearing cost and may bring the individual fertility decision to the socially optimal level.[8] The main results of this paper rely on a more detailed quantitative model calibrated to the US economy that builds on the same intuition as the stylized model but helps to address some of its shortcomings. The quantitative analysis is presented in the following sections.

4.1 Framework in the stylised model

Households live for two periods and survive to the second period with probability π. At the beginning of the first period, households know their current income y_1. However, they are uncertain about their labor income in the second period, which may take two values:

[6] White House: American Rescue Plan Fact Sheet, accessed 30 March 2023.

[7] The Center on Poverty and Social Policy : monthly poverty data, accessed 30 march 2023

[8] It is important to note that this externality is not the only source of inefficiency in the economy, as uninsurable labor income risk is another factor. Although labor is exogenous in the stylized model, addressing the insurance efficiency trade-off, i.e., endogenous labor, is necessary to account for progressive transfers adequately. In the following sections, I partially address this issue in the computational model.

$y_{2,H} = y_2 + \sigma$ and $y_{2,L} = y_2 - \sigma$, each with a probability of $\frac{1}{2}$. There is a social security contribution rate τ. Each young household pays a lump sum tax θ covering the cost of family policy φ. The remaining income is divided into consumption, child-rearing cost, and savings. The price of consumption is normalized to one. The total cost of child-rearing is equal to p per child. However, the family policy implies a φ transfer per child. In the first period, families accumulate assets, a, to smooth consumption. Hence, the budget constraint in the first period is given by:

$$c_1 + (p - \varphi)n + a = y_1(1 - \tau) - \theta. \tag{1}$$

In the second period, household income consists of labor income $y_{2,i}$, social security benefits b, and the interest on its assets ra, where r is the interest rate. Households do not have any bequest motive, and therefore consume all accumulated wealth a. Hence, the budget constraint is given by:

$$c_{2,i} = y_{2,i} + b + (1 + r)a, \tag{2}$$

for each productivity realization $i \in L, H$. I solve the problem in partial equilibrium; thus, the gross interest rate $R = (1 + r)$ and the labor incomes $y_1, y_{2,L}, y_{2,H}$ are exogenous. The households' preferences are given by:

$$U(c_1, n, c_2) = u(c_1) + v(n) + \pi E(u(c_2)). \tag{3}$$

Households derive utility from consumption in the first $u(c_1)$ and the second $u(c_2)$ period of their life. I assume $u(\cdot)$ is strictly increasing and strictly concave $u' > 0$, $u'' < 0$. Moreover, households have preferences for prudence i.e. $u''' > 0$, which is standard in the literature concerning income risk, see Carroll [1997] and subsequent literature.[9] Finally, households derive utility from the number of children $v(n)$, with v being increasing, $v' > 0$, and concave, $v'' < 0$. If the household decides not to have children, the utility $v(0)$ is finite, and the cost associated with having children is equal to zero. The fertility decision is made at the beginning of the first period. Solving the household problem leads to the following first order conditions:

$$v'(n^*) = p - \varphi u'(c_1^*), \tag{4}$$

$$u'(c_1^*) = R\pi \frac{1}{2}\left[u'(c_{2,H}^*) + u'(c_{2,L}^*)\right]. \tag{5}$$

Government runs the social security system and family policy. The social security system is balanced and operates on a PAYG basis; thus, social security benefits b paid for the old-age cohort of size π are covered by the next generation's contributions $n\tau y_1$ and are equal to $\frac{n\tau y_1}{\pi}$. Family policy is an unconditional transfer φ paid per child. The payments are covered by the lump sum tax θ. Moreover, the government budget is balanced, thus $\varphi n = \theta$.

[9] Preference for prudence means that one unit of wealth has more value under uncertainty; thus, it gives rise to a precautionary motive for savings. Technically, it means that the utility function has decreasing absolute risk aversion.

4.2 Improving welfare by supporting child-rearing families

When no family policy is in place ($\varphi = 0$), the entire cost of child-rearing is borne by the parents. However, each child provides both private (parents' utility) and public (increased future pension) benefits. This occurs because pension benefits rely on the total fertility rate in the economy, denoted by $b = \frac{n\tau y_1}{\pi}$. Households perceive social benefits as constant and do not account for fertility-benefit link. As a result, the social value of children surpasses their private value. Unaware of these positive externalities, parents end up having fewer children than optimal.

Proposition 1. *Suppose that there is no family policy, $\varphi = 0$. Then the fertility in a competitive equilibrium is sub-optimal.*

A higher number of children will be associated with higher social security benefits in old age. Thus the need for private savings would decrease. Households can enjoy greater consumption in the first period and have more children without compromising their consumption in the second period. A formal proof can be found in Appendix A. Implementing a family policy that introduces a positive Pigouvian subsidy per child may lead to optimal fertility levels.

Constrained Social Planner accounts for the link between social security benefits and fertility and maximizes the Millian Welfare function[10] (6) subject to the constraints given by (7) and (8):

$$
\begin{aligned}
SU &= U(c_1, n, c_2) && (6)\\
c_1 + pn + a &= y_1(1-\tau) && (7)\\
c_{2,i} &= y_{2,i} + \frac{n\tau y_1}{\pi} + Ra. && (8)
\end{aligned}
$$

To ensure a well-defined optimal allocation, an extra assumption is required to limit the size of social benefits, $p > \frac{\tau y_1}{R\pi}$. Without this assumption, the optimal allocation would result in infinite private debt due to the cost of an infinite number of children. Those children would create a stream of pension benefits sufficient to repay the private debt. The optimal allocation

[10] Defining the Social Welfare function is not straightforward in the framework with endogenous fertility. The key issue involves the social planner's preference for population size. A substantial number of studies that address optimality in frameworks with endogenous fertility ascribe a Millian objective to the constrained social planner problem, as seen in Conde-Ruiz et al. [2010]. In this approach, the Social Welfare function represents the expected utility of the representative household in a steady-state, indicating that the Social Planner focuses on the well-being of the representative household without factoring in population size. This view of social preferences often contrasts with Benthamite social welfare functions, where the social planner exhibits a 'natalist bias' and aims to maximize the total utility of all individuals in the economy. In this formulation, the utility of living households must be strictly positive, while the utility of unborn households is set to zero.

is given by the following first-order conditions:

$$v'(\hat{n}) = pu'(\hat{c}_1) - \pi\frac{\tau y_1}{\pi}\frac{1}{2}\left[u'(\hat{c}_{2,H}) + u'(\hat{c}_{2,L})\right], \tag{9}$$

$$u'(\hat{c}_1) = \pi R\frac{1}{2}\left[u'(\hat{c}_{2,H}) + u'(\hat{c}_{2,L})\right]. \tag{10}$$

and the constraints defined in (7) and (8). As the utility derived from children is increasing and concave, and $\tau y_1 \frac{1}{2}\left[u'(\hat{c}2, H) + u'(\hat{c}2, L)\right]$ is positive, the social planner prefers a higher fertility rate compared to the competitive equilibrium. By adjusting the share of the child-rearing cost that burdens households, the constrained social planner can equalize the allocation in the competitive equilibrium with the constrained social optimum.

Proposition 2. *The optimal allocation can be decentralized by a positive subsidy per child $\varphi = \frac{\tau y_1}{R\pi}$, that is financed with lump-sum tax.*

Proof. o implement the optimal allocation in the competitive equilibrium, we need to equalize the first-order conditions describing the intratemporal choice in the competitive equilibrium (4) and the constrained social optimum (9), which translates to the following condition:

$$\tau y_1 \frac{1}{2}\left[u'(\hat{c}_{2,H}) + u'(\hat{c}_{2,L})\right] = \varphi u'(\hat{c}_1).$$

We can simplify the formula for the optimal subsidy per child using the Euler equation (10):

$$\varphi = \frac{\tau y_1}{R\pi}.$$

To close the government budget, one needs to implement a lump-sum tax θ such that: $\theta = \varphi\hat{n} = \frac{\tau y_1}{R\pi}\hat{n}$. Such a policy is feasible. First, θ is set such that the government budget constraint holds. Second, households' budget constraint in the second period of life is not affected directly, thus it holds. Third, to examine households' budget constraint in the first period, I substitute for θ and φ into the equation (4) and obtain:

$$c_1 + (p - \frac{\tau y_1}{R\pi})n + a = y_1(1-\tau) - \frac{\tau y_1}{R\pi}\hat{n},$$

It holds for the optimal allocation $\{\hat{n}, \hat{c}1, \hat{c}2, H, \hat{c}_{2,L}\}$ introduced by Constrained Social Planer. □

4.3 Discussion and implication for quantitative model

The current section provides the theoretical background for this article: in the presence of PAYG social security, private fertility choice is suboptimal, and the fertility level is too low if there is no government intervention, see Proposition 1. In this article, I concentrate on a case of PAYG social security. However, the same intuition holds for other forms of intergenerational redistribution, such as public medical care or public debt. The optimal allocation may be obtained by the family policy that introduces a positive Pigouvian subsidy per child, see Proposition 2. In the computational model, I show that in the case of the US, an expansion of family policy may allow to improve social welfare, see section 7.

5 Quantitative model

In the previous section, I presented the key concept of how family policy affects decisions about having children in a context with a pay-as-you-go (PAYG) social security system. This section aims to develop a more comprehensive quantitative model to quantify the welfare and macroeconomic impact of family policy expansion. I study the impact of policy changes on this economy, particularly how three types of child-related policies–child tax credit, public childcare, and unconditional child allowance–can be adjusted. Policy changes are examined by comparing steady states, disregarding transitional dynamics for computational reasons.[11]

The quantitative model features a life-cycle economy with three main stages. First, individuals live with their parents. Next, they establish their own households and enter the labor market, which introduces heterogeneity as people experience different initial productivity levels. These shocks are idiosyncratic and uninsurable. During this stage, households make decisions about labor, savings, consumption, and the number of children they will have. Children require both time and financial resources. Lastly, individuals retire, no longer work, and support themselves through personal savings and retirement benefits. In this economy, perfectly competitive firms produce goods using the Cobb-Douglas production function. A government collects taxes on capital, labor, and consumption and operates a social security system. The taxes fund a fixed level of government consumption and child-related policies. The social security system runs on a PAYG basis, providing progressive benefits and balances by adjusting the size of the benefits.

5.1 Household

Households live for $j = 1, 2, ..., J_d$ periods, with each period corresponding to 5 years. In each period, they face an age-dependent conditional probability of surviving to the next period, denoted as $\pi_{j,t,t+1}$. Households are certain to die at the age of $J_d = 20$. Until the age of J_i, which corresponds to 20 years in the data, individuals live with their parents. At age J_i, they form independent households and enter the labor market. The state of each family aged j in period t is represented by $s_{j,t}$, which can be summarized by the level of private assets $a_{j,t}$, social security funds $f_{j,t}$, and individual stochastic productivity $\eta_{j,t}$, such that $s_{j,t} = (a_{j,t}, f_{j,t}, \eta_{j,t}) \in \Omega$, where Ω is a state space. A household enters the economy with no assets and no social security funds ($a_{J_i,t} = 0$, $f_{J_i,t} = 0$).

[11]It's worth noting that the welfare effects described in this paper may overestimate the benefits of policy implementation, as family policies involve immediate costs and future gains.

Households derive immediate utility from consumption, leisure, and children given by the felicity function:

$$u(c, l, n) = \ln(c) + \phi \ln(1 - l - t(n)) + \phi_n \ln(1 + n).$$

Here, c represents consumption, l represents labor supply, and $t(n)$ represents the time cost of raising n children. Time subscripts are omitted for brevity. Instantaneous utility from the number of children n is given by $\phi_n \ln(1 + n)$. Individuals do not make any decisions while living with their parents. The following sections describe the household decision problems for working and retirement ages.

Working stage Households enter the labor market at age $j = J_i$, work until age $j = J_r$, and choose the number of children they have during the fertility period $j = J_f$. Children stay within a family until the period J_k when they become independent. For periods $j \in [J_i, J_f) \cup (J_k, J_r)$, each household is in the working and childless stage. The optimization problem for such a household is given by maximizing equation (11), subject to the budget constraint in equation (12) and social security fund accumulation in equation (13):

$$V_{j,t}(s_{j,t}) = \max_{c_{j,t}, l_{j,t}, a_{j+1,t+1}} u(c_{j,t}, l_{j,t}, 0) + \pi_{j,t,t+1}\beta \mathbf{E}\big(V_{j+1,t+1}(s_{j+1,t+1}) \mid s_{j,t}\big), \tag{11}$$

subject to:

$$a_{j+1,t+1} + (1 + \tau_{c,t})c_{j,t} = y_{j,t} - \mathcal{T}(y_{j,t}) + a_{j,t} + (1 - \tau_k)r_t a_{j,t} + \Gamma_{j,t}, \tag{12}$$

$$f_{j+1,t+1} = \frac{1}{j}((j-1) \cdot f_{j,t} \cdot (1 + g_t) + \min\{\omega_{j,t} w_t l_{j,t}, cap_t\}). \tag{13}$$

A working household earns labor income $\omega_{j,t} w_t l_{j,t}$, where $\omega_j = \eta_j e^{\varepsilon_j}$ is individual productivity described in details in section 5.3, w_t is the average wage, and $l_{j,t} \in [0, 1]$ represents the labor supply. Labor income is subject to the social security contribution rate τ_t and the progressive labor income tax. Note that social security contributions are exempt from labor taxation. The labor income tax base for a household at age j in period t is given by: $y_{j,t} = (1 - \tau_t)w_t\omega_{j,t}l_{j,t}$.

Following Benabou [2002], the formula for taxes is: $\mathcal{T}(y_{j,t}) = y_{j,t} - (1 - \tau_l)y_{j,t}^{1-\lambda}$, where $\mathcal{T}(y_{j,t})$ is the labor tax due at income level $y_{j,t}$. In addition to labor income, a household earns capital income $(1 - \tau_k)r_t a_{j,t}$, with r_t denoting the interest rate and $a_{j,t}$ denoting assets accumulated at age j. Capital income is taxed at the rate τ_k. Households also receive unintended, cohort-specific bequests $\Gamma_{j,t}$. Income is used to accumulate assets $a_{j+1,t+1}$ and purchase consumption goods $(1 + \tau_{c,t})c_{j,t}$, with $\tau_{c,t}$ denoting tax on consumption. Social security funds at age j are given by average earnings accumulated since entering the labor market. Funds are subject to cap cap_t and increase in line with payroll growth rate g_t.

Fertility decision and raising children At age $j = J_f$, the household chooses consumption $c_{j,t}$, labor supply $l_{j,t}$, savings $a_{j+1,t+1}$, and the number of children $n_{j,t}$, which is a discrete choice with $n_{j,t} \in 0, 1, 2, 3, 4$. Rearing children is costly. Parents pay the cost of children consumption

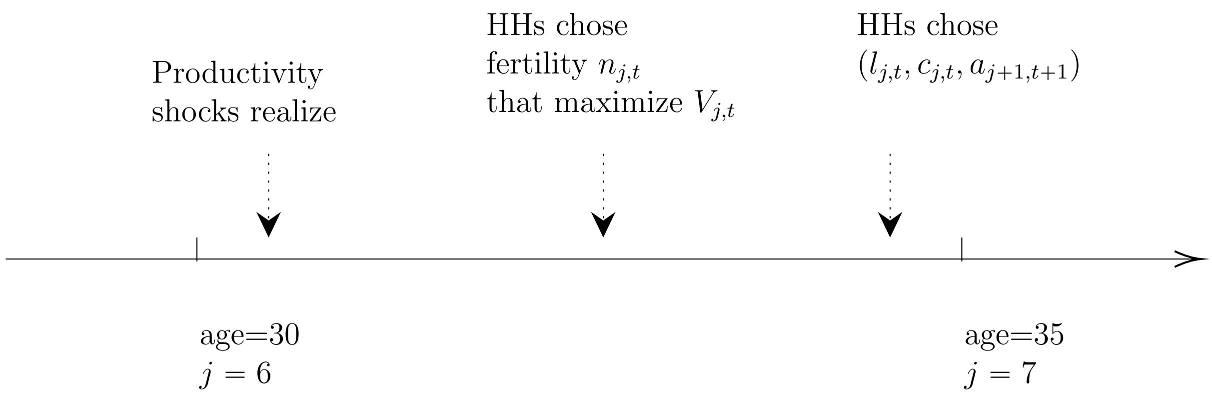
$m(n)$ and allocate $t(n)$ units of time to raise children. Due to child rearing, the time endowment is reduced to $l_{j,t} \in [0, 1 - t(n)]$. The government supports households in raising children with three policy instruments. The child allowance, μ_g, changes the monetary cost of child rearing to $(1 - \mu_g)m(n)$. The childcare t_g changes the time cost of child rearing to $(1 - t_g)t(n)$. The child tax credit $tc(y, n)$ is a monetary transfer that depends on labor income y and the number of children n. The household problem at the age of fertility $j = J_f$ is given by:

$$V_{j,t}(s_{j,t}) = \max_{c_{j,t}, l_{j,t}, a_{j+1,t+1}, n_{j,t}} u(c_{j,t}, l_{j,t}, n_{j,t}) + \pi_{j,t,t+1}\beta \mathbf{E}\big(V(s_{j+1,t+1}) \mid s_{j,t}\big) \tag{14}$$

$$\begin{aligned} a_{j+1,t+1} + (1 + \tau_{c,t})c_{j,t} + (1 - \mu_g)m(n_{j,t}) &= \\ y_{j,t} - \mathcal{T}(y_{j,t}) + a_{j,t} + (1 - \tau_k)r_t a_{j,t} + \Gamma_{j,t} + tc(y_{j,t}, n_{j,t}), & \qquad (15) \\ f_{j+1,t+1} = \frac{1}{j}((j-1) \cdot f_{j,t} \cdot (1 + g_t) + \min\{\omega_{j,t} w_t l_{j,t}, cap_t\}). & \end{aligned}$$

Until the children become independent ($J_f < j \leqslant J_k$), the households cover the time and money cost of the children. Hence, the problem is equal to maximizing (15) subject to (16) but taking the number of children n as given.

Figure 2: Timing of fertility choice



Note: The sequence of the events during the fertility period J_f. First, the income shock is realized. Then the family decides on fertility, consumption, labor, and wealth accumulation.

Retirement stage At age $j = J_r$, the household retire. Since children become independent in period J_k, the household is childless in retirement stage, $n_{j,t} = 0$ for $j > J_r$. During the retirement household does not supply any labor, $l_{j,t} = 0$ for $j \geqslant J_r$, sice there is no child-related time cost, the whole time endowment can be spend on leisure. In retirement stage household income consists of after-tax capital income $(1 - \tau_k)r_t a_{j,t}$, social security benefits $b_{j,t}$ and unintended bequests $\Gamma_{j,t}$. Without loss of generality, there is no income tax on social security benefits. Since there is no labor income risk during the retirement stage, the problem of retired individuals is given by:

$$V_{j,t}(s_{j,t}) = \max_{c_{j,t},a_{j+1,t+1}} u(c_{j,t},0,0) + \pi_{j,t,t+1}\beta V_{j+1,t+1}(s_{j+1,t+1}) \quad (16)$$

$$a_{j+1,t+1} + (1+\tau_{c,t})c_{j,t} + \Upsilon = a_{j,t} + (1-\tau_k)r_t a_{j,t} + b_{j,t} + \Gamma_{j,t}. \quad (17)$$

5.2 The government

Taxes The government collects three types of taxes: progressive labor income tax $\mathcal{T}(y_{j,t})$, capital income tax $\tau_{k,t}r_tA_t$, and consumption tax $\tau_{c,t}C_t$:

$$T_t = \sum_{j=1}^{J_r-1} N_{j,t}\int_{\Omega}\mathcal{T}\big(y_{j,t}(s_{j,t})\big)d\mathbb{P}_{j,t} + \tau_k r_t A_t + \tau_{c,t}C_t, \quad (18)$$

$$A_t = \sum_{j=1}^{J} N_{j,t}\int_{\Omega} a_{j,t}(s_{j,t})d\mathbb{P}_{j,t},$$

$$C_t = \sum_{j=1}^{J} N_{j,t}\int_{\Omega} c_{j,t}(s_{j,t})d\mathbb{P}_{j,t},$$

where C_t and A_t denote, respectively, aggregate consumption and aggregate assets. $\mathbb{P}j,t$ is the probability measure that is consistent with the assumptions about policy functions and productivity processes described in Section 5.3. Taxes are spent on government consumption G_t, debt service r_tD_{t-1}, and cover the cost of child-related transfers CRT_t:

$$G_t + r_tD_{t-1} + CRT_t = T_t. \quad (19)$$

I assume that government consumption and public debt are constant as a share of GDP. The initial steady-state level of government consumption closes the government budget. In the reform scenario, the government uses the consumption tax to cover the cost of policy change. The social security system is balanced and it's budget constraint is given by:

$$\sum_{j=J_r}^{J} N_{j,t}\int_{\Omega} b_{j,t}(s_{j,t})d\mathbb{P}_{j,t} = \tau_t w_t L_t. \quad (20)$$

Social security in the model replicates the main features of the current U.S. social security design. It is redistributive and operates on a pay-as-you-go (PAYG) basis. I denote Average Indexed Monthly Earnings (AIME) accumulation by $f_{j,t}$:[12]

$$f_{j+1,t+1} = \frac{1}{j}((j-1)\cdot f_{j,t}\cdot(1+g_t) + \min\{\omega_{j,t}w_tl_{j,t}, cap_t\}), \quad (21)$$

[12] I compute AIME based on the whole working period rather than 35 years with the highest earnings, as it would be redundant in a setup with 5-year periods. The implementation is in line with earlier literature, such as [Nishiyama and Smetters, 2007, McGrattan and Prescott, 2017].

where cap_t denotes the OASDI cap[13], and payroll growth is given by $g_t = \frac{w_t L_t}{w_{t-1} L_{t-1}} - 1$. The replacement rate ρ is consistent with the progressive nature of the social security. I rely on bend points $(F_{1,t}, F_{2,t})$ expressed as a fraction of average earnings. The replacement is given by:

$$\rho_{J_r,t} \;=\; [f_{J_r,t}]^{-1}\big[0.9\min\{f_{J_r,t}, F_{1,t}\} + 0.32\min\{f_{J_r,t} - F_{1,t}, F_{2,t}\} + 0.15(f_{J_r,t} - F_{2,t})\big]. \quad (22)$$

The old age social security benefits in period t are given by:

$$b_{J_r,t} \;=\; \rho_t^m \rho_{J_r,t} \cdot f_{J_r,t} \quad \text{and} \quad b_{j,t} = (1+g_t) b^A_{j-1,t-1} \forall j > J_r, \quad (23)$$

where ρ_t^m is set to match the steady state social security benefit to GDP ratio and then adjusts to keep the social security system balanced.

Child-related transfers CRT consist of three types of fiscal tools: child-related tax credits CTC_t, public child-care PCC_t, and universal child allowance UCA_t. The first and second instruments are present in the current US family policy and primarily provide support to working parents. The third instrument is popular among the rest of the OECD countries but is absent in the US policy toolkit. Childcare services are provided using labor input only; thus, the cost of childcare services is proportional to the wage rate, w_t.[14]

$$\begin{aligned} CRT_t &= CTC_t + PCC_t + UCA_t, \quad (24) \\ CTC_t &= \sum_{j=J_f}^{J_k} N_{j,t} \int_\Omega tc(y_{j,t}(s_{j,t}), n_{j,t}(s_{j,t})) d\mathbb{P}_{j,t} \\ PCC_t &= w_t \sum_{j=J_f}^{J_k} N_{j,t} \int_\Omega t_g \cdot t(n_{j,t}(s_{j,t})) d\mathbb{P}_{j,t}, \\ UCA_t &= \sum_{j=J_f}^{J_k} N_{j,t} \int_\Omega \mu_g \cdot m(n_{j,t}(s_{j,t})) d\mathbb{P}_{j,t}. \end{aligned}$$

5.3 The economic environment

Production and markets Firms are perfectly competitive and operate with a Cobb-Douglas production function $Y_t = K_t^\alpha (z_t L_t)^{1-\alpha}$, with labor augmenting exogenous technological progress, $z_{t+1}/z_t = \gamma$. Capital depreciates at the rate d. Standard maximization problem of the firm yields the return on capital and the real wage:

$$r_t = \alpha K_t^{\alpha-1}(z_t L_t)^{1-\alpha} - d \quad \text{and} \quad w_t = (1-\alpha) K_t^\alpha z_t^{1-\alpha} L_t^{-\alpha}, \quad (25)$$

[13] Social Security's Old-Age, Survivors, and Disability Insurance (OASDI) program limits the earnings used in a benefit computation. This limit changes each year with changes in the national average wage index.

[14] Details on the functional form of the tax credit $tc(y(s_{j,t}), n(s_{j,t}))$, the public child care $t_g \cdot t(n(s_{j,t}))$, and the child allowance $\mu_g \cdot m(n(s_{j,t}))$ are provided in Section 6, which describes the calibration and, in particular, the family policy shape in Section 6.2.

Productivity Households' productivity evolves according to $\omega_{j,t} = \eta_{j,t}e^{\varepsilon_{j,t}}$, where $\eta_{j,t}$ is the age-dependent deterministic productivity component and $\varepsilon_{j,t}$ is a random component that follows an AR(1) process with persistence parameter ϱ and innovation $\varepsilon_{j,t} \sim \mathbf{N}(0, \sigma^2)$:

$$\varepsilon_{j,t} = \varrho\varepsilon_{j-1,t-1} + \epsilon_{j,t}. \tag{26}$$

As is standard in the literature, I approximate the process above by a first-order Markov chain with a transition matrix $\Pi(\varepsilon_{j,t}|\varepsilon_{j-1,t-1})$. Households enter the independent stage of their life with heterogeneous productivity levels uncorrelated with their parents' productivity. Income shocks are uninsurable, i.e., the asset markets are incomplete.

Demographics The number of newborns in a given period depends on the number of households choosing completed fertility in that period, represented by $N_{J_f,t}$, and the cohort completed fertility rate, denoted by $n_{J_f,t} = \int_\Omega n_{J_f,t}(s_{j,t})d\mathbb{P}j, t$. The total number of newborns in a given period can be obtained by multiplying $n_{J_f,t}$ with NJ_f, t. Since each household consists of two adults, the number of children needs to be divided by 2 to obtain the number of households that can be formed by the newborn children when they become independent after $J_k - J_f$ periods, denoted by $N_{J_i,t+(J_k-J_f)}$:

$$N_{J_i,t+(J_k-J_f)} = \frac{n_t N_{J_f,t}}{2}. \tag{27}$$

In each period, households face an age-dependent conditional probability of surviving to the next period, denoted by $\pi_{j,t,t+1}$. At the age of $J_d = 20$, households die with certainty. Thus, the number of households at age j at time t is given by:

$$N_{j,t} = \pi_{j-1,t-1,t}N_{j-1,t-1}. \tag{28}$$

Unintended bequest Since households face an age-dependent conditional probability of surviving to the next period, $\pi_{j,t,t+1} \leqslant 1$, some households die before they reach the final age J_d. Their assets are redistributed among those who survived in a given cohort in the form of unintended, cohort-specific bequest $\Gamma_{j,t}$ given by:

$$\Gamma_{j+1,t+1} = \frac{1 - \pi_{j,t,t+1}}{\pi_{j,t,t+1}} \left(1 + (1 - t_k)r_t\right) a_{j,t}. \tag{29}$$

5.4 Recursive equilibrium

Definition 1. *A recursive competitive equilibrium is a sequence of policy functions* $\{(c_{j,t}(s_{j,t}), l_{j,t}(s_{j,t}), a_{j+1,t+1}(s_{j,t}))_{j=1}^{J}\}_{t=1}^{\infty}$, *value functions* $\{(V_{j,t}(s_{j,t}))_{j=1}^{J}\}_{t=1}^{\infty}$, *prices* $\{r_t, w_t\}_{t=1}^{\infty}$, *government policies* $\{\tau_{c,t}, \mathcal{T}\big(y_{j,t}\big), \tau_k, \Gamma_{j+1,t+1}, D_t\}_{t=1}^{\infty}$, *social security system characteristics* $\{\tau, \rho_t^m, \rho_{J_r,t}\}_{t=1}^{\infty}$, *family policies characteristics* $\{\mu_g, t_g, tc(y(s_{j,t}), n(s_{j,t}))\}$, *aggregate quantities* $\{L_t, A_t, K_t, C_t, Y_t\}_{t=1}^{\infty}$, *total fertility rate* $\bar{n}_t$ *and a measure of households* $\mathbb{P}_{j,t}$ *such that:*

- ***consumer problem:*** *for each* j *and* t *the value function* $V_{j,t}(s_{j,t})$ *and the policy functions*

$(c_{j,t}(s_{j,t}), l_{j,t}(s_{j,t}), n_{j,t}(s_{j,t}), a_{j+1,t+1}(s_{j,t}), f_{j+1,t+1}(s_{j,t}))$ *solve the optimization problem* (11), (15) *and* (17) *given prices;*

- ***firm problem:*** *for each* t*, given prices* (r_t, w_t)*, the aggregates* (K_t, L_t, Y_t) *solve the representative firm problem, satisfying equation* (25)*;*
- ***government sector:*** *the government budget and the PAYG social security system are balanced, i.e. equations* (18) - (24) *are satisfied;*
- ***markets clear***

$$\begin{aligned}
\textit{labor market:} \quad L_t &= \sum_{j=1}^{J_r} N_{j,t} \int_\Omega \omega_{j,t}(s_{j,t}) l_{j,t}(s_{j,t}) d\mathbb{P}_{j,t} && (30)\\
\textit{capital market:} \quad A_t &= \sum_{j=1}^{J} N_{j,t} \int_\Omega a_{j,t}(s_{j,t}) d\mathbb{P}_{j,t} && (31)\\
K_{t+1} &= A_t - D_t && (32)\\
\textit{goods market:} \quad C_t &= \sum_{j=1}^{J} N_{j,t} \int_\Omega c_{j,t}(s_{j,t}) d\mathbb{P}_{j,t} && (33)\\
Y_t &= C_t + K_{t+1} - (1-d)K_t + G_t; && (34)
\end{aligned}$$

- ***probability measure:*** *for all* t *and for all* j*,* $\mathbb{P}_{j,t}$ *is consistent with the assumptions about productivity processes and policy functions.*
- ***population dynamics*** *follow equations* (27) *and* (28)

5.5 Welfare measurement

Measuring welfare effects in the presence of endogenous fertility is not a straightforward task. In the quantitative model, the Millian efficiency criterion is employed, as outlined in the stylized version of the model in section 4. This approach allows welfare changes to be defined solely through comparisons among individuals who are born, without the need to consider well-defined utility functions for the unborn.

Welfare effects are assessed using the consumption equivalent, which is expressed as a percentage of baseline consumption when individuals reach independence ($j = J_i$). Two welfare measurements are utilized: welfare for 20-year-olds with a given productivity realization ($M_{1,t}(s_{j,t})$) and welfare under the veil of ignorance ($\overline{M_{1,t}}$). Benabou [2000] refers to the latter as risk-adjusted welfare. The specific formula for calculating welfare effects depends on the instantaneous utility function, and for logarithmic utility function, the following holds.

Let V^R and V^B represent the value functions associated with the optimal choice in the reform and baseline scenarios, respectively. Let M represent the share of consumption in the baseline scenario, which a household would have to receive to be indifferent between the two scenarios:

$$M_{1,t}(s_{j,t}) = 1 - \exp\left(\frac{V_{1,t}^B(s_{j,t}) - V_{1,t}^R(s_{j,t})}{\sum_{s=0}^{J}\delta^s \pi_{1,t,t+s}}\right). \quad (35)$$

The welfare measure under the veil of ignorance, $\overline{M_{1,t}}$, represents the expected welfare effect for a household entering the economy in period t, without knowing its type yet:

$$\overline{M_{1,t}} = 1 - \exp\left\{\int_\Omega \left(\frac{V_{1,t}^B(s_{j,t}) - V_{1,t}^R(s_{j,t})}{\sum_{s=0}^{J}\delta^s \pi_{1,t,t+s}}\right) d\mathbb{P}_{1,t}\right\}. \quad (36)$$

where $\mathbb{P}_{1,t}$ represents the initial distribution of households across the state space. It's important to note that this measure refers to expected welfare rather than the welfare of expected realizations. A complete derivation of the welfare measurement can be found in Appendix B.

6 Calibration

6.1 Households

Preferences I calibrated the preference for leisure ϕ to match the observed share of hours worked in the economy, which is 31 percent of available time on average, as reported by the OECD's aggregate hours worked statistics. The discount factor δ was set at 1.02^5 to match the capital output ratio, which is equal to 3.[15] The Utility derived from having n children is determined by $\phi_n = 0.87$ to match the average fertility rate of 1.9 for the period of 2010-2015.

Opportunity cost of children. Children in the model are costly in terms of both money, $m(n)$, and time, $t(n)$. To calculate the **child-rearing expenditure**, I use data from the Consumer Expenditure Survey (CES). There are two important aspects of this data that I reflect in the model calibration. First, while the composition of the monetary cost differs substantially, the total amount is almost flat across child age, as shown in Figure C.5a. Second, child-rearing expenditure increases with income, which is consistent with the quality-quantity trade-off in the spirit of Barro and Becker [1989]. In the model, I ignore human capital and, therefore, endogenous quality choice. However, I incorporate the different "unit prices" of child-rearing for different labor productivity levels.[16] **Raising a child is time-intensive**. Parents spend, on average, less time on leisure and personal care activities compared to adults without

[15] In OLG models, it is not uncommon to have a discount factor above one since, with mortality, the effective discount rate is below one [e.g. Nishiyama and Smetters, 2007, McGrattan and Prescott, 2017].

[16] Heterogeneity in child-rearing costs is operationalized in the following manner. Families with the two lowest realizations of productivity shock have expenditure structures of the first income group portrayed in Figure C.5a. Families with the median shock realization face the expenditure structure as the second income group from Figure C.5a, and families with the two highest shock realizations face the cost structure of the third income group from that Figure.

children. In a household with children younger than six years old, the difference is equal to 2.2 hours per day and is flat over time, as evidenced by the Time Use data for the US. The difference is slightly lower for a family with older children, equivalent to 1.6 hours per day, as shown in Figure C.6a. This difference reflects the average time spent on intensive childcare, as seen in Figure C.6b. Following Daruich and Kozlowski [2020], I assume economies of scale in raising children, thus the time cost of child-rearing is given by:

$$t(n, j) = t_{n,j} n^{\theta} \tag{37}$$

where since the total time endowment of two parents equals 32 hours per day, the time cost for preschool children $t_{n,J_f} = 0.07$ and $t_{n,J_f+1}, ..., t_{n,J_k+1} = 0.05$ and $\theta = 0.65$, based on results by Folbre [2008]. It means that a household with n children aged $J = 1$ bares the cost of $2.2 * n^{0.65}$ hours per day, and in the case of older children, the time cost is equal to $1.6 * n^{0.65}$ hours per day.

6.2 Government

Taxes are calibrated using the approach by Mendoza et al. [1994]. The effective capital income tax rate is set to 28 percent to match the 5.4 percent ratio of the capital income tax revenues to GDP. The effective consumption tax rate is set to 9 percent to match the 2.8 percent ratio of consumption tax revenues to GDP. To calculate the shares of tax revenue in GDP, I use the average for the period of 1980-2015, as shown in Figure C.7a. The data on ratios between tax revenues and GDP are taken from the OECD data, as presented in Table C.1.

Labor income taxation in the US is progressive. To avoid kinks in the consumer problem, I approximate the US tax schedule by the tax function in line with Benabou [2002].[17] The parameters of the progressive labor income tax function are set to match the marginal and average tax rates implied by the US tax system. Holter et al. [2019] estimate that, in the case of labor income, the average λ across all family types is equal to 0.14. Accounting separately for child-related transfers lowers the progressivity of the tax system, and their estimate of λ goes down to 0.10 for childless families. Since I account for Earned Income Tax Credit (EITC) separately, I set $\lambda = 0.10$ and $\tau_l = 0.13$. These parameters match the elasticity of post-tax to pre-tax income and the 9.2% share of labor income tax revenues in GDP. The average and marginal tax rates implied by the model and tax code are presented in Figure C.7b.

The debt-to-GDP ratio is set to 110 percent.[18] To close the model in the baseline scenario, I set the government consumption share in GDP to 15 percent, which does not differ substantially from the 17 percent observed in the data. In all reform scenarios, I keep the debt and government consumption as a constant in per capita terms and close the government budget

[17] Such an approximation is also used by Holter et al. [2019], who study how tax progressivity and household heterogeneity affect Laffer curves, and Heathcote et al. [2017], who study the optimal progressive tax scheme in the US.

[18] Due to fiscal developments in the US, the debt/GDP ratio is higher in this study than in the earlier literature.

by adjusting the consumption tax.

Social security The replacement rate is progressive in the US Social Security system. Figure C.8a presents the marginal and average replacement rates. To match the 6.2 percent ratio of social security benefits to GDP, as shown in Figure C.8b, I set the benefit scaling factor ρ_m to 0.72. The effective contribution rate τ is set so that the Social Security system deficit in the baseline steady state equals 0, as in the data. The retirement eligibility age in the US is 66, which is equivalent to $J_r = 14$. The contribution rate and retirement eligibility age are kept unchanged across scenarios. The scaling factor is adjusted to avoid a deficit or surplus in the Social Security system.

Child-related transfers I explicitly model three types of child-related policies: childcare, tax credit, and child allowance. **Childcare** in the model is universal and reduces the time cost of having a child by the same amount of time endowment across all families. Therefore, families with high labor productivity value that type of transfer more than households with low productivity. Child-related **tax credit** supports working families with stable income. Namely, not all working families are eligible for that transfer; their income has to be sufficiently high. In the model, following Guner et al. [2020], I assume that all families with labor income higher than 17 percent of the average are eligible for that transfer. The size of the transfer for those families is uniform and determined by the total spending on the policy. **Child allowance** is modeled as a universal cash transfer proportional to the number of children in the household. Hence, low-income families would prefer child allowance over childcare.

In the baseline scenario, I replicate the structure of the US child-related transfers. According to the OECD data, total spending on child-related policies equals 1.1 percent of GDP and is split roughly equally between a child tax credit (CTC) and public childcare (PCC). In my model, the expenditures per each policy are equal to 0.5 and 0.6 percent of GDP, respectively. Hence, I ignore cash transfers which are almost absent in the current US system.

Public childcare (PCC) In the model, public childcare reduces the time cost of having a child and is universal. To match the total expenditures on that transfer, I set $t_g = 0.06$, i.e., public childcare covers 6 percent of the total time cost related to having a child. Thus, the time endowment of parents is equal to $1 - (1 - t_g)t(n)$.

Child tax credit (CTC) In the model, I follow Guner et al. [2020] and assume that households with income lower than 17 percent of average income do not receive a tax credit. Then I use a simplifying assumption that the tax credit is equal among other families. Matching total expenditures on child-related tax credit as a share of GDP leads to a transfer equal to 1.4 percent of average household income per child, as shown in Figure C.9.

$$tc(y, n) = \begin{cases} 0.014\bar{y}n, & if \quad y > 0.17\bar{y} \\ 0, & otherwise. \end{cases}$$

6.3 Economic environment

Production function and productivity growth I set the output elasticity of capital α to 0.33, which is the standard value in the literature. The average annual depreciation rate is 5.5 percent, as shown in Kehoe et al. [2018]. The model specifies the gross growth rate of the labor augmenting technological progress $\gamma_{t+1} = z_{t+1}/z_t$. I assume the steady growth rate of 2 percent per annum, which is standard in the literature. Details are presented in Figures C.1a and C.1b.

Demography The mortality data are based on United Nations data for cohort mortality in the period 2010-2015. To eliminate the issue of orphans, I assume that the probability of death is zero during child-rearing periods, which is for $j < J_k$. The unrealized mortality is compensated in the first model period after reaching the age of J_k, as shown in Figure C.2. This assumption is standard in the literature, as seen in Sommer [2016].

The productivity process is based on estimates from Borella et al. [2018]. There are two important features of these estimates that make them particularly suitable for my model. First, Borella et al. [2018] account for hours worked and therefore are a good match for a model with endogenous labor supply. Second, the estimates are based on data covering men and women jointly. Indeed, for the most part, the literature studying quantitative life-cycle macroeconomic questions relies on data on men only. The deterministic age-dependent productivity component is presented in Figure C.3. The random component follows an AR(1) process.[19] As is standard in the literature, I approximate the process above by the first-order Markov chain with the transition matrix $\Pi(\varepsilon j, t|\varepsilon_{j-1,t-1})$.[20] There are five potential productivity shock realizations. Following Borella et al. [2018], I also calibrate the initial variance in income. To account for ex-ante heterogeneity in a parsimonious way, I rely on the structure implied by the shock discretization. Namely, I assume that the initial distribution of productivity is given by a symmetric three-point discrete distribution. The evolution of income shock over the life-cycle is presented in Figure C.3. The cumulative distribution of labor income implied by the model simulation fits the pattern observed in the Survey of Consumer Finance data quite well, see Figure C.4b. However, the model fails to replicate the tails of the income distribution, particularly the left tail. For instance, in the model, approximately 3% of children would live in a household with income too low to obtain child tax credit, compared to 10% in the data. This suggests that I underestimate the difference between child tax credit and child allowance, especially among households with low productivity realization.

[19]In the model, each period corresponds to 5 years. Hence I recalculate input variables according to $\varrho_\varepsilon = \bar{\varrho_\varepsilon}^5$ and $\sigma_\epsilon = \bar{\sigma}\epsilon\frac{1-\bar{\varrho\varepsilon}^{10}}{1-\bar{\varrho\varepsilon}^2}$.

[20]De Nardi et al. [2020] point out that while applying directly Markov-chain flexible discretization method to the raw data is computationally less costly compared to the two-stage approach based on the estimation of the continuous process and the discretization via the Markov chain, the latter gives a better data fit than direct Markov chain estimation.

Table 1: Calibrated parameters for the initial steady state

	Macroeconomic parameters	Calibration		Target source	Target value	Model outcome
ϕ	preference for consumption	0.262	average hours	BEA(NIPA) 31%	31%	
δ	discounting rate	1.02	interest rate			4.5%
d	one year depreciation rate	5.5%	capital output ratio	BEA(NIPA)	3	3
g	government expenditure	0.15	as % of GDP	BEA(NIPA)	17%	15%
	taxes					
τ_l	labor tax	0.13*	revenue as % of GDP	OECD	9.2%	9.2%
τ_c	consumption tax	0.09	revenue as % of GDP	OECD	2.8%	2.8%
τ_k	capital tax	0.28	revenue as % of GDP	OECD	5.4%	5.4%
λ	labor tax progression	0.10	earnings distributions	CBO and IRS **		
	social security					
ρ_m	benefit scaling factor	0.72	benefits as % of GDP	OECD	6.2%	6.2%
τ	social security contr.	0.11	social security balance	SSA	0%	0%
	productivity					
$\eta_{j,t}$	deterministic component			Borella et al. [2018]		
ϱ	shock persistence			Borella et al. [2018]		
σ	shock variance			Borella et al. [2018]		
	children					
φ_n	preferences for children	0.90	average fertility rate	WB	1.9	1.9
t_n	time cost	0.07, 0.05		Time Use Survey		
θ_n	scaling parameter	0.65		Daruich and Kozlowski [2020]		
μ_n	monetary cost***	0.27, 0.16, 0.11		CES		

* Average labor tax is equal to 13%.

** Congressional Budget Office (CBO) and Internal Revenue Service (IRS).

*** Households with two lowest productivity realisation bare the cost of 0.27 of potential labor income per child, households with median shock realisation bare the cost of 0.16 of potential labor income and households with two highest productivity realisations face the cost of 0.11 of potential labor income per child.

Notes: Heathcote et al. [2017], who use the change in government distribution pre- and post- taxes and transfers to calibrate the extent of tax progression. Tax rates calibration following Mendoza et al. [1994], see Table C.1.

7 Simulation results

I present the results in three main parts. Firstly, I outline the composition of the current policy, the expansion under the America Rescue Plan (ARP), and the optimal family mix for the US. Secondly, I present the macroeconomic effects of the family policy reforms. Lastly, I examine the impact of family policy reforms on welfare. There are two key implications for the policymakers. First, more generous support for families may lead to higher welfare. Both APR extension and policy mix increase welfare regardless of initial productivity realization. Second, the composition of family policy is crucial for welfare evaluation. Public child care offers a balance between encouraging higher fertility and promoting positive labor market outcomes, Thus is more pronounced in optimal family policy.

7.1 Composition of analysed policies

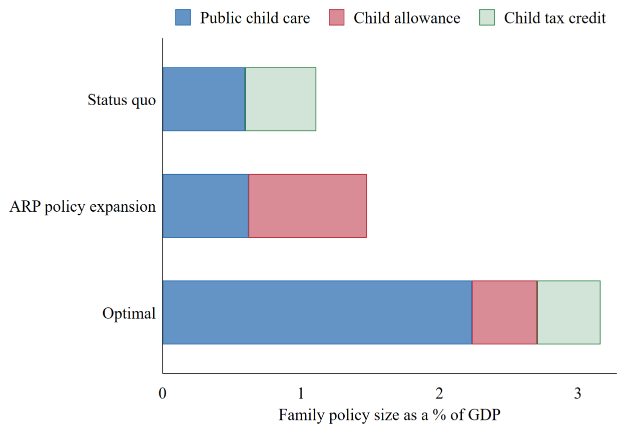
The composition of the family policy in different scenarios is depicted in Figure 3. In the **status quo** scenario, expenditures on public child care are equal to 0.6% of GDP. This is equivalent to covering the cost of 13 hours of child care per month for a family with two small children, or alternatively, 12% of child-related time costs. Child tax credit costs are equal to 0.5% of GDP, which translates to a transfer equivalent to 1% of mean labor income per child for families with sufficiently high labor income.

The **American Rescue Plan** (ARP) policy expansion increased monetary transfers by roughly 50% and provided full transfer amounts to low-income families, regardless of their ability to generate corresponding tax payments. The reform scenario replaces the child tax credit with a flat allowance equal to 1.5% of mean labor income, available to all households with children, irrespective of their labor income. In the case of households with low productivity, it covers approximately 7% of child-related monetary costs. For median and highest productivity households, it is respectively 4% and 2% of monetary costs. The child care policy remains unchanged. Since the fertility level increases, see Table 2, total expenditures on child care increase slightly.

To find the **optimal family policy mix**, I utilized the grid search method. I explored the child tax credit and child allowance values ranging from 0 to 8% of average labor income, and public child care coverage ranging from 6 to 48% of the time cost associated with raising children, with eight grid points for each dimension. In total, $8^3 = 512$ simulations were run, and the optimal family policy mix that yielded the highest welfare gains under the veil of ignorance was identified.

The expenditure on the optimal policy mix is equal to 3.2 percent of GDP. Not only the size but also the composition differentiates the optimal policy from the status quo and ARP policy expansion. The optimal family policy mix relies on childcare support to a greater extent. In fact, child care accounts for approximately $\frac{2}{3}$ of total expenditures in the optimal policy. This is equivalent to covering 42% of the time cost associated with childbearing or the equivalent of 45 hours of public child care per month provided for a family with two small children. The

Figure 3: The comparison of the composition of the status quo and optimal family policies



Note: The policy mix denoted as *Optimal* is significantly bigger than the *Status quo* policy mix. Also the composition is more shifted to financing child care.

expenditures on child allowance and child credit are roughly of a similar size, equal to 0.46% of GDP each. Combined, they are equivalent to transferring approximately 1.5% of average labor income per child.

7.2 Macroeconomic effects

Table 2 presents the macroeconomic effects of the family policy expansion and the implementation of the optimal family policy mix. In both scenarios, the private cost of children decreases, leading to increased fertility. The APR expansion slightly increases average working hours due to the discrete nature of fertility choice and income risk. This increase in working hours primarily occurs among young childless households and is linked to the accumulation of precautionary savings. In the optimal policy mix scenario, labor supply increases further due to the reduced time cost associated with childbearing. When child care is provided within a household, it is not subject to taxes, etc. However, in the case of public child care, the service is performed by workers in the labor market, contributing to an increase in labor tax revenue.

Owing to higher fertility and increased working hours, the replacement rate in old-age benefits paid by the PAYG social security system increases. In the case of ARP expansion, the replacement rate increases by five percentage points, or approximately 11%. In the case of the optimal policy mix, since both labor supply and fertility boosts are larger, the growth is even greater, equivalent to a rise by 13 percentage points, or 28%. In both reform scenarios, an increase in the labor supply overcomes the increase in savings; the capital-output ratio decreases, implying a higher interest rate. As a result, capital tax revenue in terms of GDP increases. The consumption tax rate rises to cover the more generous family policy transfers. To implement an optimal policy mix, the consumption tax has to increase from 9 percent in the status quo calibration to 15.9 percent. Therefore, the cost is much higher than the one associated with implementing the ARP family policy extension, which leads to tax increase only by 0.7 .p.p., see Table 2. However, it is worth noting that such a consumption tax rate is aligned with the value observed in other OECD countries, where the 2022 average was equal to 19.2%. Both policies yield higher welfare, discussed in further detail in the following section.

Table 2: Aggregated effect of implementing different family policy

	Status Quo	ARP expansion	Optimal policy mix
fertility level	1.9	2.1	2.3
average working hours	31%	32%	35%
average replacement rate	46%	51%	59%
capital to output ratio	3.0	2.9	2.8
interest rate	4.50	4.80	5.15
labor tax revenue	9.2%	9.2%	9.3%
capital tax revenue	5.4%	5.7%	6.0%
consumption tax rate	9.0%	9.7%	15.9%
welfare under the veil of ignorance	.	9.5%	12.2%

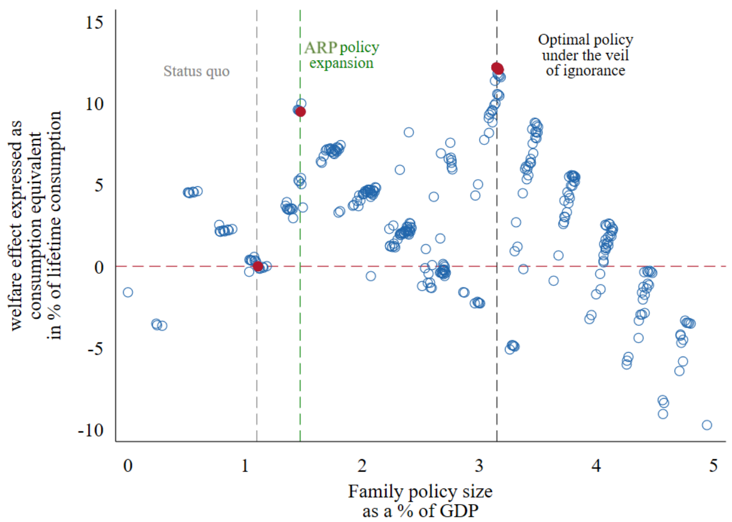
Notes: Average working hours expressed as a share of time endowment. Tax revenue expressed in % of GDP. Welfare effect is calculated as consumption equivalent under the veil of ignorance.

7.3 Welfare effects

The welfare effects associated with the family policies reform are hump-shaped in total expenditures, see Figure 4. In line with the prediction of the theoretical model, compare Proposition 2, lack of family policy leads to lower welfare compare to the status quo. The hump shape of the welfare effects is also in line with the results from section 4. Since the family policy is a tool to correct for the positive externalities associated with PAYG social security, the size of desired family support is linked to the size of social security. Extending family support, i.e., more than 3.2 % of GDP in my simulations, yields a gradual welfare decrease. Furthermore, it is important to notice that not only the size but also the composition matter for welfare evaluation. For a given family policy size, i.e., 3.3-3.5 % of GDP, welfare gains vary between -1% to +10%.

Overall gains due to the implementation of the optimal policy mix are equal to 12.2 percent, compare to 9.5% increase due implementation of ARP extension. For both policies, ARP expansion and optimal family policy mix, all households, regardless of initial productivity realization, gains from the reforms, see Figure 5. However, the welfare gains are higher among households with a high initial productivity shock. It is due to the fact that children are a normal good. Therefore, high-income households with higher expected wealth levels have more children and receive a higher share of the family policy budget. The discrepancies in welfare effects across productivity types are even more significant for the optimal family mix. It is since

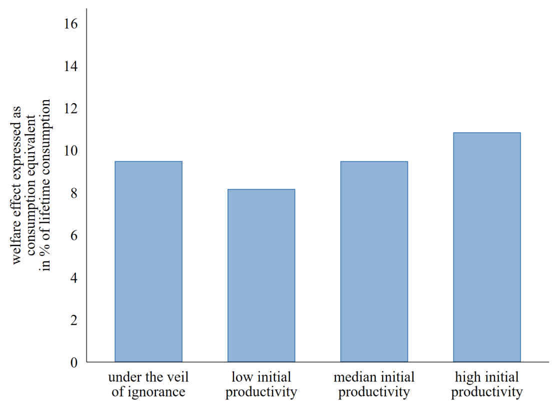
Figure 4: Welfare effects for different combinations of family policies tools



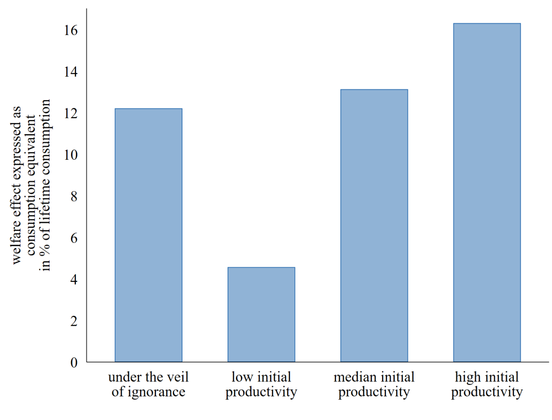
Note: Welfare effects due to family policy are measured as consumption equivalent.

childcare support releases time endowment and time is more valuable for higher productivity households. The results are aligned with the one obtained by Bucciol et al. [2017].

Figure 5: Welfare effects of more generous policy mix across initial productivity



(a) ARP family policy expansion

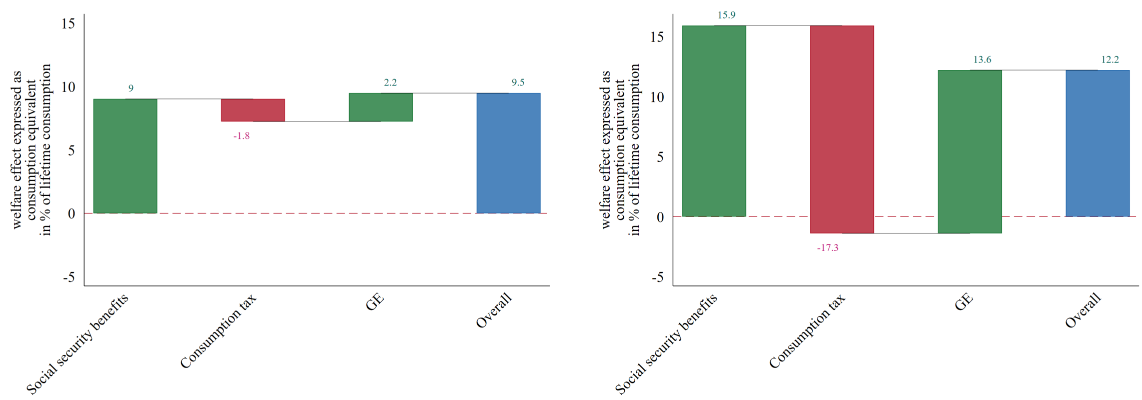


(b) Optimal family policy

Note: Implementing more generous family policy generates welfare gains regarding the initial productivity level.

Increased spending on family support boosts social security benefits but also results in higher family policy expenditures and thus higher taxes. To analyze the overall welfare effect, I employ partial equilibrium to explore three channels: social security, consumption tax, and the general equilibrium (GE) channel, as illustrated in Figure 6. This decomposition of welfare effects is grounded in measurements under the veil of ignorance.

Figure 6: Decomposition of welfare effects into macroeconomic channels



Note: Decomposition of results under the veil of ignorance obtained by partial equilibrium. The main driver of welfare gains is higher social security benefits.

In this simulation, social security benefits account for the increased benefits stemming from higher fertility and a lower old-age dependency ratio, while other factors influencing household choices remain at the status quo levels. The rise in fertility and labor supply enhances the value of benefits. Thus, the welfare increase. The consumption tax channel signifies the adjustment in the consumption tax rate required to implement a specific policy reform. As taxes must increase to cover the cost of the expanded policy, this channel contributes to a decrease in welfare. The GE effect, calculated as a residual value, has a positive impact.

The difference in GE effects is the primary factor behind the varying welfare gains between the ARP family policy extension and the optimal policy mix. First, higher fertility in the optimal policy mix scenario could be closer to the optimal fertility level. Second, the increase in child care, which is the most pronounced component of the optimal policy mix, introduces a kind of "free lunch" to the model. When child care is performed within a household, it is not considered market labor, is not taxed, and does not contribute to social security. In contrast, when part of the child care is provided as a public service, it contributes to the labor force.

Additionally, public child care offers benefits related to the composition of the labor force. Since children are considered normal goods, wealthier households have more children; in fact, the fertility rate is the highest among households with the second-highest shock realization. Public child care is offered by individuals of average productivity. Thus one hour of work for highly productive individuals can be perfectly substituted for one hour of work for child care providers with average productivity. Therefore, the total labor productivity increases. This channel would be even more significant if we assumed economies of scale in childcare services. The distinct treatment of child care services between the two scenarios plays a crucial role in the contrasting welfare outcomes.

8 Conclusion and policy implications

This article examines the macroeconomic and welfare impacts of reforming family policies in the US. The study focuses on the current ARP family policy extension and the optimal policy mix. APR family policy expansion applied during Covid -19 pandemic leads to replacing child tax credit with unconditional child allowance and increasing its value. I show that such policy improves welfare. A static comparison reveals that the expansion enhances welfare for all households, irrespective of their initial labor productivity. Accounting for general equilibrium adjustments, particularly positive externalities linked to fertility due to the PAYG social security, is essential for evaluating welfare effects. The decomposition shows that the main channel for welfare improvement is the increase in social security benefits. In the model, reform leads to a rise in the fertility rate. Thus reform lowers the old-age dependency ratio and leads to higher old-age benefits. I also show that the reform does not have a negative impact on the labor supply. In fact, average worked hours increases slightly. Family policy expansion implies fiscal costs corresponding to the rise in consumption taxation by less than one percentage point.

The optimal family policy is characterized using the grid search method, comparing 512 potential family policy compositions by varying the scale of child care, child allowance, and child tax credit. The optimal policy mix is more generous than the status quo policy in the US and places greater emphasis on public child care. Expenditures on family policy increase from 1.1% of GDP in the status quo to 3.2% in the optimal policy mix scenario. Childcare is the predominant factor in the optimal policy mix, accounting for 2/3 of total family expenditures. By shifting some child care responsibilities from households to public services, there is an increase in labor force participation, especially among wealthier households. This shift also leads to improvements in overall labor productivity. Implementing the optimal policy significantly reduces the private child-rearing cost, resulting in an increased fertility rate and higher old-age benefits. To implement the optimal policy, the consumption tax rate must increase from 9% in the status quo to 15.9% in the reform scenario. The study highlights that the structure of family policies is crucial for welfare evaluation, as different compositions can yield positive or negative effects for similar family policy expenditures.

The optimal policy mix strikes a balance between encouraging higher fertility levels and promoting positive labor market outcomes. Policymakers should carefully evaluate the trade-offs between fertility incentives and their impact on labor force participation and productivity. Expanding public child care services support families and improves labour market structure. While expanding family policy, may leads to welfare gains, it also requires higher taxes to cover the increased expenditures. Policymakers must assess the fiscal sustainability of family policies and consider the long-term implications since the child-related investment are highly productive but requires longer periods to realise, compare for example Hendren and Sprung-Keyser [2020].

The study is closely related to the work of Guner et al. [2020], who shows that in the case of the US, expansion of child care would lead to welfare gains and an increase in labor supply. The present study supports these findings, even when accounting for idiosyncratic income risk and endogenous fertility. Guner et al. [2020] also analyses the effect of universal monetary transfer. However, in their setup, the policy leads to a decrease in labor supply and adverse welfare effects, contrasting with the results presented here. Endogenous discrete fertility decisions are the primary mechanism behind the difference in long-term labor supply and welfare evaluation of the reform. In this model, an increase in unconditional monetary transfers results in lower private fertility costs, higher fertility, and increased social security benefits. Additionally, the income risk considered here favors unconditional transfers that may provide partial insurance, aligned with the results of Shaefer et al. [2018]. In my model, childcare is determined by the size of the support which is universal across income. Ho and Pavoni [2020] analyse not only the size but also the shape of child care support. They show that the optimal policy decease steeply with income. Kurnaz [2021] show that optimal child tax credits are U-shaped in income and decrease with family size. Raising credits for high-income parents not only boosts their consumption but also lowers their marginal tax rates. This reduction in tax rates alleviates the distortion on their labor margin, encouraging them to work more. The same mechanism applies to child care in my model.

The model has a number of limitation. First, it relays on the comparison across steady states. Family policies are associated with immediate costs and gains that are realized in the future. Therefore future studies that account for transition costs would be welcomed. Second, studies based on empirical data show much smaller effects of family policies on fertility than one generated in my model. For example, in the case of cash transfer in Argentina, Garganta et al. [2017] shows an increase of 2 percent in the intended fertility rate in reaction to introducing a family policy that costs 1 percent of GDP. Frejka and Zakharov [2013] show more significant but phasing out effects in the case of cash transfer in Russia. The important challenge that life-cycle literature is facing right now is building frameworks that not only replicate the decision of the household across ages but also match the elasticities of response from empirical studies. Third, in the study, the children do not affect the labor productivity process. However, as described by Doepke et al. [2022], fertility decisions in developed countries often are associated with the career-family trade-off. Therefore further investigation in that domain would be welcome. Accounting for the impact of the child-rearing period on future labor income would likely increase the benefits of public-child care.

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A Theoretical model

Proposition 3. *Suppose that there is no family policy, $\varphi = 0$. Then the fertility in a competitive equilibrium is sub-optimal.*

Proof. Let $\{c_1^*, n^*, c_{2,L}^*, c_{2,H}^*)\}$ be the competitive equilibrium allocation. Let $U^* = U(c_1^*, n^*, c_2^*)$ be the utility in competitive equilibrium. I will construct a feasible allocation $\{\tilde{n}, \tilde{c}_1, \tilde{a}, \tilde{c}_{2,L}, \tilde{c}_{2,H}\}$ such that the utility $\tilde{U} = U(\tilde{c}_1, \tilde{n}, \tilde{c}_2)$ is higher than $U^* = U(c_1^*, n^*, c_2^*)$. The main idea is based on Taylor expansion of the utility function around the competitive allocation. Consider the following allocation $\{\tilde{n}, \tilde{c}_1, \tilde{a}, \tilde{c}_{2,L}, \tilde{c}_{2,H}\} = \{n^* + \varepsilon, c_1^* + \varepsilon(\frac{\tau y_1}{R\pi} - p), a^* - \varepsilon\frac{\tau y_1}{R\pi}, c_{2,L}^*, c_{2,H}^*\}$. Such an allocation is feasible. Substituting from the government budget constraint into the first period consumer budget constraint for $\theta = \phi n$ and $\varphi = 0$ leads to:

$$c_1 = y_1 - a - pn.$$

Budget constraint is satisfied in case of allocation $\{\tilde{n}, \tilde{c}_1, \tilde{a}, \tilde{c}_{2,L}, \tilde{c}_{2,H}\}$:

$$\tilde{c_1} = y_1 - \tilde{a} - p\tilde{n}.$$

Substituting for $\tilde{n} = n^* + \varepsilon$ and $\tilde{a} = a^* - \varepsilon\frac{\tau y_1}{R\pi}$ we obtain:

$$\tilde{c_1} = c_1^* + \varepsilon(\frac{\tau y_1}{R\pi} - p).$$

The change in pension benefit due the higher fertility rate $\varepsilon\frac{\tau y_1}{\pi}$ compensates for the change in private savings $\varepsilon R\frac{\tau y_1}{R\pi}$. Substituting for social security constrain benefit reshapes the second period budget constraint in the following way:

$$c_{2,i} = y_{2,i} + \frac{n\tau y_1}{\pi} + Ra.$$

This budget constraint is satisfied in case of allocation $\{\tilde{n}, \tilde{c}_1, \tilde{a}, \tilde{c}_{2,L}, \tilde{c}_{2,H}\}$ because if we substitute for $\tilde{n} = n^* + \varepsilon$ and $\tilde{a} = a^* - \varepsilon\frac{\tau y_1}{R\pi}$ we obtain:

$$\tilde{c}_{2,i} = y_{2,i} + \frac{n\tau y_1}{\pi} + \frac{\varepsilon\tau y_1}{\pi} + Ra^* - \varepsilon\frac{\tau y_1}{\pi}.$$

Thus, consumption in the second period is equal in both allocations:

$$\tilde{c}_{2,i} = c_{2,i}^*.$$

For small enough ε the following $\tilde{U} > U^*$ holds. Since consumption in the second period of lifetime is the same for both allocations, $\tilde{c}_2 = c_2^*$, it is sufficient to compare the utility derived form fertility and consumption in the first period of life, i.e. $v(n^* + \varepsilon) + u(c_1^* + \varepsilon(\frac{\tau y_1}{R\pi} - p)) >$

$v(n^*) + u(c_1^*)$. If $\varphi = 0$ the initial level of fertility is too low and there exist $\varepsilon > 0$ such that:

$$v(n^* + \varepsilon) + u(c_1^* + \varepsilon(\frac{\tau y_1}{R\pi} - p)) > v(n^*) + u(c_1^*)$$

If $\frac{\tau y_1}{R\pi} - p > 0$ it is straightforward and the inequality holds for any ε, since both v and u are increasing functions[21]. For $\frac{\tau y_1}{R\pi} - p < 0$, I use Taylor expansion of the left hand side and rewrite above inequality as :

$$v(n^*) + \varepsilon v'(n^*) + u(c_1^*) - \varepsilon(p - \frac{\tau y_1}{R\pi})u'(c_1^*) + E_2(\varepsilon) > v(n^*) + u(c_1^*) \quad (38)$$

where $E_2(\varepsilon)$ is Taylor (Maclaurin) Polynomial Remainder, or in other words an error term which is smaller than $\frac{\varepsilon^2}{2!}(v''(n^* + z\varepsilon) - (p - \frac{\tau y_1}{R\pi})^2 u''(c_1^* + z\varepsilon(\frac{\tau y_1}{R\pi} - p))$, for $z \in (0, 1)$. Equation (38) simplifies and it is sufficient to show that for sufficiently small $\varepsilon > 0$ the following inequality holds:

$$\varepsilon v'(n^*) - \varepsilon(p - \frac{\tau y_1}{R\pi})u'(c_1^*) + E_2(\varepsilon) > 0.$$

I substitute $v'(n^*)$ using first order condition implied by the solution in competitive economy:

$$\varepsilon u'(c_1^*)\frac{\tau y_1}{R\pi} - +E_2(\varepsilon) \quad > \quad 0.$$

Substituting for $E_2(\varepsilon)$ and dividing both sides by the marginal utility derived form consumption $u'(c_1^*)$ and the ε we get:

$$\frac{\tau y_1}{R\pi} + \frac{\varepsilon}{2!}\frac{v''(n^* + z\varepsilon) - (p - \frac{\tau y_1}{R\pi})^2 u''(c_1^* + z\varepsilon(\frac{\tau y_1}{R\pi} - p))}{u'(c_1^*)} > 0$$

Since $\frac{\tau y_1}{R\pi} = \bar{\varepsilon} > 0$, there exist small enough $\varepsilon > 0$ such that the following holds:

$$\bar{\varepsilon} + \varepsilon\frac{v''(n^* + z\varepsilon) - (p - \frac{\tau y_1}{R\pi})^2 u''(c_1^* + z\varepsilon(\frac{\tau y_1}{R\pi} - p))}{2!u'(c_1^*)} > 0$$

regrades of the sigh of $\frac{v''(n^*+z\varepsilon)-(p-\frac{\tau y_1}{R\pi})^2 u''(c_1^*+z\varepsilon(\frac{\tau y_1}{R\pi}-p))}{u'(c_1^*)}$. □

B Quantitative model: welfare effects

It is not straightforward how to measure welfare effects with endogenous fertility. For the quantitative model, I use the Millian efficiency criterion as in the stylized version of the model described in section 4. Thus, welfare changes are defined only through comparisons among individuals born, and hence the unborn does not need to have well-defined utility functions.

I measure the welfare effects using the consumption equivalent expressed as a percentage of baseline consumption at the age that individuals become independent, $j = J_i$. Two measure-

[21] However such case when $\frac{\tau y_1}{R\pi} - p > 0$ has to be excluded to obtain well defined optimal allocation

ments of welfare are used in the text: welfare for 20-years old given productivity realization ($M_{1,t}(s_{j,t})$) and and welfare under the veil of ignorance ($\overline{M_{1,t}}$). Benabou [2000] refers to it as risk-adjusted welfare. An explicit formula for calculating the welfare effect depends on the instantaneous utility function. The following section provides derivation for the concepts used for the normative inference in this article.

Welfare for 20-years old with productivity realization This paragraph contains derivation of welfare change measure for 20-years old given productivity realization. The derivation is based on backward induction. First, I show the formula for consumption equivalent for the household in the last period of their life then I generalize it.

Assume that $j = J$, thus household is in the last period of a their life, and there are no children within the household. We can write the value function as:

$$V_{J,t}(s_{J,t}) = \max_{c_{J,t},l_{J,t},a_{J+1,t+1}} u(c_{J,t}, l_{J,t}) \tag{39}$$

Denote x^R and x^B as an optimal choice in the reform and baseline scenario, respectively. Denote μ as the share of consumption in the baseline scenario which household would have to receive to be indifferent between the two scenarios:

$$\begin{aligned}
\phi\log((1+\mu)c^B_{J,t}) + (1-\phi)\log(1-l^B_{J,t}) &= \phi\log(c^R_{J,t}) + (1-\phi)\log(1-l^R_{J,t}) \\
\phi\log(1+\mu) + V^B_{J,t}(s_{J,t}) &= V^R_{J,t}(s_{J,t}) \\
\mu &= exp\left(\frac{V^R_{J,t}(s_{J,t}) - V^B_{J,t}(s_{J,t}}{\phi}\right) - 1
\end{aligned}$$

For a household at age $j = J-1$ in period t and state $s_{j,t}$ we can write the value function as:

$$V_{j,t}(s_{j,t}) = \max_{c_{j,t},l_{j,t},a_{j+1,t+1}} u(c_{j,t}, l_{j,t}) + \delta\pi_{j,t,t+1}\mathbf{E}\big(V(s_{j+1,t+1}) \mid s_{j,t}\big) \tag{40}$$

Denote $\mathbb{P}_{j+1,t+1}(s_{j,t})$ as the conditional probability distribution at age $j+1$ for household who at age j is described by the state $s_{j,t}$

$$\begin{aligned}
\mathbf{E}(V^R_{j+1,t+1}(s_{j+1,t+1})) &= \int_\Omega \Big(\log(c^R_{j,t}(s^q_{j+1,t+1})) + \phi\log(1-l^R_{j,r}(s^q_{j+1,t+1}))\Big)\, d\mathbb{P}_{j+1,t+1}(s_{j,t}) \\
\mathbf{E}(V^B_{j+1,t+1}(s_{j+1,t+1})) &= \int_\Omega \Big(\log((1+\mu)c^B_{j,t}(s^q_{j+1,t+1}) - \phi\log(1-l^B_{j,t}(s^q_{j+1,t+1})\Big)\, d\mathbb{P}_{j+1,t+1}(s_{j,t})
\end{aligned}$$

Using properties of logarithmic function and the fact that $\int_\Omega 1\mathbb{P}_{j+1,t+1}(s_{j,t}) = 1$ one obtains:

$$\mathbf{E}(V^R_{j+1,t+1}(s_{j+1,t+1}) = \log(1+\mu) + \mathbf{E}(V^B_{j+1,t+1}(s_{j+1,t+1}))$$

Combining the above formula with equation (40) one obtains:

$$\begin{aligned}
V^R_{j,t}(s_{j,t}) &= \phi\log(c^R_{j,t}) + (1-\phi)\log(1-l^R_{j,t}) + \delta\pi_{j,t,t+1}\ \mathbf{E}(V^R_{j+1,t+1}(s_{j+1,t+1})) \\
V^R_{j,t}(s_{j,t}) &= \phi\log(1+\mu) + \phi\log(c^B_{j,t}) + (1-\phi)\log(1-l^R_{j,t}) + \delta\pi_{j,t,t+1}\big(\phi\log(1+\mu) + \mathbf{E}(V^B_{j+1,t+1}(s_{j+1,t+1}))\big)
\end{aligned}$$

Therefore the μ for the household at the age of $j = J - 1$ has to satisfy:

$$\begin{aligned} V^R_{j,t}(s_{j,t}) &= \phi(1 + \delta\pi_{j,t,t+1}) \log(1 + \mu) + V^B_{j,t}(s_{j,t}) \\ \mu &= exp\left(\frac{V^R_{J,t}(s_{J,t}) - V^B_{J,t}(s_{J,t})}{\phi(1 + \delta\pi_{j,t,t+1})}\right) - 1 \end{aligned}$$

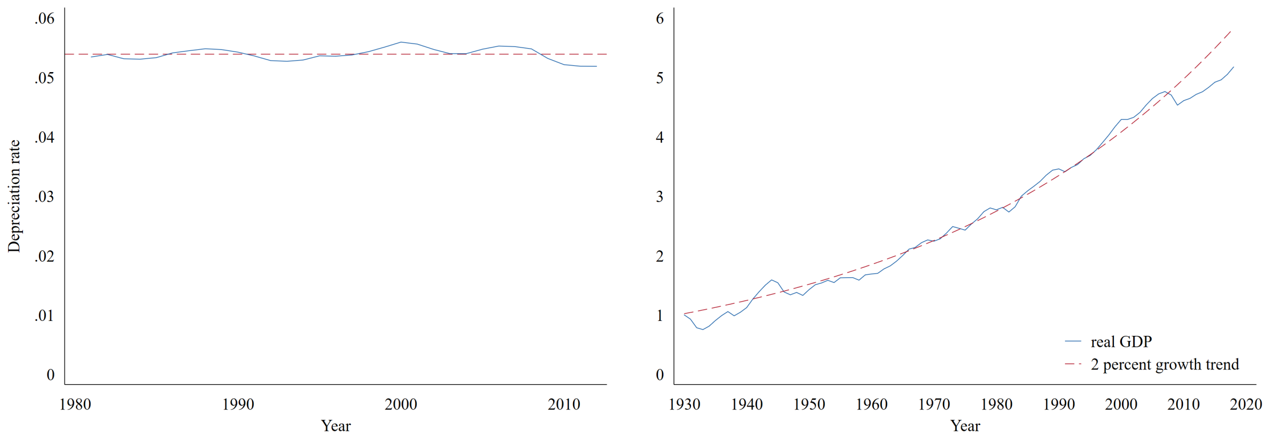
We can repeat aforementioned steps for each $j = \{J-2, J-3, ..., 1\}$ and for $j = 1$ we will get:

$$M_{1,t}(s_{j,t}) = 1 - \exp\left(\frac{V^B_{1,t}(s_{j,t}) - V^R_{1,t}(s_{j,t})}{\sum_{s=0}^{J} \delta^s \pi_{1,t,t+s}}\right). \tag{41}$$

Note that if the utility function is additively separable in consumption and leisure, functional form of utility concerning leisure does not affect the derivation above. The same is true for the utility derived from having a child. For families with ages between J_f and J_k children are present in the household; there is an additional utility stream. However, that does not change the derivation above.

C Quantitative model: calibration

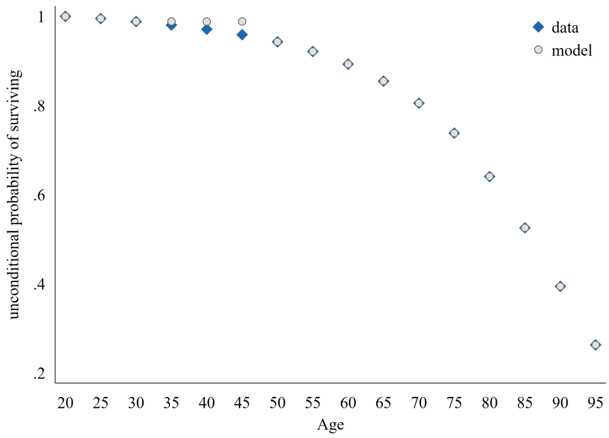
Figure C.1: Calibration of production function



(a) Depreciation rate (b) Balanced growth path

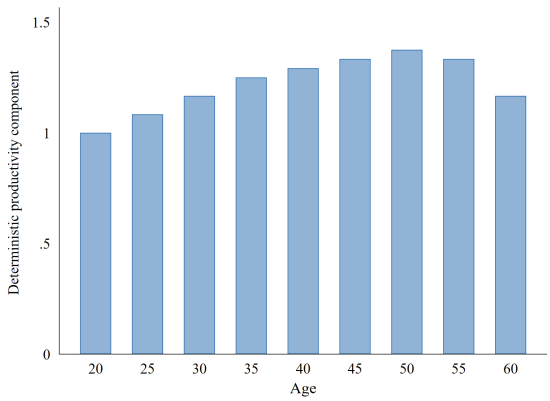
Note: The depreciation rate is based on BEA data on the consumption of fixed capital and capital stock calculations following Backus et al. [2008]. Labor augmenting technological progress is set to 2% following Kehoe and Ruhl [2010].

Figure C.2: Unconditional survival probability

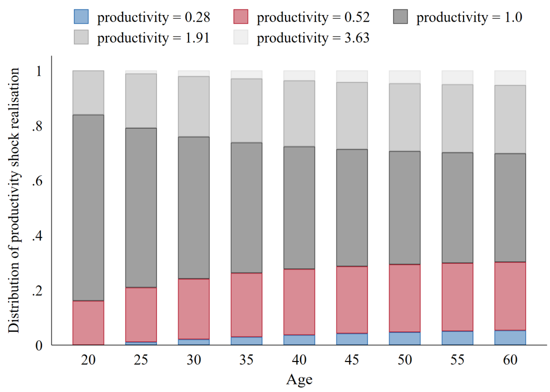


Note: The unconditional survival probabilities are base on HMD and UN for men and women jointly. I assume that there is no mortality during the childbearing period.

Figure C.3: Labor productivity evolution over the life cycle



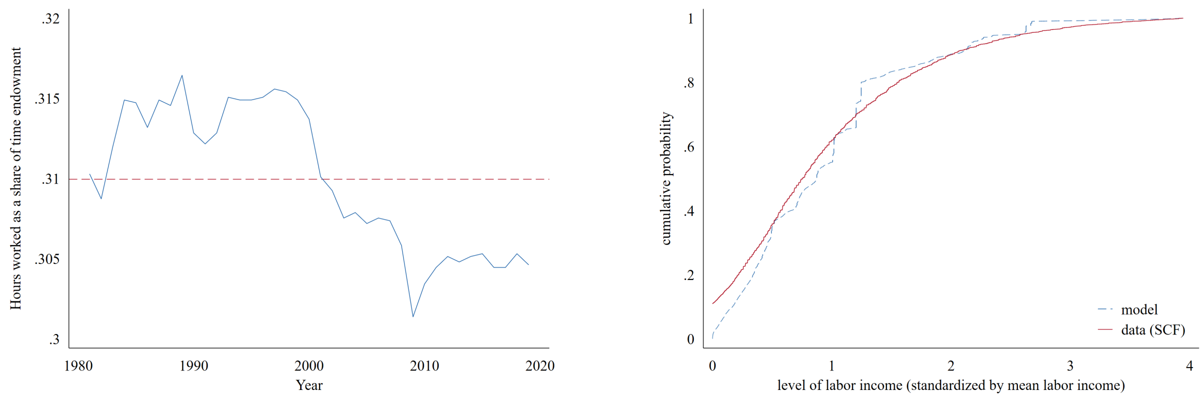
(a) Deterministic age-depended productivity component



(b) Stochastic component distribution over life-cycle

Note: There are two sources of households' heterogeneity in productivity. First, households' productivity differs ex-ante. Second, during working periods, productivity follows AR(1) process discretized by the Markov process. In the calibration of both sources of heterogeneity in productivity, I follow Borella et al. [2018]. To account for the initial variance in a parsimonious way, I rely on income process discretization. With the probability equal to μ, households receive $\eta = 0.52$, with the same probability families, may obtain $\eta = 1.91$. The residual mass of households equal to $1 - 2\mu$ obtains median productivity shock realization with $\eta = 1.0$. The probability μ is set such that the initial variance coincides with the Borella et al. [2018] estimates.

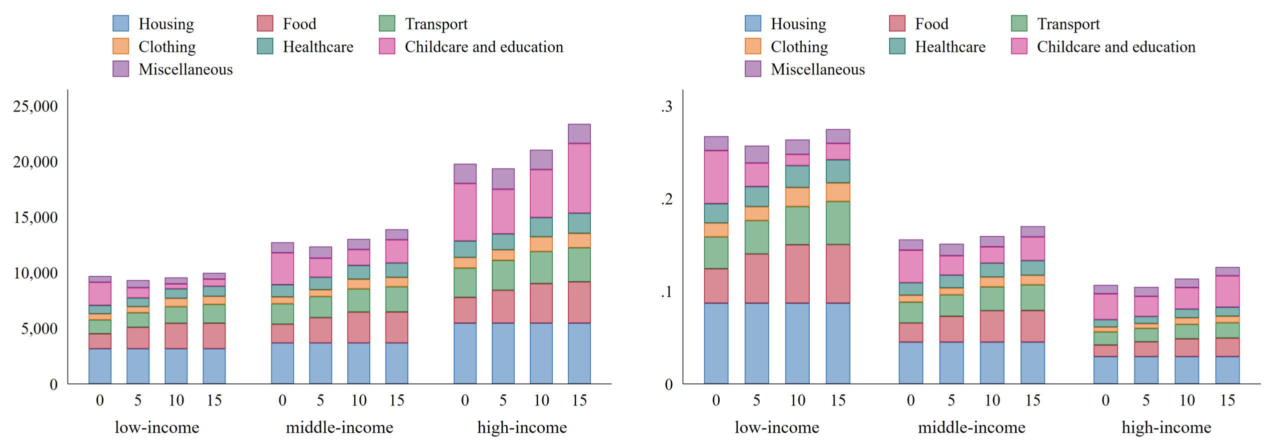
Figure C.4: Targets for leisure preference calibration and labor incoem



(a) Hours worked as a share of time endowment (b) Cumulative distribution of labor income

Note: Hours based on OECD and labor income based on Survey of Consumer Finances (SCF) data, sample restricted to 1st-99th percentile.

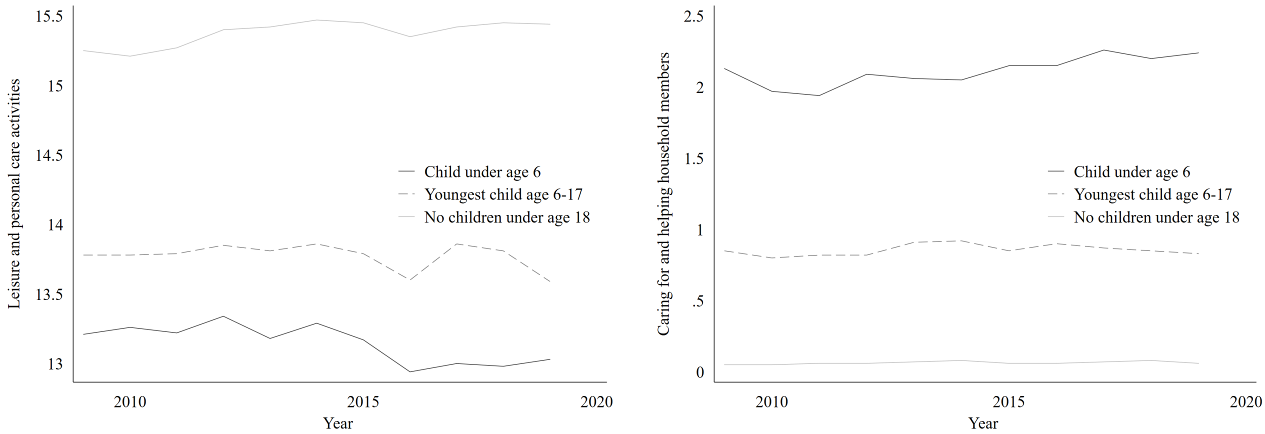
Figure C.5: Monetary cost of raising children (in America Consumer Expenditure data), by child age and family income



(a) Expenditures in dollars (b) Expenditures as a share of family income

Note: Each income group consists of 33 percent of households with children. The first income group consists of households with income lower than \$59,200; the second income group consists of people with income between \$59,200 and \$107,400; the third income group consists of households with an income higher than \$107,400. The average income in each group is, respectively \$36,300, \$81,700, \$18,5400.

Figure C.6: Time associated with raising children (in American Time Use data)



(a) Leisure and personal care, hours per day (b) Child-care hours per day

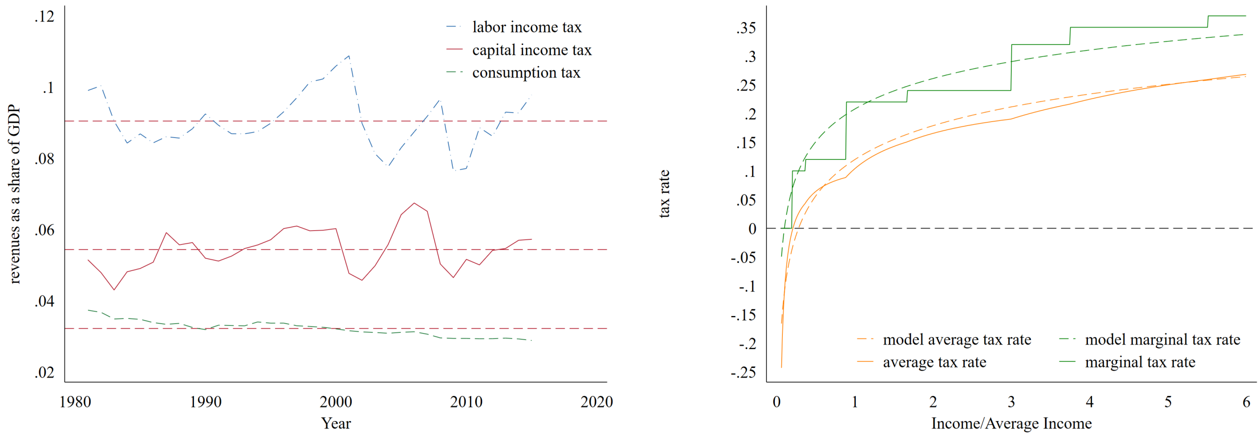
Note: Estimates base on Time Use Survey. Time devoted to leisure and personal care is 2.2 hours per day lower in households with children under age six compared to families without children. Households with older children devote to leisure and personal care 1.6 hours per day less than families without children.

Table C.1: Tax revenue

Macroeconomic parameters		Calibration	OECD code	revenue as % of GDP
τ_l	labor tax	0.150	1110	9.2%
τ_c	consumption tax	0.065	5110, 5121	2.8%
τ_k	capital tax	0.130	1120, 4000	5.4%

Notes: Tax rates calibrations following Mendoza et al. [1994], using averages of tax shares in GDP from (1980-2015).

Figure C.7: Tax system

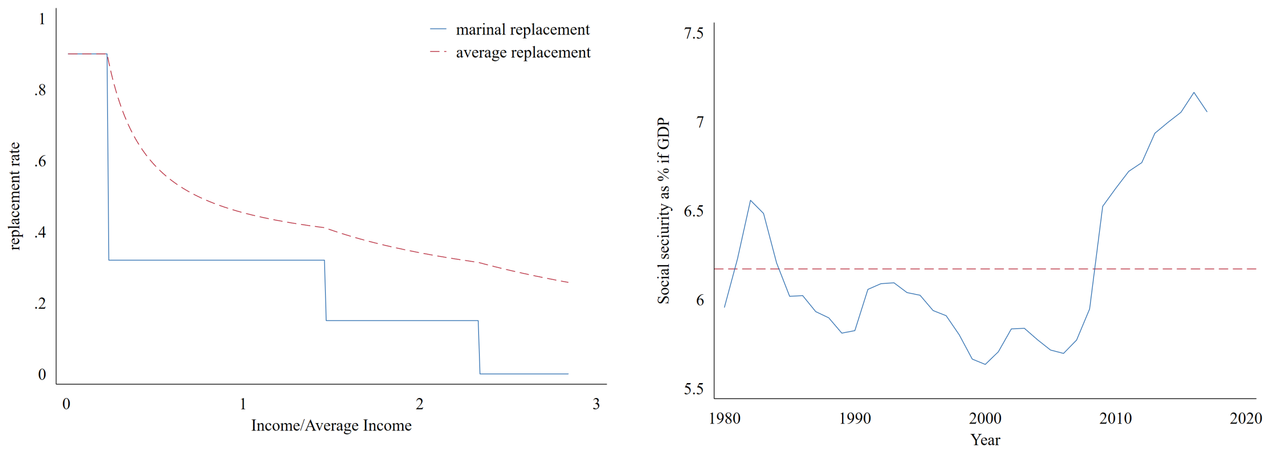


(a) Tax revenue as a share of GDP

(b) Marginal and average labor income tax

Note: Tax revenues are base on OECD data. The marginal and the average labor income tax rates implied by the US tax system is approximate following Heathcote et al. [2017].

Figure C.8: Social security

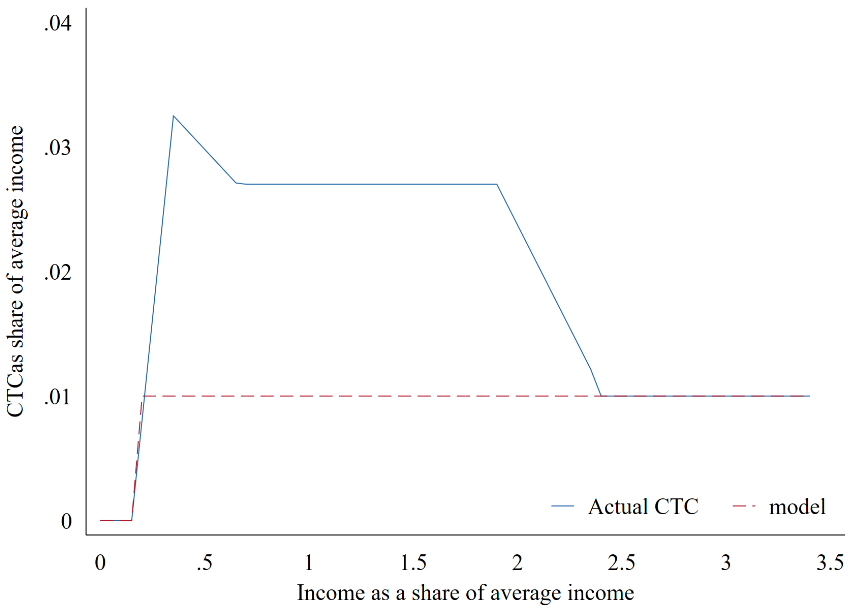


(a) Social security replacement rate as a function of $\frac{AIME}{\bar{y}}$

(b) Social security benefits as a share of GDP

Note: The social security system is progressive and offers a high replacement rate for low-income individuals.

Figure C.9: Actual child-related tax credit in the US, model status quo calibration and data



Note: The actual CTC by family income following Guner et al. [2020] and the one used in the model. Low-income families do not receive CTC.

D Related literature

Table D.1: Family structures and decision making in selected macroeconomic literature

Paper	Topic	Household structure	Decision-making process	Endogenous labor	Income risk	GE
Greenwood et al. [2003]	taxation and social security	yes	yes	yes	yes	yes
Restuccia and Urrutia [2004]	taxation	no	no	no	yes	yes
Apps and Rees [2004]	family policies	no	no	yes	no	no
Hong and Ríos-Rull [2007]	social security	yes	no	no	no	yes
Guner et al. [2012]	taxation	yes	no	yes	no	yes
Erosa et al. [2010]	family policies	yes	yes	yes	yes	yes
Hong and Ríos-Rull [2012]	social security	yes	no	no	no	yes
Blumkin et al. [2015]	family policies	no	no	no	no	yes
De Nardi and Yang [2016]	taxation	yes	no	no	yes	yes
Blundell et al. [2016]	taxation and social security	yes	no	yes	yes	no
Sommer [2016]	family policies	no	no	no	yes	no
Agénor [2017]	taxation	yes	no	yes	no	yes
Choi [2017]	family policies	yes	no	no	yes	no
Jørgensen [2017]	family policies	no	no	no	yes	no
Borella et al. [2018]	taxation and social security	yes	no	yes	yes	yes
Auerbach et al. [2018]	social security	no	no	yes	no	yes
d'Albis et al. [2018]	family policies	no	no	no	no	yes
Stauvermann and Hu [2018]	social security	no	no	no	no	yes
Yew and Zhang [2018]	family policies	no	no	no	no	yes
Komura and Ogawa [2018]	family policies	yes	no	no	no	yes
Blundell et al. [2018]	social security	no	no	yes	yes	no
Bar et al. [2018]	family policies	no	no	no	no	no
Ejrnæs and Jørgensen [2020]	family policies	no	no	no	yes	no
De Nardi et al. [2019]	taxation and social security	yes	no	yes	yes	no
Wu and Krueger [2021]	taxation	yes	no	yes	yes	no
Spataro et al. [2019]	family policies	no	no	no	no	yes
Doepke and Kindermann [2019]	family policies	yes	yes	yes	yes	no
Hannusch et al. [2019]	family policies	no	no	yes	no	no
Guner et al. [2020]	family policies	yes	no	yes	no	yes

Notes: I denote by 'yes' those studies which account for men and women as household members. I denote by'no' these studies which rely on a nucleus household. In column 'endogenous' labor, I delineate studies which allow for flexible labor supply (denoted by 'yes') and studies where labor is supplied inelastically or assigned to households with a random component (denoted by 'no'). In column GE, I mark studies in partial equilibrium (denoted by 'no') and studies in full general equilibrium setup (denoted by 'yes').

Table D.2: Macroeconomic models with endogenous fertility

Paper	Household structure	Human capital	Endogenous labor	Heterogeneous of productivity	Stochastic productivity	fertility	human capital	GE	Transition
Greenwood et al. [2003]	yes	yes	yes	yes	yes	no	no	yes	no
Da Rocha and Fuster [2006]	no	yes	no	no	no	no	no	no	no
Fenge and Meier [2009]	no	no	no	no	no	no	no	no	no
Fenge and Von Weizsäcker [2010]	no	yes	no	no	no	no	no	no	no
Erosa et al. [2010]	yes	no	yes	yes	yes	yes	no	yes	no
Oguro et al. [2011]		no	no	no	no	no	no	yes	no
Baudin [2011]	no	no	no	no	no	no	no	yes	no
Fehr and Ujhelyiova [2013]	yes	no	yes	yes	no	no	no	yes	no
Schoonbroodt and Tertilt [2014]	no	no	no	no	no	no	no	no	no
Blumkin et al. [2015]	no	yes	no	yes	no	no	no	yes	no
Wang [2015]	no	no	no	no	no	no	no	yes	no
Sommer [2016]	no	yes	no	yes	yes	yes	no	no	no
Agénor [2017]	yes	yes	yes	no	no	no	no	yes	no
Choi [2017]	yes	no	no	yes	yes	yes	no	no	no
Fenge and Scheubel [2017]	no	no	no	no	no	no	no	no	no
De la Croix and Pommeret [2018]	yes	no	no	yes	yes	yes	no	no	no
d'Albis et al. [2018]	no	yes	no	no	no	no	no	yes	yes
Stauvermann and Hu [2018]	no	yes	no	no	no	no	no	yes	no
Yew and Zhang [2018]	no	no	no	no	no	no	no	yes	no
Komura and Ogawa [2018]	yes	no	no	no	no	no	no	yes	no
Kurnaz [2021]	no	yes	yes	yes	no	no	no	no	no
Bar et al. [2018]	no	yes	no	yes	no	no	yes	no	no
Doepke and Kindermann [2019]	yes	no	yes	yes	yes	no	no	no	no
Spataro et al. [2019]	no	no	no	no	no	no	no	yes	no
Petit [2019]	no	yes	yes	yes	yes	yes	yes	yes	no
Guner et al. [2019]	no	yes	yes	yes	yes	no	no	yes	no
Lopes [2020]	yes	yes	no	yes	yes	no	no	no	no
Ejrnæs and Jørgensen [2020]	no	no	no	yes	yes	yes	no	no	no
Daruich and Kozlowski [2020]	no	yes	no	yes	yes	no	no	no	no

Notes: See table D.1. For 'Heterogeneous productivity', 'yes' marks studies where households differ by productivity type, and 'no' marks studies with homogeneous households with respect to productivity.In the next set of columns, 'yes' denotes studies that account for productivity, fertility, and human capital risk, respectively, as sources of risk in the model.I In the 'transition' column, 'yes' mark studies that account for transitional dynamics are marked.