The Macroeconomic Consequences of Family Policies*

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Abstract

I build a quantitative general equilibrium overlapping-generations model with heterogeneous agents, endogenous fertility, child human capital formation, and inter-vivos transfers to study the macroeconomic consequences of large-scale family policies (e.g. baby bonus, childcare subsidies). In the calibrated model that matches the U.S. data, I find: (1) In contrast to conventional wisdom from studies with exogenous fertility, parents optimally reduce child human capital investments in response to child-related cash transfers due to quality/quantity trade-off, which dampens social mobility as this reduction is larger among low-income households. (2) A $31,000-dollar baby bonus raises the aggregate fertility rate to replacement level but reduces average human capital by 1.5%. (3) This baby bonus increases long-run welfare by 2.2% as old-age dependency ratio falls, but it requires heightened taxes in transition phase to finance larger child-related expenditures. (4) Among different policies, subsidized childcare combines childbearing and labor force participation; while education expenditures are the most effective in boosting child outcomes and social mobility despite having mild effects on fertility.

JEL classification: E62, H31, H52, J11, J13

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1 Introduction

Family policies are social programs, laws and public directives designed to promote and enhance marriage, reproduction and raising children. Examples of family policies include but not limited to baby bonus[1], subsidized childcare, and parental leaves. These policies are extremely prevalent in developed countries and are often large in scale. Public expenditures on family benefits accounts for 2.1% of GDP on average among OECD countries in 2015.

Family policies are key instruments for governments to encourage childbirth and address population aging which poses great threat to economic growth (Aksoy et al., 2019) and the sustainability of public pension system (Bongaarts, 2004).[2] For example, parents of every child born in Australia after July 1st 2004 are eligible to receive a lump-sum payment of A$3,000[3] as the country tried to mitigate the effects of its aging population. Peter Costello, the Treasurer of Australia at that time, said that the baby bonus could help families to have “one (baby) for the Mum, one for the Dad, and one for the country". Similar financial benefits that are linked to the event of childbirth or designed to reduce the burden of child-rearing are widespread in the developed world and countries that are struggling with low fertility such as Russia, Spain, France, Italy, Canada, Singapore, Korea and so on. Concerns about low-fertility are also becoming increasingly relevant for the United States as recent Census data shows record-low level of birthrate.

Another commonly-stated goal of family policies is to alleviate child poverty, foster children's human capital formation, and raise social mobility. On such grounds, proposals to expand child tax credit (CTC) have received supports from bipartisan members of the Congress, and the maximum amount of CTC awarded to each child per year exceeds $3,000. Changes in CTC are also reinforced by the recently-proposed $1.8 trillion American Families Plan which provides additional financial support to parents. Guided by empirical evidence suggesting that transfers to families with children could raise children's human capital (Heckman and Mosso, 2014), the U.S. administration views family policies as “an investment in our kids, our families, and our economic future" (The White House, 2021). Economists predict family policies will “lift children out of poverty today and help them tomorrow" (Schanzenbach et al., 2021) and boost social mobility (Pulliam and Reeves, 2021).

With growing popularity of large-scale family policies, it is important to understand their macroeconomic consequences. Are family policies cost-effective in raising fertility, reducing old-age dependency ratio, and improving social welfare? Will generous child benefits improve children's human capital and raise social mobility? Moreover, will parents' decisions help achieve or go against stated policy goals? This paper seeks to understand these questions.

[1] Baby bonus is a one-time, lump-sum transfer to parents of each newborn child.

[2] Alternative policy instruments include immigration policies and pension reforms. I keep these policies unchanged in this paper and focus on the impacts of family policies.

[3] Equivalent to 4 times weekly average earnings or $2,800 in 2010 U.S. dollars.

I study the macroeconomic consequences of family policies in a quantitative general equilibrium overlapping-generations model with heterogeneous agents and distortionary taxes. The model has two key components. First, households make endogenous fertility choices. Second, parents make choices that affects child quality, a termed coined by Gary Becker, via investments in child human capital formation and inter-vivos transfers. Family policies affect households' decisions along both quantity and quality margins through price and income effects.

Compared with previous literature (more discussions below) that mainly focus on how family policies affect the quality margin for existing children, the addition of quantity margin in this paper is crucial to understanding the impacts of family policies for three reasons. First, if parents raise fertility to take advantage of more generous child benefits, the larger number of children would increase the marginal costs of child quality. Therefore, policies that aim at boosting fertility could actually worsen the outcome of children due to *quality/quantity trade-off* a lá Becker and Lewis (1973).[4] Second, family policies induce *composition effects* on aggregate variables. Due to intergenerational persistence of traits (e.g. human capital), aggregate variables gravitate towards the traits of those families that respond most strongly in fertility since these children account for a larger share of the population in future generations. Third, higher fertility induces *demographic structure effects* on government budget and taxes due to changes in the share of population in each age group. As population growth rate rises, the burden of pension payments under pay-as-you-go (PAYG) system is relieved but public education expenditures on children rise. These changes in expenditures are of first-order importance to government budget and taxes, which in turn affects people's welfare.

All three channels mentioned above depend on the magnitude of fertility response to financial incentives provided by family policies, hereafter denoted as *fertility elasticities*. If fertility is exogenous or fixed, child-related benefits offered by family benefits would simply induce income effects on children's quality and the model predictions would be similar to that in Daruich (2018) and Mullins (2019). I discipline the magnitude of fertility elasticities using a battery of calibrated parameters that matches salient empirical regularities in the United States in 2010. I also provide external validation[5] of fertility elasticities using policy variation from Alaska Permanent Fund Dividend (APFD) and show that the quantitative predictions of the model is consistent with design-based evidence.

The calibrated model generates four key findings. For the first three findings, consider the case where the government implements a universal baby bonus of $31,000 in 2010 dollars.[6]. First, the

[4]See Mogstad and Wiswall (2016) for recent quantification of quality/quantity trade-off and its policy implication.

[5]Additional validation exercises are also conducted using Australian baby bonus, Spanish child benefits, and Georgia's Cherokee Land Lottery of 1832.

[6]To put this number in perspective, this baby bonus is similar to the size of expansions in Child Tax Credit (CTC) from 2010 to 2021 in net present value (author's own calculation). It offsets the average cost of raising on child by 19% using estimates from U.S. Department of Agriculture (USDA).

model predicts that average fertility rate rises from 1.9 children per women to 2.1 children per women. Meanwhile, in contrast to conventional wisdom that more generous child benefits improve child outcomes, parents optimally reduce private educational investments to children by 8% on average due to quality/quantity trade-off.

Second, I find that intergenerational income mobility falls by 1.6% under the baby bonus since parents with lower human capital have stronger responses in fertility and reduces private educational investments by a larger amount. While such effect is derived under a baby bonus that is uniform across households and birth order, the result of falling social mobility will be even stronger when baby bonus targets lower-income families, as seen under current Child Tax Credit (CTC). Moreover, larger fertility responses by parents with low human capital generate composition effects on aggregate human capital. Combined with reductions in private education investments, average human capital in the economy falls by 1.5%.

Third, I find that despite reductions in average human capital and social mobility, long-run welfare[7] rise by 2.2% in consumption equivalence units. As the baby bonus raises population growth rate and lowers the old-age dependency ratio[8], the government is able to reduce tax rates while still keeping fiscal budget at balance. Assuming exogenous fertility in the cost-benefit analysis of family policies misses a key channel through which welfare gains are obtained. The transition towards such long-run welfare improvements features a prolonged path where the government actually needs to temporarily raise taxes to finance higher child-related expenditures. Total dependency ratio[9] spikes before converging to the long-run level. Welfare impacts on future households along the transition path are positive but smaller than that in the long-run equilibrium. Most households in the current economy lose due to higher taxes in the transition phase.

Lastly, I use the calibrated model to study the macroeconomic impacts of alternative policies at the forefront of public debate such as subsidized childcare and expansions in public education expenditures. Among different policy options, I find that (1) subsidized childcare encourages childbearing and labor force participation at the same time, and (2) public education expenditures are the most effective policies in improving child outcomes and boosting social mobility despite having mild effects on fertility.

Related Literature

This paper is related to four strands of literature. The first set of papers study fertility in a macroeconomic context and analyze how it is related to the fiscal stability, economic growth, intergenerational mobility, and inequality. Prominent examples include Doepke (2004), Greenwood et al. (2005), Manuelli and Seshadri (2009), Cordoba et al. (2016), De Silva and Tenreyro (2020) and

[7] Average utility of new-born under the veil of ignorance. See Section 2.3 for more discussions on welfare criteria.
[8] The number of retired households divided by the number of working population.
[9] The number of retired people plus the number of children, divided by the number of working population.

Jones (2020) among many others. The closest work is the paper by de La Croix and Doepke (2003) where they study how higher inequality reduces growth through the channel of fertility differentials. While I adopt their basic framework featuring general equilibrium, heterogeneous agents, endogenous fertility, and human capital formation, I extend the model in various dimensions and use the model to study aggregate impacts of family policies.

Second, the paper is related to the literature on positive and normative aspects of fiscal policies regarding fertility, redistribution and education. On the positive side, Daruich (2018) and Abbott et al. (2019) are the closest papers. Both papers use heterogeneous agent overlapping generations model to study large-scale education policies. I differ from these work by modeling endogenous fertility choice and considering the interaction of family and education policies. On the normative side, Guner et al. (2020) considers optimal design child-related transfers with heterogeneous households making both intensive and extensive labor force participation choices while keeping fertility exogenous. This paper add to the literature by studying the design of family policies with endogenous fertility responses.

This paper is also related to a large body of empirical work on the fertility effects of family policies (e.g. Milligan, 2005; Drago et al., 2011; González, 2013; Laroque and Salanié, 2014 among many others). Meta-analyses of these studies have concluded that "the directional finding that pronatal benefits boost fertility is nearly uniform", and an increase in present value of child benefits equal to 10% of household annual income would lead to 0.5% to 4.1% increase in total fertility rate (McDonald, 2006; Stone, 2020).[10] These papers, however, are not tailored to address the broader consequences of family policies beyond fertility, such as the effects on output, human capital and welfare. The design-based approach is also not able to predict the consequences of family policies in the long-run when children being affected become parents themselves. This paper takes a structural approach to answer these questions.

Lastly, the paper is related to a growing literature that evaluates the impacts of transfers or subsidies to families with children. Prominent examples include Akee et al. (2010), Dahl and Lochner (2012), Mullins (2019) and García et al. (2020) among many others (see Heckman and Mosso, 2014 for recent summary). With both design-based methods and structural models with exogenous fertility, the conventional wisdom in this literature is that transfers to families with children have positive impacts on children's outcomes including but not limited to health, education attainment and criminal records. This papers utilizes experimental evidence from this literature to inform parameter choices in Section 3. But since this literature exclusively evaluates policy effects of transfers to families with existing children and abstracts away fertility changes, I argue that their conclusions could not be directly used to extrapolate the aggregate impacts of family policies.

[10]The distinction between quantum versus tempo effects on fertility, i.e. total fertility rate versus completed fertility rate, will be discussed with more details in Section 4.

The rest of the paper is organized as follows. In Section 2, I present the quantitative model. The calibration of the model is discussed in detail in Section 3. I conduct the validation exercise in Section 4. Section 5 presents our policy counterfactuals results. Section 6 discusses the robustness of our results to alternative assumptions. Section 7 concludes.

2 Model

The model is based on the framework in de La Croix and Doepke (2003) where heterogeneous households make endogenous fertility and child human capital investment decisions in an overlapping-generations, general equilibrium economy. I extend it in multiple directions. First, I model realistic lifespan with working and retirement stages. Households make both life-cycle and precautionary savings under idiosyncratic uninsurable labor market shocks. By extending household lifespan to more than two periods, the model captures the changes in age structure of the population induced by family policies. Second, I incorporate government policies including taxation, pension payments, public education and expenditures on family policies. In particular, I explicitly model the role of public education in children's formation of skills. These features allow me to evaluate the comprehensive effects of family policies on the government's budget. Lastly, I consider parents' choices in childcare arrangements. They can either choose to take care of children at home by themselves or utilize marketable childcare services. This feature of the model allows me to evaluate the effects of childcare subsidies on parents' labor supply which could in turn affect their own human capital accumulation through on-the-job learning.

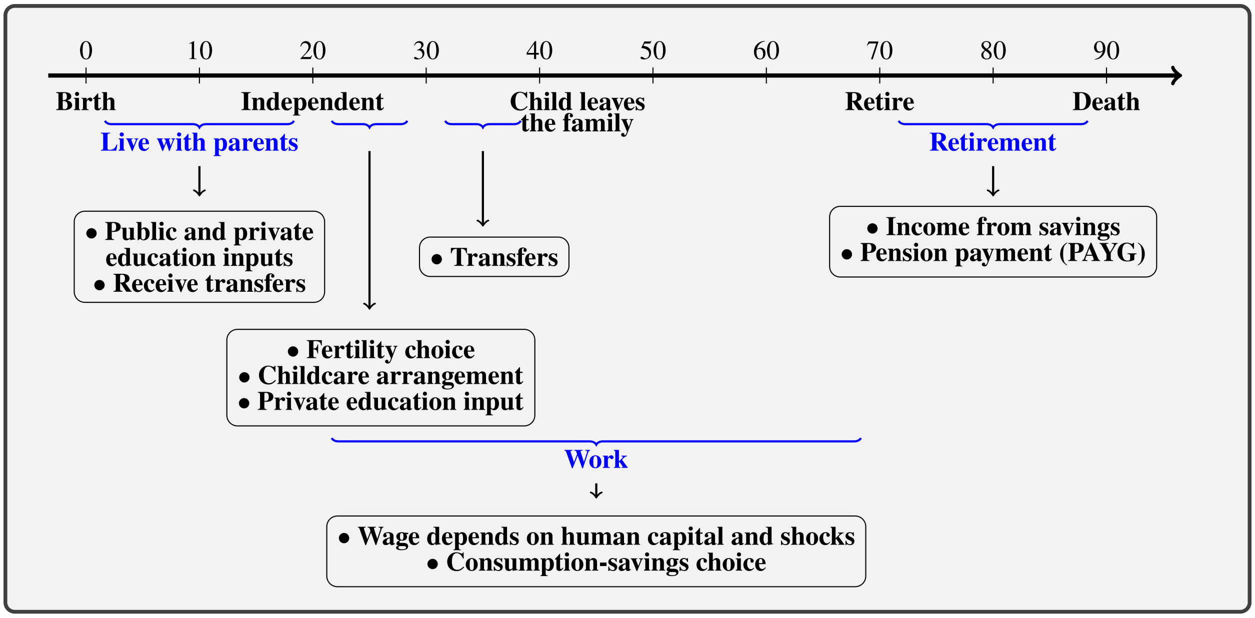
2.1 Household

Consider overlapping generations of households that can live up to 90 years old. I split the life-cycle into 9 periods where where each period stand for 10 years and is indexed by $j \in \{0, 1, 2, \dots, 8\}$. Period j stands for age $j \times 10$ to age $(j + 1) \times 10$.

The timeline of the model is presented in Figure 1. Children live with their parents from age 0 to 20 where they make no choices and receive human capital investments from both public and private sources. Children also receive inter-vivos transfers (from parents) when they become independent and form their own families at age 20. Households make fertility choice, childcare arrangements, and private child human capital investments decisions from age 20 to 30.[11] Parents make inter-vivos transfers choice between age 30 and 40, one period before the child becomes independent. People

[11] In this paper, I model unitary/collective decision-making within families and abstract away from intra-household bargaining. Promoting gender equality in sharing childcare burden is an interesting alternative policy for future research (e.g. Doepke and Kindermann, 2019).

Figure 1: Model Timeline



work from age 20 to 70 where their wage depends on human capital and idiosyncratic uninsurable shocks. They retire at age 70 and receive income from savings and pension payments. Households make consumption-savings choices every period in their lives and face age-specific survival rate δ_j.

For working adults, I assume that their human capital evolve over time following a learning-by-doing process:

$$h_{j+1} = L(h_j, t_w, z_{j+1}) \tag{1}$$

where z_{j+1} is an idiosyncratic uninsurable shock to human capital that occurs at the beginning of period $j+1$; h_j is the amount of human capital at period j; and t_w is the time worked in period j. I assume that agents have unit time endowment and supply labor inelastically except in the period where they need to make childcare arrangement choices. This assumption captures the key trade-off between providing childcare and supplying labor in the market for households with children.[12]

The state variables of young adults at the beginning of period 2 (age 20-30) are human capital level h and assets a, i.e. inter-vivos transfers from their own parents. Households choose consumption c, savings a', fertility n, total time spent at home taking care of children t_h, amount of market childcare purchased for each child m and private education investment for each child e. Parents' value is composed of flow utility of consumption $u(c/q(n))$ where consumption expenditure c is divided by equivalence scale $q(n)$ and the discounted continuation value $V_3(\cdot)$. Their maximization

[12]In the class of models with endogenous fertility, it is common to abstract away from labor/leisure choices and focus on the time costs of children, e.g. de La Croix and Doepke (2003), Cordoba et al. (2016), and Daruich and Kozlowski (2020).

problem is given by:

$$V_2(h,a) = \max_{c,a',n,t_h,m,e\geq 0} u(c/q(n)) + \beta \mathbb{E} V_3(h', a', n, \mathbb{E}h_k)$$

subject to

$$n \cdot \chi = \left(t_h^{\upsilon/\iota} + (n \cdot m)^{\upsilon} \right)^{1/\upsilon} \qquad \text{[time cost]}$$

$$y = wh \cdot (1 - t_h) \qquad \text{[labor income]}$$

$$(1+\tau_c)(c + mp_m(1-\mathcal{S})n + e \cdot n) + a' = (1+r)a + y - \mathcal{T}(y,a,n) + \mathcal{B} \cdot n \qquad \text{[BC]}$$

$$h' = L(h, 1-t_h, z') \qquad \text{[learning OTJ]}$$

$$h_k = G(h, \mathcal{E}, e, \epsilon) \qquad \text{[skill formation]}$$

To raise n children, parents need to meet $n \cdot \chi$ amount of childcare needs (in time units). Parents could satisfy this need either by spending their own time at home (t_h) or spend money purchasing market childcare services of m per child. I assume that these two forms of childcare is combined in a constant-elasticity-of-substitution (CES) production function where υ governs the elasticity of substitution. Home production of childcare enjoys an economy of scale with parameter $\iota \in (0,1)$. This captures the fact that taking care of two children at home takes less than two times the amount of hours needed to take care of one child (Folbre, 2008).

The opportunity cost of home production of childcare t_h is hours spent in the labor market. Household's labor income y is the product of market wage w, human capital h, and time worked $(1-t_h)$. Total resources available to the household consist of risk-free asset multiplied by interest rate $(1+r) \cdot a$, labor income y, net taxes paid $\mathcal{T}(y,a,n)$, and the total amount of baby bonus received $\mathcal{B} \cdot n$. Household divide resources into savings a' and three kinds of expenditures which are multiplied by consumption tax τ_c. These expenditures are composed of consumption c, total spending on market childcare $m \cdot p_m \cdot n$ and private educational expenditure $e \cdot n$. I use p_m to denote the price of market childcare relative to consumption goods[13] and I assume that for each dollar spent on childcare, the government could choose to refund $\mathcal{S} \in [0,1]$ dollars back to parents.

Children's human capital production function $G(h, \mathcal{E}, e, \epsilon)$ combines parents' human capital h, public education $\mathcal{E}$, private investment e and idiosyncratic ability shock ϵ that is unknown to parents. To keep the tractability of the model, I make a simplifying assumption that parental investment in children's human capital takes place when children's age is between 0 to 10 while public education $\mathcal{E}$ takes the major role from age 6 to 20. The function $G(\cdot)$ captures the overall human capital

[13] In this paper, I will be assuming that the supply of childcare services is perfectly elastic at baseline price p_m since each period represents ten years, which allows adjustments in or out of the childcare industry. In the short-run, relative prices of childcare may rise in response to family policies, such as a large childcare subsidy.

production function that spans age 0 to 20 without explicitly modeling several stages of production with dynamic complementarity. Since I view the bulk of childcare needs $n \cdot \chi$ as non-educational, i.e. preparing food or changing diapers, the arrangement of childcare does not affect children's human capital directly. Parents are allowed to invest in their children's human capital through monetary investments e, which could be converted into time units using parent's market wage $w \cdot h$. Since the government chooses public education expenditure $\mathcal{E}$, the model could also replicate public provision of high-quality childcare as a policy that combines higher $\mathcal{S}$ with an expansion in $\mathcal{E}$.

In the baseline economy, I assume that households face inter-temporal borrowing constraint $a' \geq 0$ that is standard in the class of Aiyagari-Huggett models. With idiosyncratic uninsurable shocks, this induces households to save for precautionary motives beyond life-cycle asset accumulation. Parents are not allowed to invest in negative amounts of resources in children's education, $e \geq 0$. Therefore, public investment $\mathcal{E}$ provides a lower-bound of total educational investments received by any child.

Parents' choice problem at age 30-40 is given by:

$$V_3(h, a, n, \mathbb{E}h_k) = \max_{c, a', a_k \geq 0} u(c/q(n)) + \beta \mathbb{E} V_4(h', a') + v(n, \mathbb{E}h_k, a_k)$$

subject to

$$y = wh$$

$$(1 + \tau_c)c + a' + n \cdot a_k = (1 + r)a + y - \mathcal{T}(y, a, n)$$

$$h' = L(h, 1, z')$$

where parents choose consumption, savings, and the amount of transfers to be received by each child at the beginning of next period (a_k). Following the literature, it is assumed that parents face intergenerational borrowing constraints so that they are not allowed to make negative transfers to children, i.e. $a_k \geq 0$. I use $v(n, \mathbb{E}h_k, a_k)$ to denote parents' preferences over child quantity, child human capital, and inter-vivos transfers. The parametric form of $v(\cdot)$ will be discussed in detail in Section 3.3.

For $j \in \{4, 5, 6\}$, households solve a simple consumption-savings problem with idiosyncratic shocks to human capital. For computational simplicity, I assume that parents and children no longer interact in these periods.[14] The maximization problem is given by:

$$V_j(h, a) = \max_{c, a' \geq 0} u(c) + \beta \mathbb{E} V_{j+1}(h', a') \qquad j \in \{4, 5, 6\}$$

[14]Otherwise, parents need to keep track of all children's state variables, including that of the grandchildren. This will make the problem computationally infeasible.

subject to

$$(1+\tau_c)c + a' = (1+r)a + y - \mathcal{T}(y, a, 0)$$

$$h' = L(h, 1, z)$$

Finally, retired agents solve:

$$V_j(h, a) = \max_{c, a' \geq 0} u(c) + \beta V_{j+1}(h, a') \qquad j \in \{7, 8\}$$

$$(1+\tau_c)c + a' = (1 + r - \tau_a r)a + \pi \cdot wh$$

$$V_9(\cdot) \equiv 0$$

where household income is composed of risk-free assets and pension payment $\pi \cdot wh$. I use π to denote the replacement rate of pension and assume pension payments are not subject to income taxes. Capital income $r \cdot a$, on the other hand, is subject to a flat-rate tax rate τ_a.[15]

2.2 Firms

There is a representative firm in the economy that hires labor (in efficiency units) and borrows capital from households to produce final goods with Cobb-Douglas technology:

$$Y = A \cdot K^{\alpha} L^{1-\alpha} \tag{2}$$

In (2), K is aggregate capital used in production and H is total efficiency units employed. Total factor productivity A is normalized to be one.[16]

I assume physical capital depreciates at rate δ_K after use. With competitive factor markets, wage and risk-free interest rate in equilibrium are given by:

$$r = \alpha \left(\frac{K}{H}\right)^{\alpha-1} - \delta_K, \quad w = (1-\alpha)\left(\frac{K}{H}\right)^{\alpha}$$

2.3 Government

The government collects revenues from taxing labor income, capital income, and consumption. The expenditure side includes public education, family policies, pension and other per-capita

[15] Flat-rate capital income taxes for households in other periods are embedded in the tax function $\mathcal{T}(y, a, n)$.

[16] I abstract away from population externalities that could affect aggregate production such as pollution (Bohn and Stuart, 2015) and ideas creation (Jones, 2020). This choice is made since (1) the literature on measurement of population externalities is still developing, and (2) paper results will change in expected ways once positive/negative externalities are incorporated.

exogenous expenditures. I assume that the government balances budget from period to period.[17]

I use $\{\mu_j\}_{j=0}^{8}$ to denote the distribution of households across state space and use $\{\omega_j\}_{j=0}^{8}$ to denote the fraction of each age group in the population with total mass normalized to one. The government balance constraint at each time is given by:

$$\underbrace{\left(\sum_{j=2}^{6}\omega_j\int\mathcal{T}(y_j^*,a_j^*,n_j^*)\,d\mu_j\right)}_{\text{labor and capital income taxes}}+\underbrace{\left(\sum_{j=2}^{8}\omega_j\int\tau_c c_j^*\,d\mu_j\right)}_{\text{consumption tax}}=\underbrace{\left(\sum_{j=7}^{8}\omega_j\int w\pi h\,d\mu_j\right)}_{\text{pension payments}}$$
$$+\underbrace{(\omega_0+\omega_1)\cdot\mathcal{E}}_{\text{public education}}+\omega_2\left(\underbrace{\int n^*\cdot\mathcal{B}\,d\mu_2}_{\text{baby bonus}}+\underbrace{\int(1+\tau_c)m^*n^*p_m\cdot\mathcal{S}\,d\mu_2}_{\text{subsidized childcare}}\right)+\underbrace{\mathcal{X}}_{\textbf{other spendings}} \tag{3}$$

In (3), government balances budget by equalizing tax revenues from labor income, capital income and consumption to expenditures consisting of pension payments, public education, baby bonus, subsidized childcare. Each source of revenue or expenditure is weighted by the corresponding mass of the corresponding age group. The exogenous per-capita expenditure $\mathcal{X}$ is fixed across policies.

I define social welfare in the long-run $\mathcal{W}$ as the average value of households at the beginning of their life-cycle, i.e.

$$\mathcal{W}=\int V_2\,d\mu_2 \tag{4}$$

This measures the expected utility of a newborn under the veil of ignorance. When making welfare comparisons, I will convert changes in $\mathcal{W}$ into percentage changes in consumption equivalence using utility function $u(\cdot)$. This assumption on welfare is a pragmatic approach that sidesteps a body of theoretical and philosophical discussions on the definition of welfare with endogenous fertility (see Golosov et al., 2007 and de La Croix and Doepke, 2021). Here, I simply evaluate whether higher fertility, i.e. additional people, is going to improve the average well-being of all households who are actually alive in the long-run economy.

Note that this measure of long-run welfare $\mathcal{W}$ does not capture the well-being of existing agents or households along the transition path. To this end, I will discuss how these people are affected by family policies in Section 5.2.

Government policies could be welfare-improving for two reasons. First, childbearing and child-rearing carries fiscal externalities as parents do not internalize the effects of having an additional child or investing in children's human capital on future tax base and government revenues. In other words, infinitesimal parents take the age structure $\{\omega_j\}_{j=0}^{8}$ and tax rates as given. But these objects

[17] An interesting extension for future research is to allow the government to issue debts to finance family policies. This point will be discussed in Section 5.2.

will change when a mass of parents adjust their decisions on fertility and educational investments. This is due to the lack of property rights of parents on children's future output (Schoonbroodt and Tertilt, 2014). Second, parents face both inter-temporal and intergenerational borrowing constraints due to imperfections in capital markets. Parents will not be able to use children's future income to finance children's education. Parents are also constrained in borrowing from their own future income to finance current expenditures. Government policies could overcome these inefficiencies by providing resources to parents or expanding public education (Daruich, 2018, Abbott et al., 2019).

2.4 Equilibrium

I use t to denote time. The equilibrium of the economy is defined as a tuple composed of:

- Decision rules $\{c_t^*, a_t'^*, n_t^*, m_t^*, t_{h,t}^*, e_t^*, a_{k,t}^*\}_{t=0}^{\infty}$
- Prices $\{w_t^*, r_t^*\}_{t=0}^{\infty}$
- Government policies $\{\mathcal{T}_t(\cdot), \tau_{c,t}, \mathcal{B}_t, \mathcal{S}_t, \mathcal{E}_t\}_{t=0}^{\infty}$
- Distribution of agents $\{\{\mu_{j,t}\}_{j=0}^{8}, \{\omega_{j,t}\}_{j=0}^{8}\}_{t=0}^{\infty}$

such that households maximize utility, prices clear labor and capital markets, government balances budget in each period, and the distribution of agents evolve following the dynamics shaped by household decision rules, exogenous labor market shocks z, and ability shock for children ϵ.

The evolution of the human capital distribution[18] from parents to children is given by:

$$\mu_2'(h) = \frac{1}{N} \iint n^*(x) \mathbb{1}_{h_k^*(x,\epsilon)<h} \, d\mathcal{Q}(\epsilon) \, d\mu_2(x) \tag{5}$$

where $\mathcal{Q}$ denotes the distribution of child ability shock ϵ; $h_k^*(x, \epsilon)$ is the human capital of children born into family with parents human capital being x and receive ϵ as ability shock, and N is the aggregate fertility rate in the economy:

$$N = \int n^*(x) \, d\mu_2(x) \tag{6}$$

In a stationary equilibrium of the economy.decision rule, prices, and distributions that are unchanged over time.[19] The process defined in (5) is a multi-type branching (or Galton-Watson) pro-

[18] For simplicity of exposition, here I omit the distribution over initial assets, which is decided by parents at $j = 3$.

[19] The size of the population, however, could change of time as aggregate fertility rate is not necessarily at replacement level

cess. Under mild conditions, it can be shown that a stationary distribution of agents exists and is unique (see Mode, 1971 and Chu, 1990).

2.5 Discussion of Mechanisms

In this section, I discuss why adding endogenous fertility makes the model predictions on aggregate impacts of family policies distinct from that using structural models with exogenous fertility or design-based studies with existing parent-child pairs.

2.5.1 Quality/Quantity Trade-off

Consider the effect of an increase in baby bonus $\mathcal{B}$ on transfers to each child a_k holding education investment e constant. The first-order condition for a_k is given by:

$$\frac{\partial v(n, \mathbb{E}h_k, a_k)}{\partial a_k} = \lambda_3 \cdot n$$

where λ_3 denotes the Lagrangian multiplier on parents' budget in period 3.

When fertility is exogenous, i.e. n is fixed, the increase in $\mathcal{B}$ is an *income transfer*, which implies that a_k rises unambiguously due to the income effect:

$$\underbrace{\lambda_3 \downarrow}_{\text{income effect on } MU_c} \cdot n \quad \Rightarrow \quad \frac{v(n, \mathbb{E}h_k, a_k \uparrow)}{\partial a_k}$$

When fertility is endogenous, however, the increase in $\mathcal{B}$ is a *price change*. The direction in which a_k changes is ambiguous:

$$\underbrace{\lambda_3 ?}_{\text{change in } MU_c \text{ as } n\uparrow} \cdot \underbrace{n \uparrow}_{\textbf{fertility response}} = \underbrace{\frac{\partial v(n\uparrow, \mathbb{E}h_k, a_k \mathbf{?})}{\partial a_k}}_{\text{interaction in preferences}} \tag{7}$$

As fertility rises due to more generous child benefits[20], it affects the first-order condition of child quality a_k in three ways. First, it interacts with a_k in parents preferences $v(\cdot)$. If quality and quantity are complements (substitutes), then parents would desire higher (lower) a_k. Second, rising quantity could offset the income effect since higher n raises in the marginal utility of consumption via change in equivalence scale $q(n)$. Lastly, marginal costs of child quality a_k rises because it is proportional to fertility n due to their interaction in parents' budget constraint.[21]

[20] This will be true as long as child quantity is not a Giffen good. See McDonald (2006) and Stone (2020) for supporting evidence.

[21] Becker and Lewis (1973) named this last effect quality/quantity trade-off. In this paper, I abuse this notation

To summarize, considering endogenous fertility permits the possibility that child quality could fall when child benefits become more generous via family policies. This stands in contrast with previous literature on family policies that only considers the income effects of transfers.

2.5.2 Composition Effects

When fertility is endogenous, parents' responses to family policies generate composition effects on aggregate variables. Families or dynasties with stronger fertility responses will gain representation over time since their children will take a larger fraction of future population. Since individual traits, such as human capital, are persistent across generations, aggregate variables will gravitate towards the traits of those families that increase fertility the most due to policies. For example, Vogl and Freese (2020) argues that composition effects could shape public opinions towards policies regarding conservative family values. de La Croix and Doepke (2003) and Vogl (2016) show that changes in fertility differentials in the economy affect long-run growth via composition effects.

2.5.3 Demographic Structure Effects

When fertility is endogenous, family policies change the population growth rate and hence the demographic structure $\{\omega_j\}_{j=0}^{8}$. This change has profound implications on the government budget constraint (3) since it determines how each source of revenue or expenditure is weighted. In particular, higher fertility rate reduces the old-age dependency ratio $\left(\sum_{j=7}^{8}\omega_j\right) / \left(\sum_{j=2}^{6}\omega_j\right)$ but may raise the total dependency ratio $\left(\sum_{j=7}^{8}\omega_j + \sum_{j=0}^{1}\omega_j\right) / \left(\sum_{j=2}^{6}\omega_j\right)$. The government needs to balance its budget, family policies induce further adjustments to taxes in the general equilibrium. In fact, allowing for endogenous fertility is a necessary condition for a model to have the ability to study the impacts of large-scale family policies on population aging.

2.5.4 Summary of Mechanisms

As discussed above, relative to design-based analysis or structural models with exogenous child quantity, explicitly modeling fertility choice of households incorporates quality/quantity trade-off, composition effects, and demographic structure effects. The key moment in the model that governs the strength of these mechanisms is the magnitude of fertility responses to financial incentives because if households do not respond to family policies by adjusting fertility, the model predictions would be similar to that in Daruich (2018) and Mullins (2019). A large part of the next two sections

slightly to denote the overall effects of an increase in fertility on child quality.

of the paper is devoted to disciplining this elasticity using data from various sources and validating its magnitude using policy variations.

3 Calibration

In this section, I describe the calibration procedures of the model. There are a number of parameters that are picked exogenously. I calibrate 13 parameters inside the model using simulated method of moments by matching the steady-state of baseline model to the United States in 2010.

3.1 Costs of Children and Childcare

The household equivalence scale $q(n)$ is taken from the OECD standard:

$$q(n) = 1.7 + 0.5 \cdot n$$

where n is the number of children residing with the family.

Recall the childcare requirement constraint, i.e. time costs of child, is given by:

$$n \cdot \chi = \left(t_h^{\upsilon/\iota} + (n \cdot m)^{\upsilon} \right)^{1/\upsilon}$$

I choose $\chi = 0.18$ following estimated by Folbre (2008) (Table 6.2) calculated using American Time Use Survey (ATUS) data. I calibrate the economies of scale in providing childcare at home $\iota = 0.7$ to match the estimates by Folbre (2008) (Table 6.4). The parameter governing the elasticity of substitution between home care and market care υ is calibrate to be 0.5 to match the average expenditure on childcare as a fraction of total family income using estimates from Herbst (2018). Lastly, I choose the price of full-time market care for child aged 0 sto 10, p_m, to be \$6,860 in 2010 following the statistic reported by the National Association of Child Care Resource & Referral Agencies (NACCRRA, 2011).[22]

[22] To be more specific, the average costs of full-time childcare across states are \$9,303 (infant), \$7,377 (4-year-old), and \$4,753 (school-age) for child care centers; \$6,926 (infant), \$6,131 (4-year-old), and \$4,405 (school-age) for family child care (NACCRRA, 2011 Appendix 1). I take an age-weighted average of these costs to calculate the full-time childcare costs for children age 0 to 10.

3.2 Child's Human Capital Production

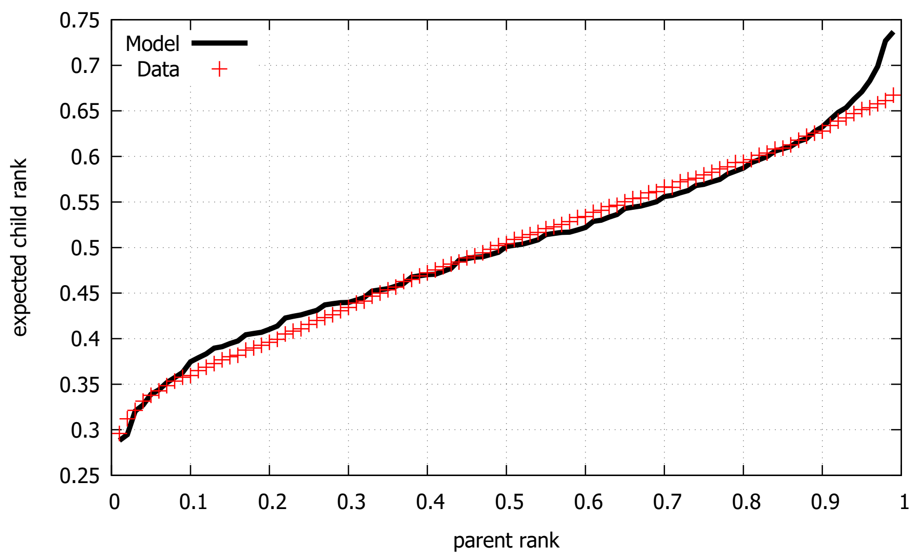
I parameterize the child human capital production function as:

$$h_k = G(h, \mathcal{E}, e, \epsilon) = \underbrace{Z}_{\text{scalar}} \cdot \underbrace{\epsilon}_{\text{shock}} \cdot \underbrace{h^\rho}_{\text{spillover}} \cdot \left(\underbrace{\mathcal{E}^\xi}_{\text{public education}} + \underbrace{e^\xi}_{\text{private input}} \right)^{\kappa/\xi} \tag{8}$$

$$\log(\epsilon) \sim \mathcal{N}(-\frac{\sigma_\epsilon^2}{2}, \sigma_\epsilon^2)$$

Parameter Z is a scaling parameter that governs the overall scale of the economy. It also enables us to normalize the total factor productivity A to be one. I choose $Z = 2.57$ so that the median income of families in the model is one, corresponding to \$49,445 estimated using Census data. Parameter σ_ϵ governs the dispersion of idiosyncratic shock to children's ability. I pick $\sigma_\epsilon = 0.45$ to match the dispersion of earnings for young households estimated by Huggett et al. (2011) calculated using data from Panel Study of Income Dynamics (PSID). I calibrate $\rho = 0.28$ to match the rank-rank intergenerational mobility estimated by Chetty et al. (2014). The model fit can be seen in Figure 2.

Figure 2: Intergenerational Income Mobility: Model vs Data



Note: This figure plots the relationship between parents' income rank and children's expected income rank in the calibrated model and that estimated by Chetty et al. (2014).

I use ξ to parameterize the elasticity of substitution between public and private education inputs and calibrate $\xi = 0.9$ to match the correlation between educational spending and household income using data from Consumer Expenditure Survey (CEX) which includes tuition, test preparation, tutoring, books, and supplies. The magnitude of public education $\mathcal{E}$ is chosen to match \$12,000 annual expenditure per student reported by National Center of Education Statistics (NCES).

The last parameter in child human capital production function that needs to be calibrated is κ which governs the productivity of educational investments. I use RCT evidence by García et al. (2020) to inform the value of κ. García et al. (2020) evaluates two early childhood programs (ABC and CARE) in the 1970s. They costs about \$13,500 per year for give years, which means the total program cost is around \$67,500 per child. The project follows the treated children into adulthood and observes their education and (part of life-cycle) incomes. They estimate that for every dollar invested, children's lifetime labor income increases by 1.3 dollars in net present value. I apply a similar policy in the model by expanding existing public education $\mathcal{E}$ by \$67,500. I apply it at a small scale so that prices and taxes remain unchanged and target it at children from parents at 10th percentile of earnings. By comparing treatment and controls groups in the model, I arrive at an estimate of $\kappa = 0.17$.

3.3 Preferences over Quantity and Quality

I assume that parents' preference over child quantity and quality is given by:

$$v(n, \mathbb{E}h_k, a_k) = \underbrace{\Psi(n)}_{\text{child discounting}} \cdot (\theta \cdot u(\mathbb{E}h_k) + \nu \cdot u(a_k)) \tag{9}$$

$$\Psi(n) = 1 - \exp(-\psi n) \tag{10}$$

$$u(x) = \frac{x^{1-\gamma}}{1-\gamma}, \quad \gamma \in (0,1), \quad x \in \{\mathbb{E}h_k, a_k, c\} \tag{11}$$

where parents value child quality weighted by child discounting $\Psi(n)$ (c.f. Barro and Becker, 1989; Scholz and Seshadri, 2007). The utility function of child quality and consumption is governed by γ which also known as the elasticity of intergenerational substitution (EGS) (c.f. Cordoba et al., 2016; Carlos Córdoba and Ripoll, 2019).[23] I use $\theta \cdot u(\mathbb{E}(h_k)) + \nu \cdot u(a_k)$ as a first-order approximation to general preferences over child quality and transfers. In Section 6, I argue that my results are robust to other common specifications, including separable preferences (de La Croix and Doepke, 2003), quality and quantity being substitutes (Jones and Schoonbroodt, 2010), and dynastic altruism (Daruich and Kozlowski, 2020).

Parameters $\theta = 2.1$ and $\nu = 0.36$ are calibrated to match the average human capital investment as a share of income and average inter-vivos transfers of \$60,000 in 2010 dollars calculated by Daruich (2018) using PSID data. I calibrate $\psi = 1.93$ to match the average fertility calculated

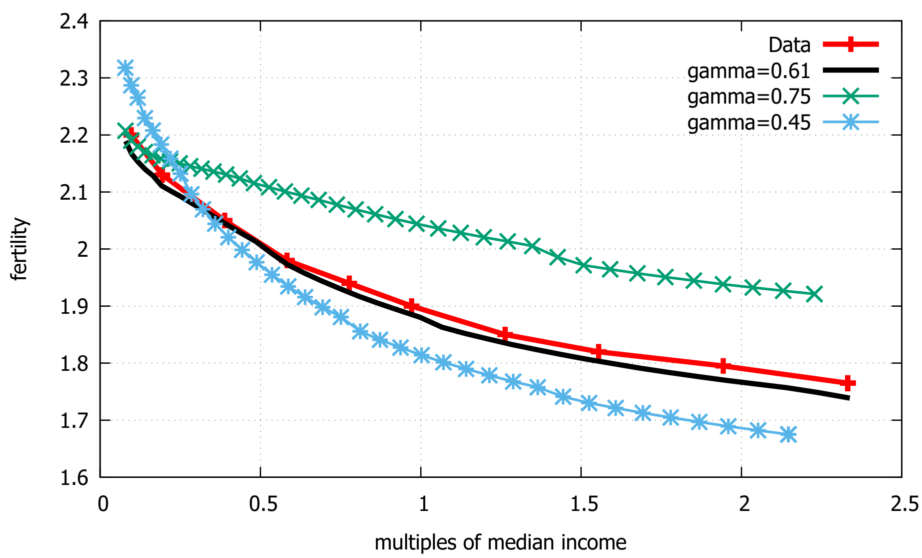
[23] Since EGS is designed to match interactions across generations, its magnitude and interpretations are distinct from that of the elasticity of intertemporal substitution (EIS) used to capture risk-aversion in business cycle models. For recent work that considers EGS and EIS jointly, see Carlos Córdoba and Ripoll (2019).

using CPS June Fertility Supplement data from 2008 to 2014.[24]

Conditional on $\{\theta, \nu, \psi\}$ and other parameters that govern costs of child and children's human capital production function, parameter γ is an important parameter governing the fertility elasticity where higher γ implies smaller fertility responses to financial incentives.[25]

On the other hand, parameter γ is identified by the fertility-income profile in the data. The logic of this identification follows Cordoba et al. (2016): controlling for other parameters, higher γ implies a larger marginal rate of substitution of quantity for quality and a flatter fertility-income profile. Numerical illustration of the identification is displayed in Figure 3. I choose $\gamma = 0.61$ such that the model best fits the observed relationship between fertility and income.

Figure 3: Identification of Elasticity of Intergenerational Substitution γ



Note: This figure plots the relationship between parents' income and completed fertility in the model under different levels of γ. The data estimate uses CPS June Fertility Supplement data from 2008 to 2014.

3.4 Other Parameters

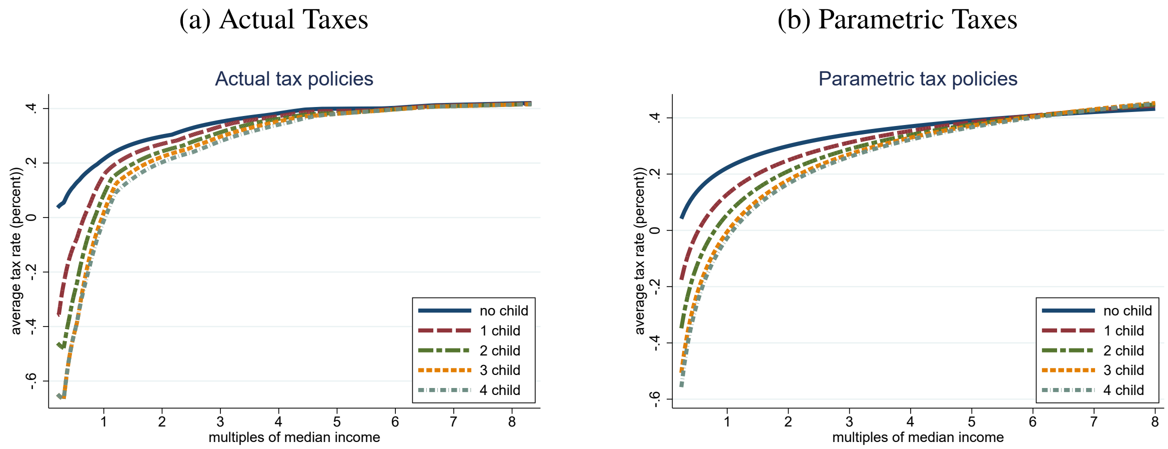
I assume the human capital of adults evolve with age according to:

$$h' = L(h, t_w, z') = \exp(z')(h + \zeta(h \cdot t_w))^\eta \tag{12}$$

$$\log(z) \sim \mathcal{N}(\mu_z, \sigma_z)$$

[24] I measure the completed fertility rate using the number of live births ever had for women aged 40 to 55.
[25] The illustrative model in Appendix C.2 shows that responses in fertility is proportional to $1 - \gamma$.

Figure 4: Labor Income Taxes



Note: These figures plot average tax rates depending on household income and number of dependent children residing with the family. The left panel shows calculations using TAXSIM. The right panel displays fits using parametric tax formulas.

I calibrate $\eta = 0.61$, $\zeta = 0.72$ and $\sigma_z = 0.42$ to match life-cycle profile of earnings and gini coefficient of earnings calculated by Huggett et al. (2011). I choose $\mu_z = -0.23$ so that skill depreciation is 2% per year.

Following Heathcote et al. (2017), I parameterize income taxes as:

$$\mathcal{T}(y, a, n) = y \cdot (1 - \tau_y^n y^{-\lambda_y^n}) + \tau_a r a \tag{13}$$

where $\{\tau_y^n, \lambda_y^n\}$ parameterize the level and progressitivity of taxes depending on the number of children residing in the household while τ_a denotes the linear capital income taxes. I obtain $\{\tau_y^n, \lambda_y^n\}$ using simulated data from TAXSIM provided by the NBER (see Figure 4). Having an additional child significantly reduces the tax burden faced by households through various programs such as Earned Income Tax Credit (EITC) and Child Tax Credits (CTC). The tax system is progressive, with lower-income households receiving subsidies rather than paying taxes. As household income grows, labor income taxes converge to 40%. Following McDaniel (2007) and Daruich and Fernández (2020), I choose capital income tax $\tau_a = 0.27$ and consumption taxes $\tau_c = 0.07$. Pension replacement rate π is set to be 40%.

In the production function of the firms, I choose the capital share α to be 0.33 following the standard literature and set the capital depreciation rate δ_k at 4% per year. Lastly, I choose the annual discount rate $\beta = 0.98$ and calculate age-specific mortality rate $\{\delta_j\}_{j=0}^{8}$ using the actuarial life table from Social Security.

To summarize, the calibrated parameters are presented in Table 1.

Table 1: Calibrated Parameters

	Interpretation	Value	Source		Interpretation	Value	Source
	Preferences				Child human capital production		
β	discount rate	0.98^{10}	standard	Z	normalizing scalar	2.57	median income =1
γ	elasticity of substitution	0.61	CPS	σ_ϵ	ability shock dispersion	0.45	PSID
ψ	fertility preference	1.93	CPS	ρ	intergenerational spillover	0.28	Chetty et al. (2014)
θ	quality preference	2.1	PSID	ξ	substitution of education	0.9	ATUS
ν	transfer preference	0.36	PSID	$\mathcal{E}$	public education	0.15	NCES
				κ	input productivity	0.17	García et al. (2020)
	Childcare arrangement						
χ	childcare cost	0.18	Folbre (2008)		Adult human capital evolution		
ι	economies of scale at home	0.7	Folbre (2008)	η	learning curvature	0.61	PSID
υ	substitutability of care	0.5	SIPP	ζ	learning level	0.72	PSID
p_m	price of full-time care	0.13	NACCRRA (2011)	μ_z	skill depreciation	-0.23	PSID
				σ_z	shock dispersion	0.42	PSID
	Taxes and pension						
τ_y^n, λ_y^n	tax levels and progressitivity	misc.	TAXSIM		Firm production function		
τ_c	consumption tax	0.07	McDaniel (2007)	A	total factor productivity	1	normalization
τ_a	capital income tax	0.27	McDaniel (2007)	α	capital share	0.33	standard
π	pension replacement rate	0.40	OECD Database	δ_k	capital depreciation	0.04^{10}	standard

Note: This table displays the list of parameters used in the model. Parameters in red are calibrated within the model while those in black are chosen exogenously.

4 Validation

In this section, I perform an external validation of the fertility responses by households to financial incentives in the model. This is an important exercise before I use the model to conduct policy counterfactuals since it lends extra credibility to the quantitative magnitude of fertility elasticities, which is the crucial moment governing quality/quantity trade-off, composition effects, and demographic structure effects. Additional validating evidence including Australian baby bonus, Spanish child benefits, and Georgia's Cherokee land lottery are presented in Appendix B.

I exploit empirical evidence from Alaska Permanent Fund Dividends (APFD). Briefly speaking, the dividend was officially established in 1982 after discovery of the petroleum and increased state revenues. Every year, it gives uniform transfers to all residents regardless of income, employment or age. In particular, the program allows a parent, guardian, or other authorized representative to claim a dividend on behalf of a child while Alaska law imposes no requirements whatsoever on how parents use a child's dividend. As a result, the policy has pronatal effects even though it is not explicitly advertised as a family policy that encourages fertility.

APFD is an ideal policy variation to validate fertility elasticities for four reasons. First, compared with other family policies which mostly took place in European countries, the cultural and institutional background of Alaska is much more similar to the overall U.S. system that I calibrate the model to match. Second, compared with other family policies which is usually less than a few thousand dollars in net present value per child (e.g. Drago et al., 2011; González, 2013), the net present value that parents could receive and use with an additional child under APFD is almost \$20,000.[26] With such a large scale, it is more likely that policies would have meaningful and observable impacts on people's behavior especially when it comes to the important and irreversible decision of having a child. Third, compared with other family policies which are typically means-tested or depends on birth order, the APFD has a clearer implementation with more than 90% of state population filing for the application historically.[27] Lastly, APFD mimics a universal basic income for parents and refundable Child Tax Credit (CTC) for children. Given that it is not advertised as a policy that aims to encourage childbirth, its effects on fertility provides a conservative benchmark for family policies that are explicitly pronatal.

In the model, I implement APFD by transferring \$1,500 (annual amount) to every household

[26] I calculated the average payment to be around \$1,500 per year. Since the amount of the dividend is tied to the performance of the fund, which in turn depends largely on overall stock market performance, one might worry about how would the uncertainty about future payment amount affect people's responses in fertility. Given that given birth to a child is an irreversible decision, I argue that larger a mean-preserving spread of the dividend payment would reduce people's responses in fertility. Therefore, since the model generates fertility elasticities that are consistent with people's choices under uncertainty, our results on child benefits (without uncertainty) is likely going to be conservative.

[27] Cowan and Douds (2021) argues that the migration effects, also known as "population magnets effect", of APFD was not large empirically, with net migration rates around one-tenth of a percent in the sample period.

member including both parents and children. Parents will receive this transfer every period until they die. They are also entitled to receive additional transfers when children reside with them prior to becoming independent. I normalize the amount of transfer by median income in Alaska relative to that in the U.S. and conduct the policy experiment in partial equilibrium without changing prices.

The model predicts that completed fertility rate, i.e. the total number of children that parents end up having, increase 4.2% compared with the scenario without AFPD. Using synthetic control methods, Yonzan et al. (2020) concludes that total fertility rate increases by 13.1% due to AFPD using Natality files. Since policy effects on total fertility rate is typically larger than that on completed fertility rate[28], I multiply it by a common adjustment (Stone, 2017) of 1/3 to get a crude estimate of the effects on completed fertility rate of 4.5% which is similar to the model estimate.

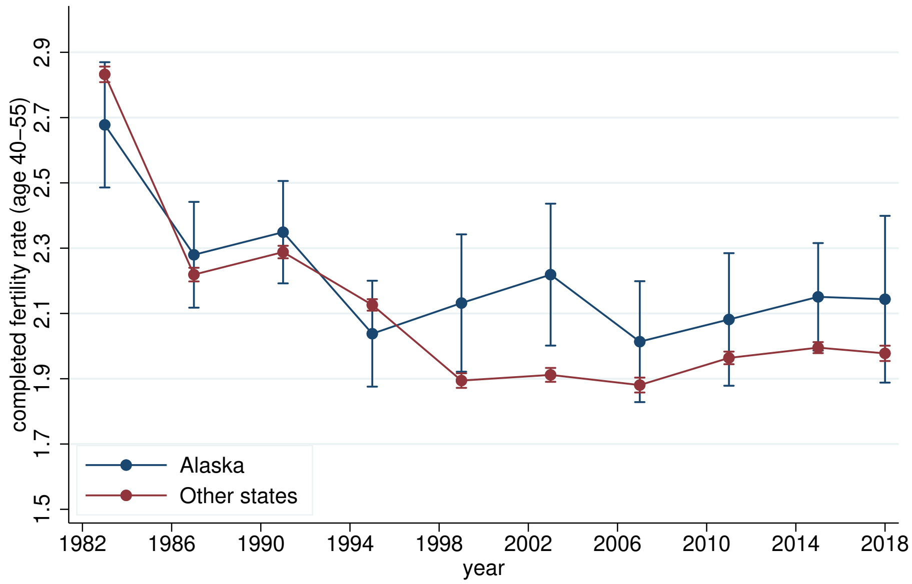
Since APFD was enacted decades ago, it is possible to explore the effects on completed fertility rate directly without extrapolating based on changes in total fertility rate. Figure 5 plots the time series of completed fertility rate (i.e. total number of live births ever had by women aged 40-55) for Alaska and the rest of U.S. from 1982 to 2018 using CPS June Fertility Supplement data. As can be seen, the trend of Alaska is indistinguishable from the rest of the U.S. prior to 1996. After 16 years of the APFD implementation, however, completed fertility rate in Alaska is persistently higher than that in the rest of the U.S.[29] by around or above 0.1 children per women. This makes the model prediction of 0.1 children per women (4.2% increase) slightly conservative.

The model also predicts heterogeneous fertility responses across households. Since the parents are entitled to claim children's dividends, and these dividends are the uniform in size, the model predicts that households with lower human capital have larger increase in fertility (e.g. see results on baby bonus in Section 5.1). This is in line with the finding by Cowan and Douds (2021) where they show larger fertility increases among Alaska natives and women without high school degree. This difference is also visible when inspecting the time series of completed fertility rate by education in Alaska versus the rest of the U.S. in Figure 6. Completed fertility rates among Alaskan women with college degree is similar to that in the other states after APFD was adopted, while Alaskan women without college degree increased childbirth relative to the other states.

[28] Changes in total fertility rate includes both quantum effect (i.e. effects on completed fertility rate) and tempo effect (i.e. change in timing of birth, also known as compression effect).

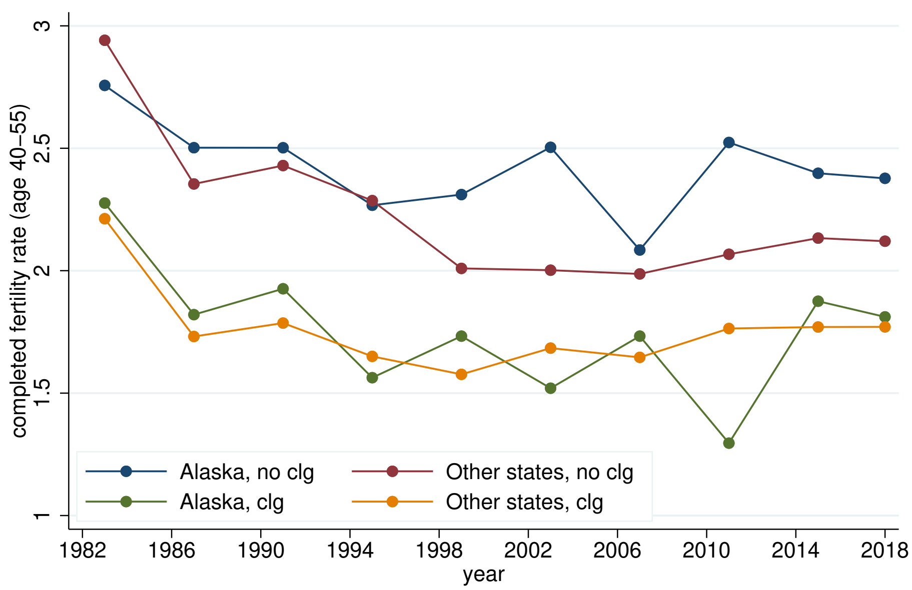
[29] The gap is only statistically significant at 10% for some of the years because the CPS sample of Alaskan women is small, leading to wide confidence intervals.

Figure 5: AFPD Effects on Completed Fertility Rate



Note: This figure plots the average completed fertility rates for women aged 40-55 by state of residence from 1982 to 2018 using data from CPS June Fertility Supplement combined into 4-year bins. Bars around the sample mean represents 90% confidence intervals.

Figure 6: AFPD Effects on Completed Fertility Rate by Education



Note: This figure plots the average completed fertility rates for women aged 40-55 by state of residence and education from 1982 to 2018 using data from CPS June Fertility Supplement combined into 4-year bins. Bars around the sample mean represents 90% confidence intervals. I define college-educated women as those who have obtained a bachelor's degree or above.

5 Counterfactuals

In this section, I use the model to evaluate policies of different sizes in the general equilibrium where prices and distribution of the population adjust. I focus on baby bonus since it has been widely adopted in the developed world (e.g. Drago et al., 2011; González, 2013) and is similar in structure to an expansion of refundable child tax credits (CTC).[30]. I will first discuss its long-run implications in Section 5.1 where I assume that the government is balancing the budget by adjusting consumption taxes. The outcome variables of interest include but not limited to fertility, human capital, average income, intergenerational mobility (measured by IGE^{-1}) and social welfare. In Section 5.2, I study the transition path leading to that long-run outcome. In Section 5.3, I compares baby bonus with other policies including subsidized childcare $\mathcal{S}$ and education expenditures $\mathcal{E}$.

5.1 Baby Bonus: Long-run Implications

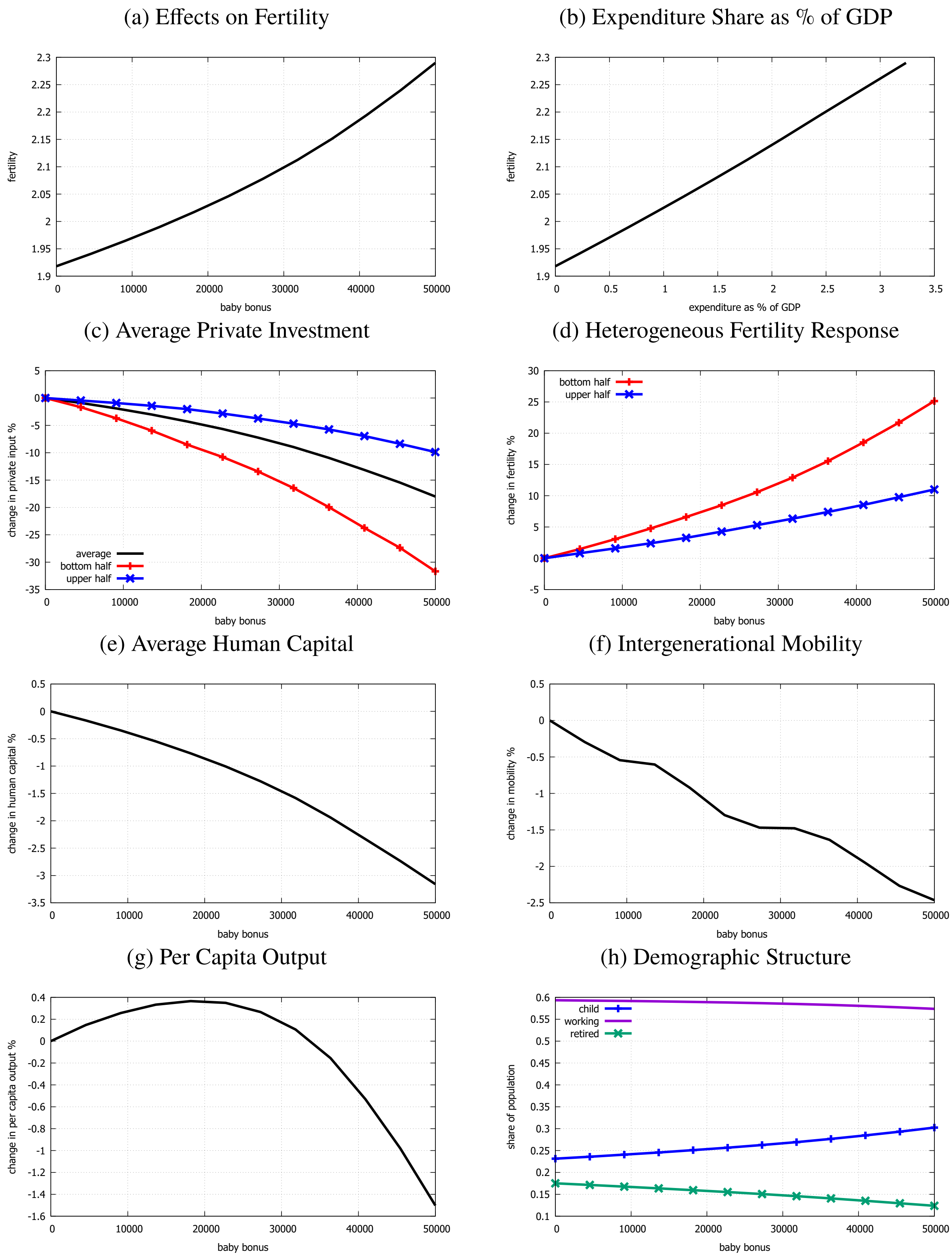
In this section, I evaluate baby bonus of different size ranging from \$0 to \$50,000. I compute the long-run macroeconomic implications of these policies by comparing the long-run steady-state of the economy with the benchmark economy where baby bonus is zero.

Figure 7a and 7b shows the fertility effects of baby bonus. To reach replacement fertility level (2.1 children per family on average), the model predicts that it would require a baby bonus of \$31,000 which will be around 1.7% of GDP in the new steady-state economy. This amounts is similar to the increase in CTC from 2010 to 2021 in net present value and offsets 19% of the average cost of raising one child (USDA estimate). These results confirm the common perception by demographers that using financial incentives to raise fertility is not “cheap". Under realistic magnitude of fertility elasticities and reasonable scale of policies, the effects of financial incentives provided by the government are small relative to historical changes in preferences, social norms, contraceptive technologies, and perhaps most important of all, changes in skill premium. The results, however, suggest that using cash transfers to prevent further crashes in fertility, or even to raise it, is feasible in practice.

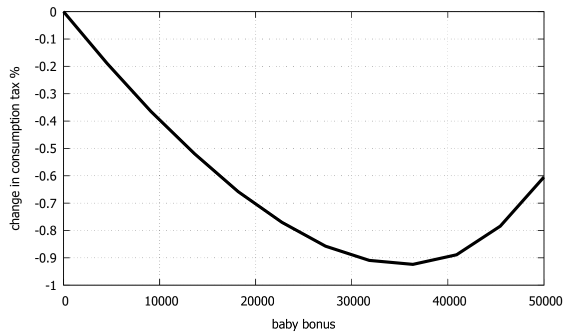
Figure 7c shows the quality/quantity trade-off channel discussed in Section 2.5.1. Baby bonus reduces the price of child quantity and parents respond by having more children. The increase quantity, in turn, raises the marginal cost of education as well as marginal utility of consumption due to larger family size. As a result, even when quality and quantity are complements in parents’

[30]There are two small differences between baby bonus and CTC. First, unlike CTC which has a phase-out criteria, baby bonus is usually not means-tested. I focus on the uniform case for simplicity and better exposition of heterogeneous responses. As will be discussed, the main results are stronger when family policies target low-income households. Second, baby bonus is a lump-sum transfer when the child is born while CTC is an annual transfer to parents when the child is below age 18. With borrowing constraints, low-income parents prefer baby bonus to CTC of the same net present value since they can replicate the latter through saving.

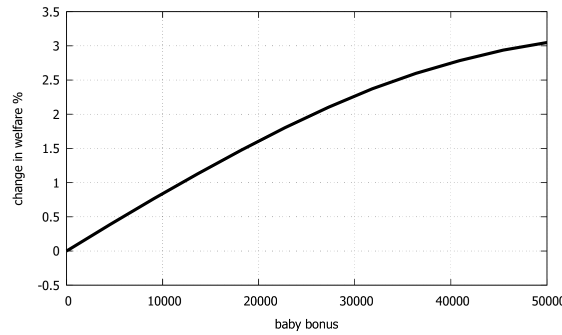
Figure 7: Effects of Baby Bonus of Different Sizes



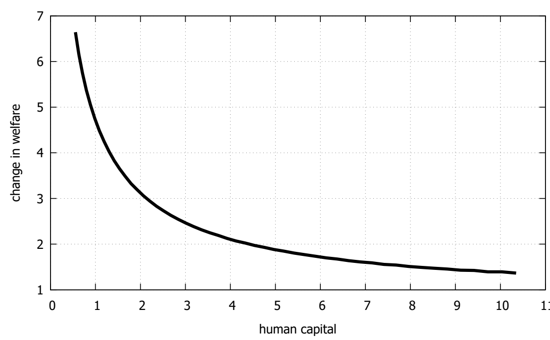
(i) Change in Consumption Tax



(j) Change in Welfare



(k) Change in Welfare by Human Capital of Parents



Note: These figures plot macroeconomic impacts of baby bonus of different sizes by comparing long-run steady-states under policies with baseline steady-state economy. See text for discussions.

preferences (see Section 3.3), parents optimally reduce the amount invested in children's education when fertility increases. When baby bonus is \$31,000, private investment per child is reduced by 8% on average.

Figure 7c and 7d shows that agents with lower human capital have stronger fertility responses and larger drops in private education investments in response to baby bonus. This is intuitive since the baby bonus of a given size accounts for a larger fraction of household income among low-income families. Due to intergenerational transmission of human capital in skill formation, heterogeneous responses in fertility induces gravitation of aggregate variables towards that of low-income families. Coupled with reductions in private investment, Figure 7e shows that average human capital falls by 1.5% under a \$31,000 baby bonus. Since the reduction of education investment is larger among low-income households, baby bonus reduces social mobility by 1.6% rather than boosting it as policy makers might have hoped.

Figure 7g shows that despite lower average human capital and social mobility, per capita output rises initially before falling around $\mathcal{B} = \$23,000$. On one hand, human capital distribution worsens as baby bonus increases. On the other hand, rising fertility shifts the composition of adults away from retired households, who are less productive.

As the size of baby bonus increases in size, Figure 7i shows that the government is able to reduce consumption tax for smaller baby bonus but needs to raise taxes for larger ones. This is a result of several forces shaping the government budget constraint in (3). First, tax revenues is affected by the change in human capital distribution. Second, as the share of retired households decrease, the government has less burden from pension payment. Lastly, as the share of children increases, the government needs to spend more on public education. When the government uses $31,000 to raise the aggregate fertility to replacement level, consumption tax could be slashed by 0.8% in the long-run.

Figure 7j plots the changes in welfare from the baseline economy expressed in change in consumption equivalence. Due to increased fertility and reduced consumption taxes, average utility of new-born under the veil of ignorance increases by 2.2% in the long-run economy when aggregate fertility reaches replacement level.

Lastly, Figure 7k plots the change in welfare by parents' human capital at $j = 2$ under a $31,000 baby bonus. Welfare improvements for parents with low human capital are much higher for two reasons. First, the size of the transfer is larger relative to their labor income. Second, they receive more bonus because they have more children (see Figure 3 and 7d).

5.2 Baby Bonus: Transition Path

In this section, I show the transition path results of aggregate variables under a $31,000 baby bonus where the policy is enacted unexpectedly at period $t = 1$ and persists afterwards. It is assumed that the government changes consumption taxes along the transition path to balance government budget period by period where each period in the model represents 10 years.

Figure 8b shows that the policy effects on fertility is immediate and persistent with a small overshooting from period 4 to 10. Figure 8b indicates that the old-age dependency ratio starts to have visible decline in period 6 since the share of working-age population and retired households are predetermined by past fertility rates. The total dependency ratio, however, increases immediately since there is a large increase in the number of children due to the baby bonus.

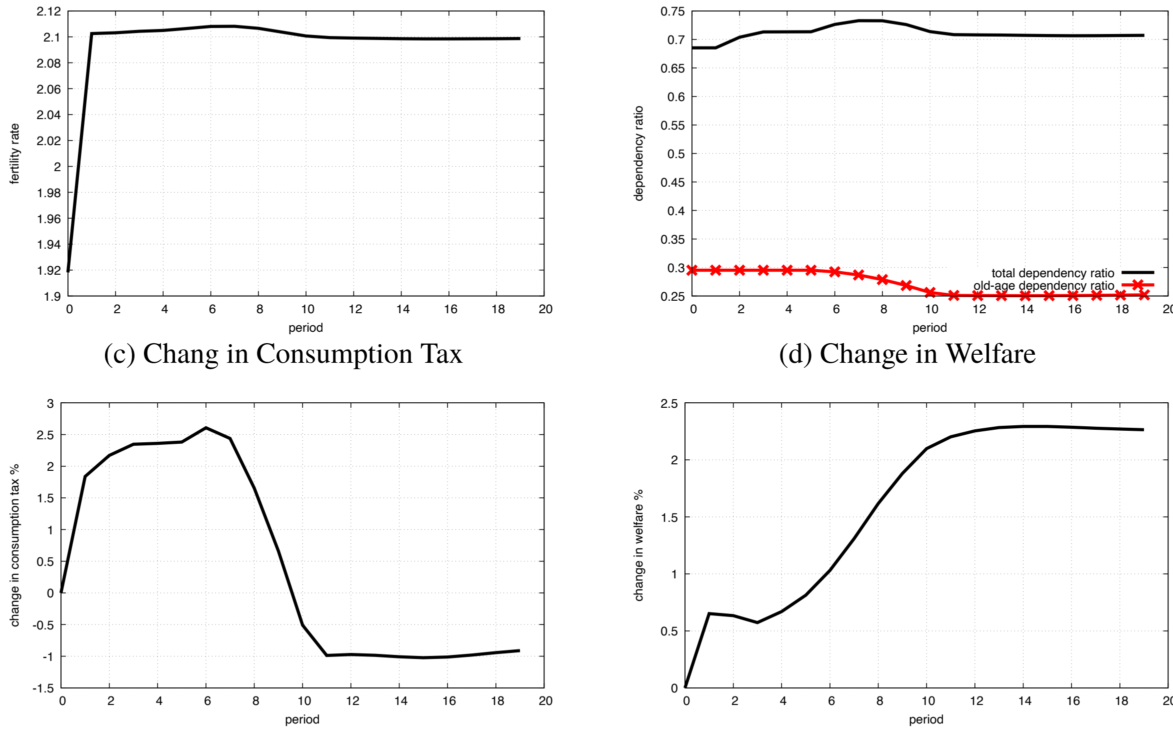
As a result of this increase in total dependency ratio, the government needs to raise consumption taxes in period 1 to 9 before being able to reduce it in the long-run. Hence, welfare changes of new-born agents after the policy are positive, but significantly smaller than that in the long-run. Lastly, since most agents in the current economy do not benefit from the baby bonus but are required to pay higher consumption taxes, they are worse off under the policy.[31]

[31] This finding suggests that despite long-run gains in welfare, the baby bonus will not gain majority support if it is financed using consumption taxes. This is a common feature in the class of overlapping-generations models even when households are altruistic towards future generations (e.g. Farhi and Werning, 2007).

Figure 8: Aggregate Variables in Transition under \$31,000 Baby Bonus

(a) Fertility Rate (b) Dependency Ratios

(c) Chang in Consumption Tax (d) Change in Welfare



Note: These figures plot evolution of aggregate variables under a baby bonus of \$31,000. Each period represents 10 years. The policy is enacted at period 1. See text for discussions.

5.3 Comparing Policies: Subsidized Childcare and Education Expenditures

In this section, I briefly discuss the policy comparison results. For more detailed results of subsidized childcare and public education expenditures, see Appendix A.1 and A.2.

Compared with baby bonus, subsidized childcare is 50% less cost-effective in raising fertility. It encourages the combination of childbearing and labor force participation by substituting at-home care by market care. This in turn, fosters adults human capital accumulation via on-the-job learning. As a result, subsidized childcare leads to higher gains in per capita output and welfare in the long-run. The responses in fertility and education investments are similar across education levels of the parents. Intergenerational mobility is not significantly changed under different levels of childcare subsidies.

Compared with baby bonus, the fertility effects of public education expenditures is smaller by an order of the magnitude. Therefore, the government should not expect to use education expenditures as pronatal policy instruments. Education expenditures have strong crowding-out effects of private investments since public and private investments are substitutes in the child human capital production function. Expanding public education, however, is most effective in raising social mobility and improving children's outcomes. A $60,000 expansion of public education (in net present value) raises intergenerational mobility by 4.6% and long-run welfare by 2.4%.

6 Robustness and Discussions

6.1 Alternative Preferences

There are alternative ways to model parents' preferences over child quantity and quality. I argue that the modeling choice in Section 3.3 makes our results a conservative benchmark.

One commonly-used assumption is separable preferences between quality and quantity (see de La Croix and Doepke, 2003; Bar et al., 2018; Vogl, 2016) where

$$v(n, \mathbb{E}h_k, a_k) = \log(n) + \theta \log(\mathbb{E}h_k) + \nu \log(a_k)$$

Compared with our benchmark case where quality and quantity are complements, parents will raise quantity and reduce quality even more strongly when costs of child is lower since the interaction in preferences at the right-hand-side of Equation 7 is not present under separable preferences. I show this argument with closed-form solutions in Appendix C.1.

Another way of modeling parents preferences are dynastic altruism (see Cordoba et al., 2016; Daruich and Kozlowski, 2020) where

$$v(n, \mathbb{E}h_k, a_k) = \Psi(n) V_2(\mathbb{E}h_k, a_k)$$

This formulation is quite similar to the one used in this paper except that utilities from child quality is pinned down recursively. Dynastic altruism is appealing aesthetically but face unresolved challenges in fitting observed transfers between parents and children (see Altonji et al., 1997 and Barczyk and Kredler, 2020). Paternalistic preferences, i.e. direct preference over children's outcomes, are often added to improve data fit (e.g. Abbott et al., 2019). I argue that our results will also be stronger under dynastic altruism since parents endogenize the fact that returns to child quality become lower as the government adopts policies such that their children will receive generous family benefits as "social safety net". As a result, parents would further increase child quantity and reduce quality investments. This mechanism is present in the class of models where parents only care about children's utility, but place no weights on child quality directly. For instance, Daruich and Fernández (2020) argues that universal basic income reduces human capital of future generations due to this reason.

6.2 Endogenous Timing of Childbirth

In the baseline model, I abstract away from birth timing by assuming that parents only make fertility choices from age 20 to 30. In reality, however, parents make decisions on when to give birth to children and family policies could affect that decision, also known as the tempo effects.[32]

I argue that adding endogenous timing will make our baseline results larger. As the model matches effects on completed fertility rate (quantum effects) in the validation exercise, policy effects on total fertility rate (quantum+tempo) are going to be larger than just the quantum effect. Suppose that in addition to increasing the number of children, some parents shift birth from 30s to their 20s in response to a baby bonus. This shift in birth timing is likely going to be detrimental to children's human capital for two reasons. First, parents' human capital grows over time in the model, so early birth reduces the spillover that the children could receive. Second, family policies of realistic size are not be enough to compensate for the income differences between early and late birth, hence on average these children are induced to be born into households with less resources. This would also reduce children's human capital. As a result, family policies will have a larger observed fertility impact on the economy if measured in total fertility rate, but the outcome of children will be worse.

6.3 Alternative Policies

Even though I only use the model to evaluate baby bonus, subsidized childcare and education which are financed through consumption taxes in the paper, the framework can be applied to analyzing a range of family and redistributive policies. For instance, instead of changing consumption tax to balance the budget, it is straightforward to calculate scenarios where additional expenditures are financed via labor taxes τ_y^n or capital income taxes τ_a. The government could also increase income tax progressitivity by raising λ_y^n.

There are also alternative policies that would manifest themselves in the model as changes in parameters. For instance, government propaganda that encourages parents to have child for the country, e.g.. in the case of Australian baby bonus, or policies that promote gender equality in childcare (see Doepke and Kindermann, 2019) could lead to changes in preferences for child quantity ψ. Education policies that equalize access to educational resources across income groups could lead to changes in intergenerational spillovers ρ. It is interesting and important for future studies to endogenize these channels, compare their cost-effectiveness with more traditional fiscal policies studied in this paper, and investigate how different policy instruments interact.

[32] An unresolved question in the literature is whether changes in timing is due to the relaxation of parents' constrains (e.g. down payments to buy a larger house) or the lack of commitment to policies by the government. In reality, governments often renege on family policies or reduces the scale of payments as fiscal condition changes. One example is the Australian baby bonus which got significantly downsized in 2014. This uncertainty creates an incentive for parents to shift timing when benefits are still in effect.

6.4 Optimal Policy Design

It is natural to ask what the optimal policy is in the model. The result from Figure 7j points to an "optimal baby bonus" under given policy instrument and long-run welfare defined as average utility of new-born under the veil of ignorance. But from the planner's point of view, what is the optimal population size, and what is the optimal distribution of children across heterogeneous parents?

The biggest challenge to these questions is the definition of welfare criteria under endogenous fertility. Unlike standard comparisons between allocations where the set of agents are fixed, there will be agents who are born in one economy but not the other when fertility is endogenous. As a result, standard Pareto principle can not be used to conduct welfare analysis in this context. The emerging field of population ethics is devoted to understanding and resolving this question. For instance, Parfit (1984) derives the famous "repugnant conclusion". Golosov et al. (2007) proposed two criteria called $\mathcal{A}-$efficiency and $\mathcal{P}-$efficiency. de La Croix and Doepke (2021) considers the optimal welfare from a soul's perspective. The debate on what is the most appropriate welfare measure to use is far from being settled.

Even though this paper does not explore optimal policies, it can still contribute to the discussion in two ways. First, once a certain welfare metric and the set of policy instrument are chosen, the model could be applied to find the optimal policy combination numerically. Second, the paper highlights some major trade-offs in policy design. On one hand, subsidizing fertility among parents with low human capital leads to larger fertility changes per dollar spent on family policies, which could result in larger welfare improvement due to demographic structure effects on age structure. On the other hand, subsidizing fertility among parents with high human capital could utilize the intergenerational transmission of human capital, which could raise welfare due to the composition effects. At the aggregate level, the government balances population growth rate and average human capital due to quality-quantity trade-off, composition effects, and demographic structure effects.

With all three countervailing forces present in the unified model, first-order stochastic dominance in equilibrium human capital distribution is neither necessary nor sufficient for choosing better policies. For instance, the equilibrium human capital distribution under a $31,000 baby bonus is first-order stochastic dominated by that in the baseline economy, but social welfare is improved by such baby bonus. Thus, the paper provides a novel counter-argument to the common conclusion in past literature on optimal policies with endogenous fertility which argues for restrictions on childbirth among parents with low human capital (e.g. Chu and Koo, 1990).

7 Conclusion

Facing the “global fertility crash" (Tartar et al., 2019), family policies are at the forefront of public attention and policy debates. Evidence on the effects of transfers to parents on existing children’s outcomes also lead policy makers and economists alike to conclude that family policies are excellent instruments to “lift children out of poverty today and help them tomorrow" (Schanzenbach et al., 2021).

In this paper, I study the aggregate impacts of family policies in a quantitative general equilibrium overlapping-generations model with heterogeneous agents, endogenous fertility, child human capital formation, and inter-vivos transfers. Relative to previous studies with exogenous number of children, I argue that explicitly modeling endogenous fertility choice is crucial for analyzing the macroeconomic implications of family policies because it speaks to (1) quality/quantity trade-off a lá Becker and Lewis (1973), (2) composition effects due to changing representation, and (3) demographic structure effects through population growth and demographic structure.

I calibrate the model to match salient features of the data including fertility-income relationship, human capital investments, childcare usage, and institutional details on child benefits through the tax system. In the external validation exercise, I show that the model-generated fertility elasticities are consistent with empirical evidence from Alaska Permanent Fund Dividend (APFD) as well as other family policies.

I find that when family policies are designed such that parents are awarded based on child quantity, they respond by having more children but optimally reduce child quality investments due to quality/quantity trade-off. Compared with education subsidies, family policies are not ideal instruments if the policy goal is to raise children’s human capital or to boost social mobility. In fact, average human capital and intergenerational mobility both fall in the long-run after implementation of large-scale family policies due to (heterogeneous) reductions in child quality investments and composition effects. The pronatal effect of family policies, however, could lead to long-run welfare gains because population growth reduces old-age dependency ratio. This allows the government to reduce tax rates without violating the fiscal constraint in the general equilibrium.

I also show that long-run gains in welfare require a prolonged transition path where the government needs to raise consumption taxes to finance higher child-related expenditures. This finding highlights the implicit costs of family policies in transition. They are typically forgotten since most attention in policy discussions are paid to reductions in the pension liabilities in the long-run.

I conclude by discussing several avenues for future research. In this paper, I focus on the positive analysis of family policies since the normative principles with endogenous fertility is still hotly debated. It would be interesting for future research to adopt some leading criteria, e.g. Golosov et al. (2007), and conduct optimal policy design. Second, given that baby bonus increases welfare of future generations but reduces that for current households (see Section 5.2), it is important for future research to explore whether such policies should be financed by government borrowings that are paid back by future generations and whether these arrangements are politically feasible. Lastly, another fruitful area of research is to link family policies with population externalities such as pollution (e.g. Bohn and Stuart, 2015), ideas creation (Jones, 2020), and firm dynamics (Peters and Walsh, 2020).

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A Additional Results

A.1 Public Childcare

In the second set of policy counterfactuals, I evaluate childcare subsidies where the government refunds $\mathcal{S} \in [0, 0.9]$ fraction of expenditures on market childcare services for all families.[33]

I find that subsidized childcare raises fertility, but at a much higher cost than baby bonus. The government needs to refund more than 80% of childcare expenses to raise the aggregate fertility rate to 2.1. This would cost almost 3.2% of aggregate GDP in the long-run steady-state economy, which means the policy is 50% less cost-effective than baby bonus.

Figure 9c shows that similar to the case in baby bonus, parents reduces private education investments due to quality-quantity trade-off. Figure 9d shows that fertility responses are similar across households with different human capital levels. As subsidy raises, the fertility responses among low-income households exceed that among high-income ones. As a result, average human capital in the economy begins to decrease (see Figure 9e). The overall effects on intergenerational mobility is small (see Figure 9f) .

Figure 9g shows that output per capita can be increased by up to 3.5% when the government refunds 80 cents per dollar spent on market childcare. Compared with baby bonus, the magnitude of change in output is larger for three reasons. First, the composition effects through intergenerational transmission channel is smaller because changes in fertility is not very different across human capital (see Figure 9d). Second, childcare subsidy raises labor supply by reducing the effective price of market care. This induces parents to reduce time spent at home taking care of children t_h. Lastly, the increased working time at age 20-30 translates to a high human capital for adults in later periods due to learning-by-doing in the labor market.

Figure 9i shows that the government is able to reduce consumption tax by 0.55% when $\mathcal{S} = 0.45$. Long-run welfare could be raised by 2.8% at replacement fertility rate with $\mathcal{S} = 0.8$.

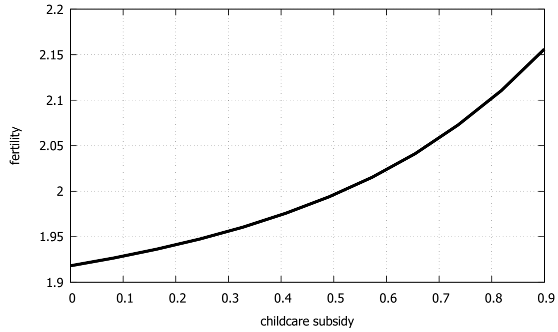
A.2 Public Education

Lastly, I evaluate an expansion of public education expenditures from the current level of $12,000 per student per year by $0 to $100,000 in net present value. Figure 10a shows that the effect on fertility is positive because children become more desirable as public education raises children's quality.

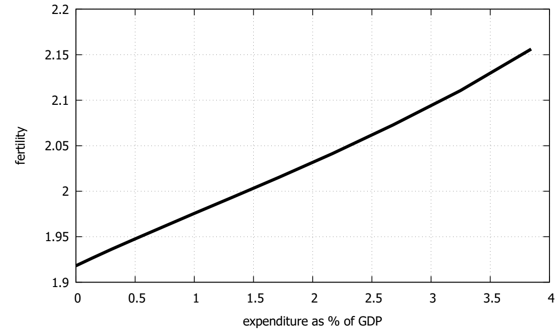
[33] Another common proposal on childcare is to provide certain amount (days) of public childcare services that is free to all parents with children. For households with middle-to-high income, this policy would be equivalent to a baby bonus since their private spending on market childcare exceeds the subsidized quantity absent of the policy. For lower-income households, they would strictly prefer to have a baby bonus as cash subsidies can be used in alternatives with higher marginal benefits. Overall, the implications on aggregate variables are quantitatively similar to that of a baby bonus.

Figure 9: Effects of Childcare Subsidies of Different Sizes

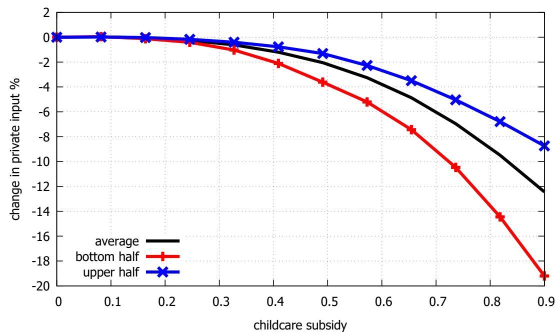
(a) Effects on Fertility



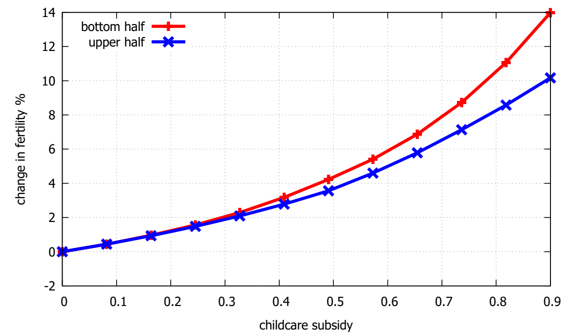
(b) Expenditure Share as % of GDP



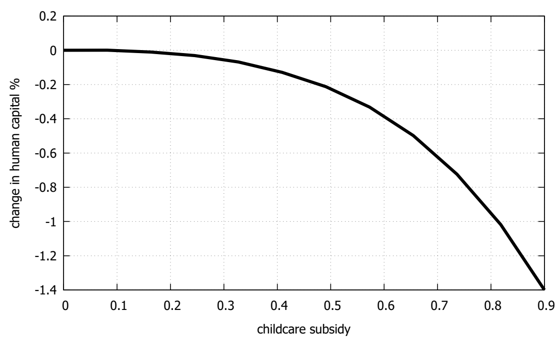
(c) Average Private Investment



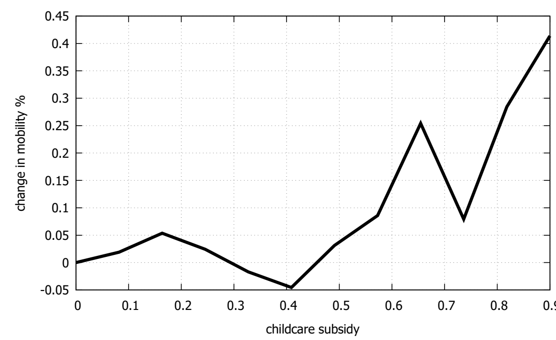
(d) Heterogeneous Fertility Response



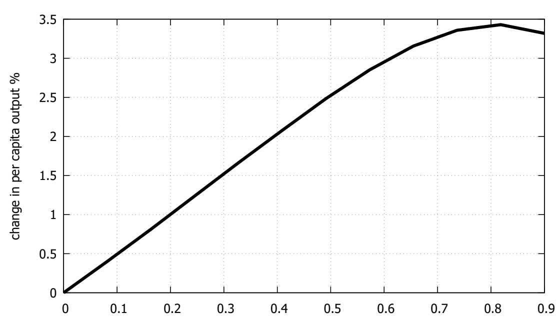
(e) Average Human Capital



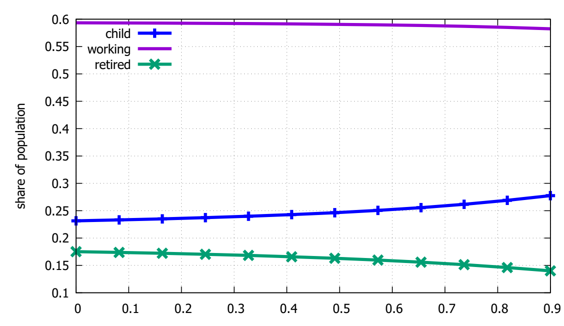
(f) Intergenerational Mobility



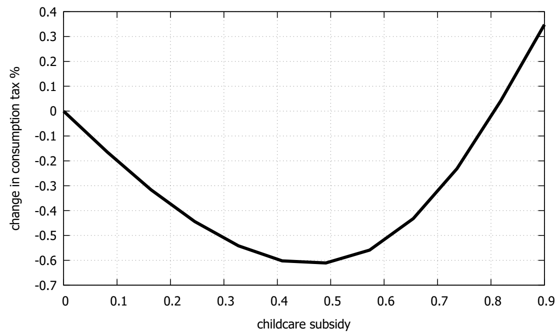
(g) Per Capita Output



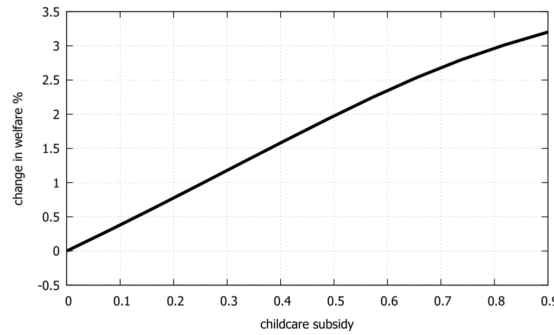
(h) Demographic Structure



(i) Change in Consumption Tax



(j) Change in Welfare



Note: These figures plot macroeconomic impacts of childcare subsidies of different sizes by comparing long-run steady-states under policies with baseline steady-state economy. See text for discussions.

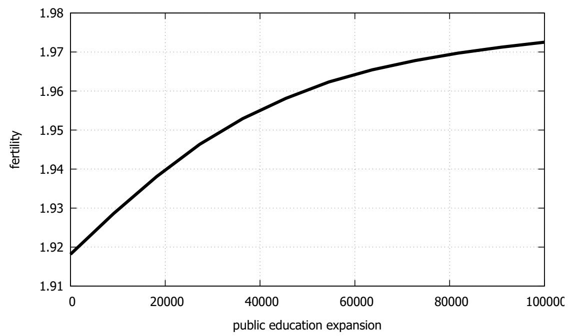
The magnitude of fertility effects here are much smaller than that of family policies. Compared with a \$30,000 baby bonus that raises fertility by 0.2, an education expansion of the same amount only raises fertility by 0.03. The government should not expect to use education policies to raise aggregate fertility to replacement level.

Figure 10d shows that fertility response is slightly higher for households with higher human capital. An increase in public education expenditure also crowds out private input (see Figure 10c). Due to strong crowding-out effects, average human capital only increases by 2.3% when the education expansion exceeds \$80,000 in net present value. It is quite costly to raise average human capital in the economy using uniform policies in general equilibrium since (1) crowding out effect is strong, and (2) investments face decreasing marginal return as $\mathcal{E}$ is already \$12,000 per year in the baseline economy.

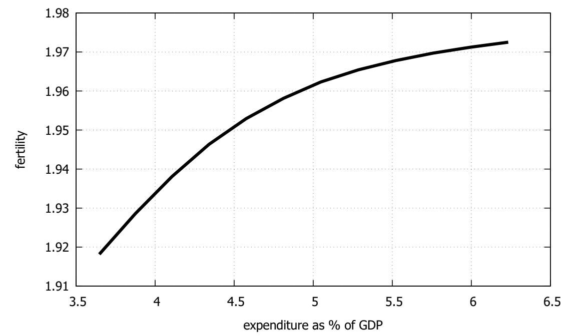
Expanding public education, however, is the most effective policy that could raise social mobility. As the expansion exceeds \$60,000 in net present value, intergenerational mobility could be raised by almost 4.6%. If the policy is designed to target lower-income households, we can expect larger effects on mobility. Due to increased human capital, public education expansion of \$60,000 raises output by 2.2%. The government needs to increase consumption tax by 0.5% to finance this expenditure. Figure 10j shows that welfare could be increased by up to 2.4%.

Figure 10: Effects of Expansions in Public Education Expenditures of Different Sizes

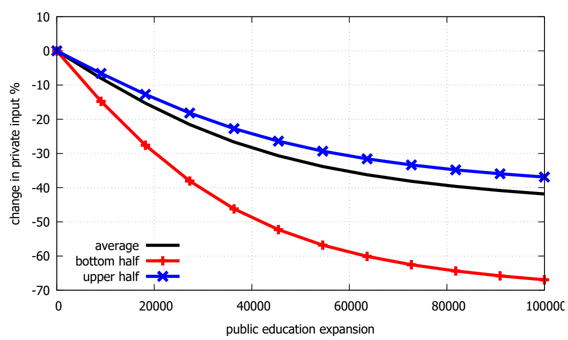
(a) Effects on Fertility



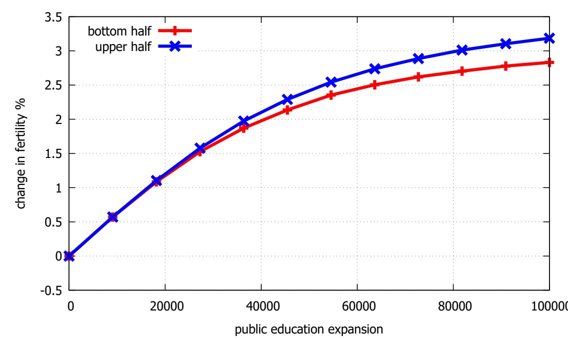
(b) Expenditure Share as % of GDP



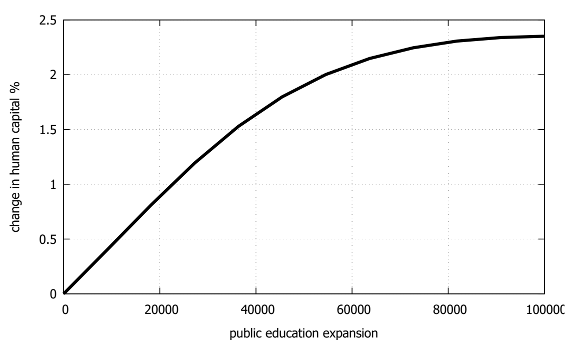
(c) Average Private Investment



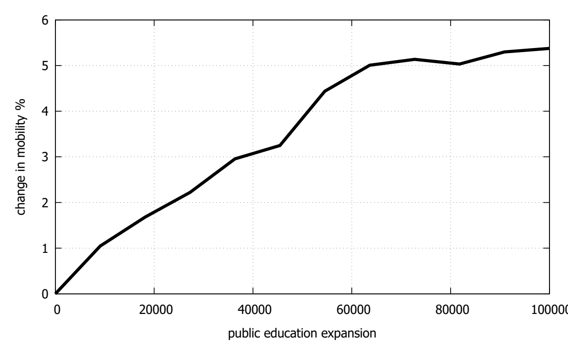
(d) Heterogeneous Fertility Response



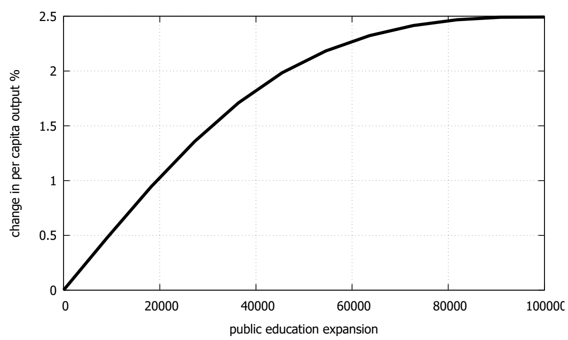
(e) Average Human Capital



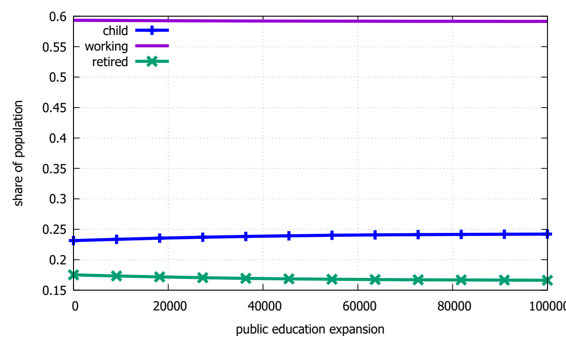
(f) Intergenerational Mobility



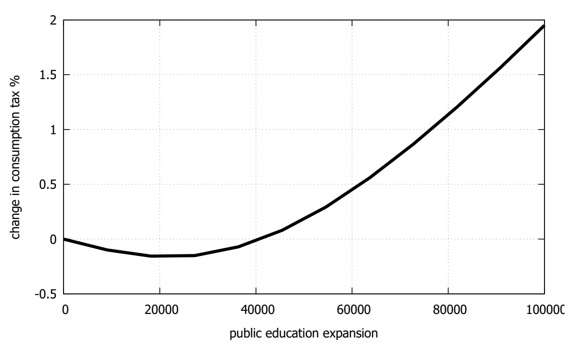
(g) Per Capita Output



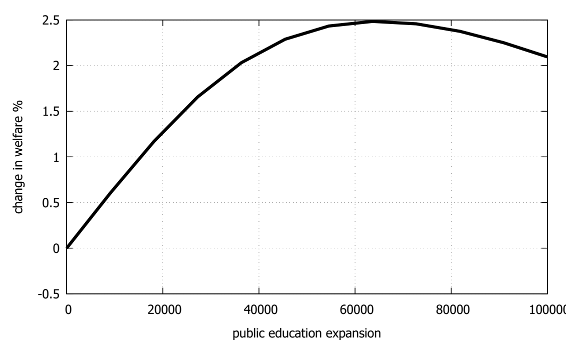
(h) Demographic Structure



(i) Change in Consumption Tax



(j) Change in Welfare



Note: These figures plot macroeconomic impacts of expansions in public education expenditures of different sizes by comparing long-run steady-states under policies with baseline steady-state economy. See text for discussions.

B Additional Validating Evidence

B.1 Australian Baby Bonus

In this section, we compare the implications of the calibrated model on baby bonus with the empirical evidence from a recently adopted baby bonus in Australia. Even though I do not re-calibrate the model to match moments in Australia, this comparison still provides valuable insights into the mechanism through which child benefits affects parents decisions and estimates of fertility elasticities that is the core of this paper.

The Australian government announced the introduction of a universal cash payment, i.e. baby bonus, in its Federal budget on May 12th 2004. It was designed to be a non-means tested and non-taxable lump-sum payment of A$3,000 to encourage childbirth, paid to parents following a childbirth or adoption of a child up to 2 years of age after July 1st 2004. Such payment is independent of family income, maternal employment status, or the number of existing children in the household. The payment is equivalent to 4 times weekly average earnings or $2,800 in 2010 U.S. dollars.

Drago et al. (2011) conduct a comprehensive analysis of the fertility effects of the baby bonus using household panel data ($N = 14,932$) from the Household, Income and Labour Dynamics in Australia Survey (HILDA) using a simultaneous equations approach. They first estimate the effect of the baby bonus on households' birth intentions in a linear regression, which, in turn, predicts actual births in a binomial probit regression. They exploited the panel structure of the data to test and correct for announcement effects, compression/tempo effects, and delayed effects. Regression results show that the baby bonus have significant and positive impacts on fertility. Moreover, the fertility responses are concentrated among low-income women.[34] Both findings are consistent with results from policy counterfactuals in Section 5.1. Drago et al. (2011) estimates that the marginal costs to the government for an additional birth is at least A$126,000 which is roughly 4 times the GDP per capita in 2004 Australia. The calibrated model generates a quantitatively similar conclusion where the marginal costs for an additional birth using baby bonus in 2010 USA is around 3.2 times the GDP per capita.

Gaitz and Schurer (2017) evaluates the effect of the Australian baby bonus on children's human capital accumulation using high-quality panel data from Kindergarten cohort (K-cohort) of the Longitudinal Study of Australian Children (LSAC). They find that the baby bonus, despite being significant in size, was not effective in boosting learning, socio-emotional or physical health outcomes of the average pre-school child. This finding is consistent with results in Section 5.1

[34] Drago et al. (2011) note that this finding is different from that in Milligan (2005) which evaluates a baby bonus in Quebec and finds larger responses among parents with higher income. Drago et al. (2011) conjecture that the difference could be due to the fact that Quebec baby bonus was significantly more generous for high-parity births. Milligan (2005) discusses some other possible explanations such as unobserved heterogeneities that are systematically related to income.

where parents optimally reduce private educational investments due to larger family size.

B.2 Spanish Child Benefits

In this section, I provide additional evidence on the fertility effects of child benefits using a universal child benefits in Spain.

The Spanish government announced the new child benefit on July 3rd 2007. The benefit was a one-time payment of €2,500 paid to the mother immediately after birth on and after July 1st 2007. Since the cash benefit was universal and independent of recipient's characteristics, it was essentially a universal baby bonus (c.f. Australian baby bonus, and $\mathcal{B}$ in the model). The size of the payment is 4.5 times the monthly gross minimum wage for a full-time worker or $3,500 in 2010 U.S. dollars.

González (2013) studies the effect of the Spanish child benefits on fertility and mothers' labor supply using monthly vital statistic, monthly abortion statistics, and Household Budget Survey 2008 ($N = 958$). In the paper, the fertility effects are gauged by inspecting the time seris of births and abortions while the effects on labor supply are estimated using a regression-discontinuity design by comparing households who had birth right before and right after the cutoff date. González (2013) finds that the fertility effects is positive and significant. The policy raises total fertility rate increases by 6%. Around 80% of this increase is due to higher number of conception while the remaining 20% is due to reductions in abortion. Applying the adjustment in Stone (2020) (see Section 4), the result suggests that in Spain, a baby bonus with the payment amount equivalent to 10% of GDP per capita, i.e. €2,500 raised completed fertility rate by 0.028. The calibrated model predicts that such a baby bonus raises completed fertility rate in the U.S. by 0.023.

González (2013) also finds that the baby bonus reduced mothers' labor force participation. The calibrated model generates this effect via two channels. First, as the baby bonus raises fertility, parents need to generate more childcare services, which raises their time at home under fixed child-care arrangements (i.e. split between home and market care). Second, higher fertility reduces the relative cost of home versus market care due to economies of scale in home production of childcare ($\iota < 1$). Therefore, the model predicts that parents optimally change the childcare arrangements so that their children spend less time in market care. González (2013) confirms this prediction by showing that Spanish parents reduces enrollment in formal child care after the baby bonus.

B.3 Georgia's Cherokee Land Lottery of 1832

In this section, I compare the model predictions with Georgia's Cherokee Land Lottery in North-west Georgia, 1832.

Following the eviction of the Cherokee from northwest Georgia, the state allocated more than 18,000 parcels of land to the public in a large-scale lottery in 1832. Every man age 18 and older who had resided in Georgia for the three years prior to the 1832 drawing was entitled to one draw, and any man who had a wife or had children under 18 and met the three-year residency requirement was entitled to an additional draw. The lottery winners were able to immediately sell the winning draw. Therefore, winning the lottery can be viewed as a substantial shock to wealth. Bleakley and Ferrie (2013) calculate that 98% of eligible man participated in the lottery and the winner is about $748 wealthier than losers by 1850. This amount is the equivalent of 1,010 days of earnings for an unskilled laborer in the South at that time.

There are two notable things about the Cherokee Land Lottery. First, unlike baby bonus that provides an estimate of the *price elasticity* of fertility, the Cherokee Land Lottery reveals the *income elasticity* of fertility. This statistic, if used directly, is mostly informative about fertility effects of policies such as a universal basic income (UBI) rather than family policies that are pronatal by design. The model in this paper, nevertheless, could generate the model counterpart to the income elasticity of fertility by varying the initial assets of parents at period 2. Second, numerous changes have taken place in the U.S. in the past two centuries. The average white women gave birth to around seven children in 1830s but less than two children in 2010. The biggest factor explaining the decline of fertility and the rise of schooling is the increase in skill premium (Greenwood and Seshadri, 2002). Therefore, the Cherokee Land Lottery is expected to generate responses that are *upper bounds in fertility* and *lower bounds in child human capital investment* to windfalls.

Bleakley and Ferrie (2016) identify the winners of this lottery using a list published by the State of Georgia , and linked winners to their decedents using Census data. Results show that winners had slightly more children than nonwinners, but they did not send them to school more. "Sons of winners have no better adult outcomes (wealth, income, literacy) than the sons of nonwinners, and winners' grandchildren do not have higher literacy or school attendance than nonwinners' grandchildren" (Bleakley and Ferrie, 2016).

In the calibrated model, I compare $n^*(h, a), e^*(h, a)$ with $n^*(h, a'), e^*(h, a')$ for fixed h and $a < a'$. I find that if the parents are endowed with a higher level of initial assets, they choose to have a slightly smaller number of children, i.e. $n^*(h, a') \leq n^*(h, a)$ but invest significantly more in children's education, i.e. $e^*(h, a') \gg e^*(h, a)$. Since the returns to education in 2010, to which the model targets using RCT results from García et al. (2020), is much higher than that in 1830s, these results are consistent with those found in Bleakley and Ferrie (2016).

C Illustrative Models

C.1 Simple Model of Quality/Quantity Trade-off

In this section, I show the quality/quantity trade-off mechanism with closed-form solution in a model that is adapted from de La Croix and Doepke (2003).

Consider parents solving the problem:

$$\max \quad \log(c) + \theta \log(n \cdot h_k)$$

subject to

$$c + n \cdot e = 1 - n \cdot \chi$$

$$h_k = e^{\gamma}, \quad \gamma \in (0, 1)$$

where h_k is human capital of children, e is private investment,[35] χ is fixed costs per child, and n is the number of children.

When fertility is exogenous, i.e. n is given, parents maximize over c and e. The optimal investment is given by:

$$e^* = \frac{\theta\gamma}{1 + \theta\gamma} \cdot \frac{1 - n\chi}{n}$$

When the cost of child χ decreases, e^* increases due to an income effect.

When fertility is endogenous, parents maximize over c, e as well as n. The optimal fertility and investment are given by:

$$n^* = \frac{1}{\chi} \cdot \frac{\theta(1-\gamma)}{1+\theta}, \qquad e^* = \frac{\gamma\chi}{1-\gamma}$$

When the cost of child χ decreases, n^* increases while e^* decreases. The intuition for this result is simple. Parents increase fertility due to a price effect. This increase in n^*, in turn, raises the shadow price of investment e^* due to interaction of n and e in the budget constraint. As a result, optimal investment e^* falls.

C.2 Simple Model of Fertility Elasticity

In this section, I build a simple model to illustrate the relationship between parameter γ, also known as elasticity of intergenerational substitution (EGS), and the magnitude of fertility response to family policies.

[35] In de La Croix and Doepke (2003), children receives human capital endowments. This generates non-homotheticity over child quality for parents with different human capital and leads to a negative fertility-income relationship. I abstract away from steady-state heterogeneity across households in this simple model for clearer exposition of intuition in comparative statics, but all arguments carry through when human capital endowments are allowed.

Consider a simplified problem for parents with very low income so that child quality is generated by public investments alone:

$$\max_{c,n} \quad u(c) + \Psi(n)u(\mathcal{E})$$

$$c + n \cdot \chi = 1$$

First-order condition for n:

$$\underbrace{\Psi'(n) \cdot u(\mathcal{E})}_{\text{MB of } n} = \underbrace{\lambda \cdot \chi}_{\text{MC of } n}$$

Plug in $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$, I have

$$\Psi'(n) = (1-\gamma) \cdot \chi \cdot \frac{\lambda}{\mathcal{E}^{1-\gamma}} \Longrightarrow \Delta\Psi'(n) \propto (1-\gamma) \cdot \Delta\chi$$

As can be seen, conditional on other parameters, higher γ implies smaller response in n for given changes in costs of child χ.