# Intergenerational Effects of Child-Related Tax Benefits in the US

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**Abstract**

The presence of children in US households reduces tax liabilities through deductions and tax credits. Through the lens of the quantity-quality trade-off, these benefits distort parental choices over the number and human capital of children by altering their relative implicit price. This paper quantifies the effects of child-related tax benefits on fertility and intergenerational mobility using a general equilibrium life-cycle model with endogenous fertility choices and parental investments in children's human capital, calibrated to US data. I show that tax benefits increase fertility by 16%, but they do so at the expense of lowering human capital of children. These effects are particularly strong among low educated mothers, which widens the gap in human capital between children of low and high educated mothers. As a result, the intergenerational persistence of education increases by 37% when tax benefits are introduced. Additionally, I show that an alternative program of subsidies to parental expenditures on children's human capital also generates an increase in fertility but, as opposed to tax benefits, it does not decrease children's human capital, nor intergenerational mobility.

*JEL Codes:* E62, H31, J13

*Key words:* Fertility, child-dependent taxes, intergenerational mobility

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# 1 Introduction

Most advanced economies are experiencing a period of low fertility rates. This has increased the interest in pronatalist policies among policymakers. There are many examples of such policies: from paid parental leaves to direct transfers. One example, which is particularly extended across countries, are tax benefits, defined as reductions in the tax liabilities of households with children through deductions and tax credits. Pronatalist policies are generally evaluated according to the their fertility effects. This paper argues that the evaluation of such policies should go beyond these effects. The reason is the existence of a quantity-quality trade-off. The number of children is a key determinant of the cost of providing these children with a high level of human capital. Thus, policies that increase fertility may also generate a reduction in the human capital of children. Moreover, if these policies are progressive, they may generate negative effects on intergenerational mobility by fostering fertility —and thus, potentially reducing children's human capital— among low-income families. According to the literature, most economic inequality is explained by differences in initial conditions (Keane and Wolpin, 1997; Huggett et al., 2011). Thus, if tax benefits have differential effects on low- and high-income families, they may, in fact, induce higher economic inequality. This paper studies such long-run effects of tax benefits in the US, where child-related tax benefits are generous and progressive, using a calibrated general equilibrium life-cycle model.[1]

I develop and calibrate a life-cycle model with overlapping generations of married households featuring endogenous labor supply, fertility choices, parental investments in children's human capital and parental transfers when children become independent. In the model, households face both income and fertility risk and derive utility from having children and from their children's human capital. When deciding how many children to have, parents take the effect of children on the implicit price of children's human capital into account, yielding a quantity-quality trade-off. Households face a progressive tax schedule that, as in the data, depends on the number of children.[2] I represent the US tax system by means of a standard parametric tax function, which is estimated using household-level data. The life-cycle structure of the model allows me to connect parental choices to initial conditions of new generations. This is crucial for the purpose of this paper, as it establishes the link between the tax schedule faced by parents and the initial conditions of children.

The key model parameters are calibrated using data from the Panel Study of Income Dynamics (PSID) and the Child Development Supplement in the 2000s. The model replicates well the fertility and human capital profiles of the data, as well as the patterns in parental investments. Interestingly, the model generates an intergenerational persistence of education that is very close to its data coun-

[1] According to Maag (2013), a family with children receives $3,400 on average from benefits in the federal tax system.

[2] Child-dependencies come from different programs such as the Child Tax Credit, the Earned Income Tax Credit or the Personal Exemption. Section 3 describes these sources in detail.

terpart, despite not being explicitly targeted in the estimation process. It also generates an income elasticity of fertility that is very close to what I find in PSID data, both on aggregate and by maternal education. All this indicates that the model can be used as a laboratory economy for policy analysis.

The calibrated model is used to analyze the effects of child-related tax benefits by simulating an economy in which taxes are independent of the number of children. The results are consistent with the main prediction of the quantity-quality trade-off: child-related tax benefits significantly increase fertility at the expense of lowering children's human capital. In particular, completed fertility, defined as the number of children ever born to females at age 38, increases by around 16% when tax benefits are introduced. This increase in fertility is due to both an increase in the share of households that decide to have children at all, from 0.87 to 0.91, and to a 12% increase in the fertility of mothers. At the same time, human capital of children at the age of independence falls by more than 17%, yielding a share of highly educated (college graduates) 9 p.p. lower. Since fertility increases, so does the share of the working population, lowering the capital-to-labor ratio, and pushing down wages. Since parents are now poorer, they cannot afford a sufficiently high level of human capital for their children, inducing further substitution of children's human capital for more children, as predicted by the quantity-quality trade-off. These general equilibrium effects are quantitatively important: they account for 25% of the increase in fertility and for around 50% of the decrease in human capital of children.

As shown in section 3, child-related tax benefits are progressive: low-income households benefit relatively more from having children. As a result, the fertility effects of tax benefits are particularly strong for low educated households. In particular, completed fertility increases substantially more among low educated females than among high educated ones (19% and 9% respectively) making the fertility gap to rise from 0.12 to 0.32 children per female. Consequently, the fall in human capital at independence is especially large among children of low educated mothers. In particular, the gap in human capital at independence between children of low and high educated mothers increases by 44% which, in turn, increases the intergenerational persistence of college education by more than 37%.

These results suggest that progressive pronatalist policies may have negative effects on intergenerational mobility by fostering fertility, especially among low-income households, yielding a larger fall in human capital for their children, and increasing the gap in initial conditions. It is natural then to ask whether a regressive policy may generate the opposite result. However, tax benefits, whether progressive or regressive, reduce the cost of having children without affecting the price of providing these children with a high level of human capital, beyond the family size effect. An alternative would be to lower the cost of children by lowering the cost of providing them with human capital.

To explore this, I define a (revenue-neutral) program of subsidies to parental expenditures on children's human capital. Since high-income parents invest more in their children's human capital, they enjoy larger benefits, making the program regressive. I find that this program is also effective at fostering fertility, although not as much as tax benefits. In particular, the education subsidies program generates 66% of the increase in fertility induced by tax benefits. However, contrary to what happens with tax benefits, education subsidies do not induce a fall in children's human capital, and even slightly increases it by 4%. Furthermore, the effects of education subsidies are larger for high income, whose fertility grows relatively more, limiting the increase in their children's human capital. As a result, the gap in human capital between children with low and high educated mothers stays roughly constant, and thus, intergenerational mobility is not damaged. Although effects on human capital are small, the fact this subsidy to education does increase fertility without damaging intergenerational mobility makes it an interesting policy tool for countries with low fertility rates.

In sum, this paper shows that child-related tax benefits are an effective tool to foster fertility, but they generate a more unequal distribution of initial conditions. Education subsidies also increase fertility, but, as opposed to tax benefits, they do not damage intergenerational mobility. There are two differences between these two policies: first, tax benefits reduce the cost of children without affecting the price of children's human capital, and second, tax benefits affect more to low-income households. By comparing the results of the two policies, one could conclude that governments that want to increase the fertility rate face a trade-off between short-run and long-run inequality: progressive pronatalist policies may generate a decrease in intergenerational mobility. Whether the government should eliminate tax benefits, or substitute them by education subsidies, is something that goes beyond the current scope of this paper. However, the results do suggest that a complete evaluation and design of pronatalist policies should take the potential effects on intergenerational mobility into consideration. It is also an important result when evaluating changes in tax schemes affecting benefits for families, like the one passed in the US in December 2017.[3]

The rest of the paper is organized as follows. Section 2 locates this paper within the literature. Section 3 briefly describes the functioning of income taxes in the US, explains the sources of child-related benefits and presents the estimation of the tax function. Section 4 presents the economic environment. Section 5 explains how I calibrate the model. Section 6 presents the quantitative analysis of child-related tax benefits and explore the effects of subsidies to parental investments. Finally, section 7 concludes.

## 2 Related literature

One of the main ingredients of the model is the presence of a quantity-quality trade-off. The existence of this trade-off is well known since the seminal work by Gary Becker (Becker, 1960; Becker and Lewis, 1974; Becker and Tomes, 1976), and has been empirically tested in very different contexts. For example,

[3]Among many other things, this reform duplicates the size of the Child Tax Credit from $1,000 to $2,000 per child.

Juhn et al. (2015) estimate the causal effect of family size on children's cognitive ability, instrumenting family size with twins birth. They find strong evidence of a negative effect of the number of children on parental investments and children's cognitive ability using data from the National Longitudinal Survey of the Youth. More importantly, they find that the strength of this trade-off is larger for low educated mothers. Using data from China, Li et al. (2008) show that this trade-off is not exclusive of developed countries.[4]

There are a number of papers that incorporate this trade-off into a macroeconomic model, although with different goals. Most of them include it exogenously: households decide how many children to have, given some exogenous cost function. A recent example is the paper by Córdoba et al. (2016) who show that, under some assumptions, the standard Bewley model with endogenous fertility can generate the degree of intergenerational persistence of inequality observed in the data. Also Daruich and Kozlowski (2016), who use a life-cycle model with endogenous fertility to study the inequality implications of the negative income elasticity of fertility. However, there are some remarkable exceptions that incorporate the quantity-quality trade-off endogenously. One is the paper by Caucutt et al. (2002) who proposes a life-cycle model with endogenous fertility and marriage/divorce choices to show how returns to experience induce fertility delays among females. A second exception is the paper by Sommer (2016) who posits a life-cycle model with fertility and earnings risk to study the effects of risk on fertility decisions. Apart from the policy that is evaluated, this paper is different from Caucutt et al. (2002) and Sommer (2016) in that the production children's human capital is dynamic, while they consider children's human capital as a static choice. In particular, and based on recent evidence on child's skill formation (Cunha et al., 2010; del Boca et al., 2014; Attanasio et al., 2017), I incorporate dynamic complementarities in the production of children's human capital.[5]

The goal of this paper is to understand the effects of the tax schedule on parental choices, and through them, on intergenerational mobility. To the best of my knowledge, this is the first paper studying such effects.[6] However, there are some papers that study these two channels separately: how taxes affect parental choices, especially over the number of children, and how parental choices translate into a higher/lower economic inequality. Among the former, mainly empirical, maybe the paper that is closer to my research goal is Azmat and González (2010), who study the effects of the

[4]Using administrative data from Norway, Mogstad and Wiswall (2016) find that family size affects negatively to children's outcomes only in large families, while small families exhibit strong complementarities. These results suggest that the public provision of education can alleviate, and even reverse, the negative effects of having more children on children's education found in countries with lower provision of publicly funded education. Black et al. (2005) also find negligible family size effects on children's education in Norway. Using data on Israel, Angrist et al. (2010) find no evidence on the quantity-quality trade-off. Israel, however, is an outlier in terms of fertility behavior. According to OECD, the total fertility rate in 2014 was 3.1 for Israel and 1.8 for the US.

[5]Dynamic complementarities in the production function of child's skills mean that this period's skills are increasing in the level of previous skills. One of the most important implications of dynamic complementarities is that parental investments have an effect, not only on this period's children's skills but also in the future.

[6]There are some examples of papers studying taxes and child-related benefits, with very different goals. For example, Hoynes et al. (2015) show that the US tax system creates a tax penalty for middle-income parents.

2003 income tax reform in Spain by which a new tax credit was available for working mothers. They find strong positive effects on fertility, that were more pronounced among less educated women, in line with my findings. For the US, Baughman and Dickert-Conlin (2009) study the effects of an expansion of the EITC on fertility using state-level variation and find small effects.[7] There are more examples of papers studying the effects of transfers, rather than taxes, on fertility. Also for Spain, González (2013) studies the effects of a universal child benefit introduced in Spain in 2007, and again, find significant positive effects on fertility, in line with what Milligan (2005) finds in the Canadian province of Quebec.[8] Although these papers point towards fiscal policy being effective at fostering fertility, empirical studies based on reduced-form analysis, cannot account for general equilibrium nor intergenerational effects.[9] Moreover, they usually study short-term policies and find it difficult to disentangle fertility and timing effects. In short, it is difficult to distinguish whether a positive reaction of fertility to a particular policy is due to an increase in the demand for children, or a change in the timing of births. My paper contributes to this literature by analyzing the impact of a permanent change in the fiscal policy on fertility accounting for those effects.

Abstracting from taxes, there are some papers that study how different public policies affect fertility decisions. Some examples are Björklund (2006), Erosa et al. (2010), Bauernschuster et al. (2016) and Bick (2016). In Erosa et al. (2010), the authors build a search and matching model of the labor market to study how parental leaves policies affects fertility and labor market decisions of females. Using a general equilibrium model, Bick (2016) studies how a German reform in the supply of subsidized child care facilities affected fertility, finding little effects. However, using an empirical approach, Bauernschuster et al. (2016) find that this supply did, in fact, increase fertility. In Björklund (2006) the author studies the Swedish experience with financial and in-kind support to families with children, and conclude that family policies are effective at fostering fertility.

The analysis of how parental choices affect economic inequality has gained great popularity in the last few years. We can divide this strand of the literature into two groups: those papers that focus on the number of children, taking their human capital as exogenous, and those that focus on parental investments in children's human capital, taking fertility as exogenous. The aforementioned Daruich and Kozlowski (2016) and Córdoba et al. (2016) are two recent examples of the former. In the latter, we can find examples as Restuccia and Urrutia (2004), Lee and Seshadri (2018) or Daruich (2018). In Restuccia and Urrutia (2004) the authors develop a simple overlapping generations model

[7]As the authors claim, this cannot be considered as evidence that tax incentives have no effects on fertility because they lack an exogenous source of variation.

[8]Although most empirical evidence points towards positive effects of pronatalist fiscal policy, there some papers than find no effects. An example is Riphahn and Wiynck (2017) who study a benefit program in Germany in 1996.

[9]If a policy changes fertility patterns, this will be reflected in the demographic structure, which in turns may have potentially important effects on aggregate savings and labor supply, altering equilibrium prices. Moreover, if the increase in fertility comes along with a reduction in human capital, the next generation of parents will have lower education, potentially changing their preferences towards fertility.

in which parents invest in early and college education. They show that parental investments explain around 50% of the intergenerational correlation of earnings, especially parental investments in early education. Lee and Seshadri (2018) and Daruich (2018) embody the child's skill production function of Cunha et al. (2010) into an otherwise standard life-cycle model, to study the effects of a large-scale government program funding investments during early childhood. This paper contributes to this literature by considering both channels —fertility and parental investments— simultaneously.

**Contribution** Summarizing, the contributions of this paper are the following. First, this is the first attempt to quantify the effects of child-related tax benefits on fertility and intergenerational mobility. Second, it is the first macroeconomic model that incorporates endogenous fertility, children's human capital and parental transfers into a life-cycle model. Although Caucutt et al. (2002) and Sommer (2016) do incorporate endogenous fertility and parental investments in children's human capital, they model human capital as static rather than dynamic, as found in recent empirical papers. They also abstract from parental transfers. Finally, this paper contributes to the empirical literature analyzing the effects of a pronatalist policy taking general equilibrium and intergenerational effects into account.s

# 3 Child-related tax benefits in the US

The US federal tax code follows the structure of most industrialized countries. In a few words, it takes the total income of a taxpayer, whether an individual or a couple, subtract some deductions, apply a progressive tax rate schedule and reduce tax liabilities with some tax credits. The following table summarizes how the federal tax liability is computed.

| | |
|---|---|
| | Gross income |
| − | Adjustments to gross income |
| = | Adjusted gross income |
| − | Standard deduction |
| − | Personal exemptions, or Itemized deductions |
| = | Taxable Income |
| − | Taxes |
| = | Tax imposed |
| − | Nonrefundable credits |
| − | Refundable credits. |
| = | Tax liability after credits |

Some elements of the US tax code are affected by the presence of (eligible) children in the taxpayer's household. Eligible children are those children under the age of 19 (24 if in college) that live with, and depend economically on, the taxpayer for more than half of the year. In particular, deductions and tax credits increase with the number of children. According to Maag (2013), in 2013 all these child-related tax benefits reached a total of $170.84 billion, or $3,400 per family with children.

This is a large number, given that in 2013 total federal revenue was $1,234 billion, and the median household income was $52,250. The sources of child-dependencies are the following:

1. *Standard deduction*: Taxpayers reduce their taxable income by a fixed amount that depends on the filing status: singles or married filing separately, head of households and married filing jointly. The standard deduction for a head of households is larger than for singles or married filing separate returns. Singles are considered as 'head of households' if they have eligible children living with them more than half of the taxable year.

2. *Personal exemptions*: Extra amount to deduct from adjusted income for taxpayers with eligible dependents or nonworking spouses. This deduction phase out as income increases.

3. *Itemized deductions*: This is a list of specific expenses that the taxpayer can deduct from his/her adjusted gross income to a limited extent. Two of these deductions are clearly linked to the presence of children: one from interests paid on qualifying education loans, and another one from higher education expenses. The former reduces taxable income by the amount of interest paid on any indebtedness incurred by the taxpayer solely to pay qualified higher education expenses, up to a limit. The latter reduces taxable income by the cost of tuition and fees required for the enrollment or attendance of the taxpayer, his/her spouse of his/her dependents to a higher education institution.

4. *Children and dependent care tax credit (CDCTC)*: This is a non-refundable tax credit if the taxpayer has incurred in payments from expenses for household services, and for the care of dependents, and if incurring in those allows the taxpayer to work. The credit is equal to a fixed percentage of the total expenses which declines by household income, up to a limit.

5. *Child tax credit (CTC)*: Partly refundable credit of $1,000 per eligible child. The credit is reduced by $50 per $1,000 that the taxpayer's earned income exceeds a certain threshold. The fraction of the credit that is refundable equals 15% of taxpayer's income if income is greater than $3,000 and lower than $6,667.[10]

6. *Earned income tax credit (EITC)*: Taxpayers with earned income below a certain threshold enjoy a tax credit equal to a fixed percentage (credit rate) of taxpayer's earned income. If the taxpayer's income exceeds this threshold, she/he enjoys the maximum credit until a second threshold is reached, above which the credit rate starts to decline at a fixed rate until it reaches zero. Eligible children increase the credit rate, increase the maximum credit, increase the threshold above which the credit starts to decline, and reduces the rate at which the credit phases out.

7. *Tax rates*: Although the presence of children does not affect tax rates explicitly, single households

[10] The reform in December 2017 doubles the size of the CTC from $1,000 to $2,000 per eligible child, increases the fraction that is refundable and increases the threshold above which the credit starts to decline.

with dependent children are considered 'head of households', whose tax rates are lower than that for single taxpayers.

Overall, the presence of children affects tax liability by reducing the taxable income, lowering tax rates (only for singles or married filing separate returns), and by increasing tax credits. The aforementioned study by Maag (2013) estimates that the effects of children on the EITC accounts for 37% of total child-related benefits in federal taxes, and is the most important source of child-dependencies. The CTC is also quantitatively relevant with a 32% of total benefits, followed by the increase in the personal exemption that accounts for a 22% of tax benefits. The head of household filing status (a mix of higher standard deduction and lower taxes rates) and the CDCTC are small in comparison to the other sources, accounting for just 3.5 and 2% of total benefits respectively.s

## 3.1 Estimation of tax functions

I estimate a parametric tax function that dependents on the number of children in the household. There are also three items that take parental expenditures into account. The main one is the CDCTC that gives taxpayers the right to receive a nonrefundable tax credit of an amount equal to a fixed percentage of care expenses —up to a limit— if those allowed the taxpayer to work. There are also two deductions that are related to children's human capital: the deduction from interests paid on qualifying education loans and the deduction from higher education expenses. However, I do not allow tax rates to vary with parental expenditures on children. First, because of its small impact on taxes. Second, because they mainly subsidize higher education but not parental investments during childhood, which is the main focus of this paper.

### 3.1.1 Data

I use data from the Annual Survey of Economic Conditions Supplement to the CPS for the years 2000 to 2010. The CPS provides a large sample size, something that allows me to cluster the population by the number of children in the household without suffering from small-sample issues. However, tax-related variables are not determined by direct questioning of respondents. Instead, they come from the Census Bureau's tax model, which simulates individual tax returns to produce estimates of federal, state, and payroll taxes.[11] I use this information to compute household level average tax rates as total tax liabilities (federal and state) before credits over total household income.[12] Given that

[11]The model incorporates information from non-CPS sources, such as the Internal Revenue Service's Statistics of Income series, the American Housing Survey, and the State Tax Handbook to improve the estimates.

[12]State-level income taxes vary considerably across states. In particular, nine states do not have any income taxation, eight have a flat tax rate and the rest follow standard brackets-based taxation of income, similar to the federal system (similar definition of taxable income, standard deduction, personal exemption or itemized deductions, etc.), but substantially lower in magnitude. State income taxes are allowed as a deduction in computing federal income tax up to a limit.

this paper focuses on married households, I only keep observations of married households filing joint returns. I also drop observations with negative or zero income. Table 1 collects average tax rates for married households with different number of children and level of income.

**Table 1:** Average tax rate by number of children and income level

| | Number of children | | | |
|---|---|---|---|---|
| Income | 0 | 1 | 2 | 3 |
| 0.50 | 0.06 | 0.05 | 0.02 | 0.00 |
| 1.00 | 0.14 | 0.11 | 0.09 | 0.08 |
| 1.50 | 0.18 | 0.16 | 0.15 | 0.14 |
| 2.00 | 0.22 | 0.19 | 0.19 | 0.18 |

Notes: Income is defined as multiples of average married household income.

In the data, tax rates are decreasing in the number of children for any level of income. However, the rate at which taxes decline is different for poor and rich households. A household with half the average household income and with 2 children pays one-third of what a childless household with the same level of income does. However, a family with twice the average household income and 2 children, pays 14% fewer taxes than a family with the same level of income and no children. These differences imply that the presence of children reduces tax rates for any level of income, but also that these benefits phase out as family income grows. But the size of tax benefits doe not only decreases with the level of income but also with the number of children. This follows the fact that most of the child-related benefits explained before, limit the size of the benefit to 2 or 3 children per family.

### 3.1.2 Average tax rate function

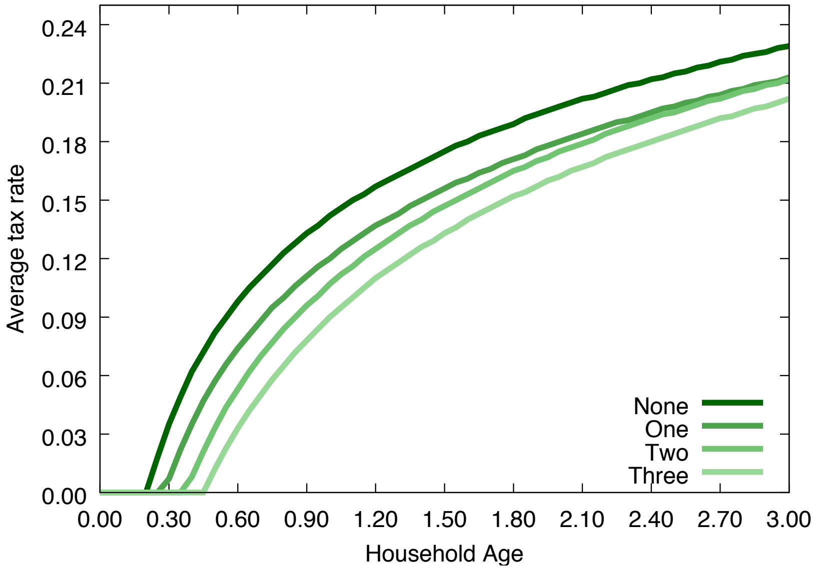
There are several tax functions that have been used in the literature. I take one of the most widely used.[13] In particular, average tax rate for a household with total income of $y$ and $n$ children is:

$$t(y,n) = 1 - \lambda(n) \left(\frac{y}{\bar{y}}\right)^{-\tau(n)}, \tag{1}$$

where $\bar{y}$ is the average (married) household income. One of the interesting properties of this tax function is the easy interpretation of its parameters. Wile $\tau(n)$ drives the degree of progressivity of the tax schedule, the parameter $\lambda(n)$ controls the level of taxes while the parameter More precisely, $\lambda(n)$ equals to 1 minus the average tax rate for a family with $n$ children and the average income. I estimate this function by Nonlinear Least-Squares for couples with different number of children in the household and positive average tax rate. Table 2 collects the estimated parameters and figure 1 plots

[13]For example Bénabou (2002), Heathcote et al. (2012) and Heathcote et al. (2017) use the same parametric function. Guner et al. (2014) estimate different parametric tax functions, including the one I use, using administrative data.

**Figure 1:** Tax functions




Notes: Lines represent the average tax function for different number of children using the estimates presented in table 2. Income is defined as multiples of average household income.

the estimate tax function for couples with different number of children. Figure A.1 plots the estimated functions and the data averages for different normalized income intervals.

**Table 2:** Parameters of the tax function

| Number of children | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Level, $\lambda$ | 0.858 | 0.880 | 0.893 | 0.910 |
| Progressivity, $\tau$ | 0.097 | 0.101 | 0.114 | 0.119 |
| Obs. (1,000) | 65.9 | 40.3 | 44.9 | 15.8 |

Notes: Standard errors are all less than 0.01.

The parameter $\lambda(n)$ increases with the number of children, which implies that the average tax rate is decreasing in the number of children. This increase in $\lambda(n)$ is particularly large when comparing childless households with families with 1 child. For larger families, taxes still decrease but at a smaller rate. The progressivity parameter, $\tau(n)$, also increase with the number of children, especially when comparing families with one or no child with those with 2 children. These results show that taxes help families to overcome the expenses of raising children, but they do so more for low-income families. At the same time, given that larger families receive larger benefits, the rate at which these benefits phase out increases. The fact that taxes help poor families relatively more than high-income ones can also be seen in the level of income at which they start paying taxes. This is much more visible in figure 1. While childless households pay taxes if their income is larger than 25% of average household income, families with 2 children do not start paying taxes until the reach 40% of average income.

Despite using simulated data, my results are in line with those obtained by Guner et al. (2014), who estimate the same functional form using administrative data from the IRS. I do not take their estimates because they only consider federal taxation whereas I use both federal and state tax liabilities to compute the average tax rate. This functional form is also used in Heathcote et al. (2017), finding a progressivity parameter larger than the one I find. However, they use taxable income as their measure of income, and thus, their estimates of $\tau$ do not capture the progressivity in deductions from gross income. On top of this, they do not distinguish between households with different number of children. Larger families pay lower taxes, and, on average, are poorer. Thus, abstracting from the number of children induces an upwards biased in the estimation of the progressivity parameter.

# 4 Model

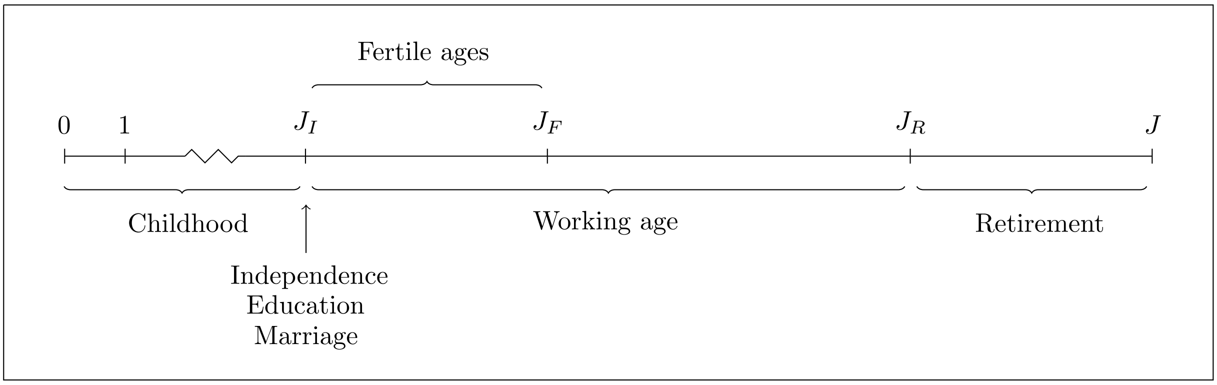
Consider a stationary economy with a continuum of overlapping generations of two-earner households. Let $j = \{0, ...J\}$ denote the age of an individual. Life is divided into three stages: childhood, adulthood, and retirement, as described in figure 2. Adult households consume, save in risk-free assets and work until they retire at age $J_R$. They also decide whether to get pregnant and, subject to some risk, have a child next period. Households with children invest time and goods in their children's human capital and make transfers when their children become independent. This is a key feature of the model, as it allows the model to generate an endogenous distribution of initial conditions. Children make no choices and live with their parents until they reach age $J_I$, when they become independent with some initial level of assets (parental transfer) and a level of human capital. At this point, they decide on their education, meet a spouse and form a new household. For the rest of the paper, I use the term "human capital" to refer to the level of skills of children before going (or not) to college, and the term "education" to refer to the outcome of the college attendance choice. Retirees receive social security benefits and die at age $J$ with certainty, leaving no bequests.

There is a government that taxes income to finance some exogenous (useless) expenditures. There is also a social security administration who collects taxes to finance retirees pensions. Finally, there is a representative firm that combines capital and low and high educated labor to produce a single homogeneous good, whose price is normalized to 1.

## 4.1 Adult households

Households are formed by a male ($g = m$) and a female ($g = f$) of the same age who stay together until they die and maximize a joint utility function. Each spouse is characterized by a level of education and a level of labor productivity. Education is given by $e$ and can take two values, $e = \{\underline{e}, \bar{e}\}$, where $\underline{e}$ refers to low educated (less than a college degree), $\bar{e}$ to high educated (at least college degree). The

**Figure 2:** Life-cycle structure




level of education is chosen by individuals when they become independent from their parents and stays fixed through their lives. Labor productivity is denoted by $z$ and follows an education-specific AR(1) with normally distributed shocks. Spouses share assets, $a \in \mathbb{R}_+$, and receive a net return of $r \in (0, 1)$ on their asset holdings.

### 4.1.1 Income

Individuals supply labor to the market at an hourly wage given by $w_g(e_g, z_g, j)$. Education and labor productivity, jointly with age and gender, determine wage rates according to:

$$\ln w_g(e_g, z_g, j) \;=\; \begin{cases} \ln \underline{w} \;+\; \mu(g, \underline{e}, j) \;+\; z_g, & \text{if} \;\; e_g = \underline{e} \\ \ln \overline{w} \;+\; \mu(g, \bar{e}, j) \;+\; z_g, & \text{if} \;\; e_g = \bar{e}, \end{cases} \tag{2}$$

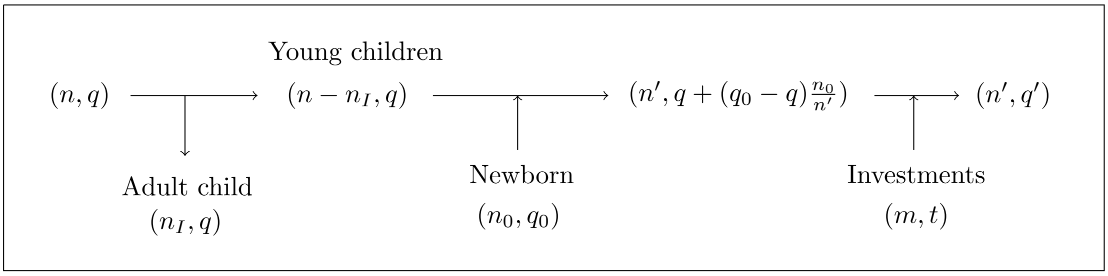
where $\underline{w}$ and $\overline{w}$ are the wage per efficiency unit of labor for low and high educated individuals respectively, $\mu(g, e, j)$ is a deterministic age profile that depends on gender and education, and $z_g$ is the labor productivity level of the gender-$g$ household member. Although I do not explicitly model the gender wage gap, it will be captured by gender differences in $\mu(g, e, j)$.

### 4.1.2 Children

Households decide every period whether they want to have a child until they reach age $J_F$. In particular, fertile households decide whether they want to get pregnant. I denote this choice by $k \in \{0, 1\}$. Pregnant females have a new child next period with probability $p_0(j) \in [0, 1]$. The childbirth probability is decreasing in female's age and captures biological constraints on female's ability to give birth.[14] The presence of a newborn is denoted by $n_0 = \{0, 1\}$. For simplicity, it is assumed that only one child can be born each period. Recent evidence shows that mothers suffer

[14] Sommer (2016) and Choi (2017) show that some fertility risk is needed to discipline childbirth timing. In the absence of such risk, most households would find optimal to wait until the last fertile period, when they have accumulated enough assets, to have children.

**Figure 3:** Dynamics of children and children's human capital




labor income losses when giving birth, and that part of this loss is due to a fall in wage rates.[15] Accordingly, I assume that at the time of childbirth, mothers suffer a productivity loss of $\delta_0 \in (0, 1)$. Note that this productivity loss is persistent over time, as it affects labor productivity rather than wages directly.

Young children —those born in the past— are denoted by $n \in \{0, 1, 2, ..\}$ and stay at home until they become independent. In a household aged $j$ and with $n$ children, there is a probability $p_I(n, j) \in [0, 1]$ that one of the children becomes independent, i.e. reaches age $J_I$. I assume that this probability dependents on the number of children (larger families are more likely to have an adult child) and mother's age (older mothers are more likely to have adult children) to capture the dynamics of children without keeping track of the age distribution of children. When young children reach age $J_I$, they become independent at the beginning of the period after receiving a transfer from their parents, $b \geq 0$. I denote the presence of an adult child by $n_I \in \{0, 1\}$. Overall, a household enters the period with $n$ young children, a newborn if $n_0 = 1$ and an adult child if $n_I = 1$. The latter leaves parental home and $n' = n - n_I + n_0$ children stay in the household. Figure 3 represents the dynamics of children and children's human capital within a period.

### 4.1.3 Children's Human Capital

Let $q \in \mathcal{Q} \subset \mathbb{R}_+$ denote the level of human capital of young children, and $q_0$ the level of human capital of newborns.[16] Following recent findings in the literature on child skill formation (Cunha et al., 2010, del Boca et al., 2014, Attanasio et al., 2017), child's human capital exhibits dynamic complementarities. In short, human capital formation is an increasing function of the level of human capital with which children enter the period. Thus, parental investments do not only affect this period's human capital but also in the future. In particular, children's human capital, $q$, evolves according to

$$q' = \left[\mu \bar{q}^{\theta} + (1 - \mu)\mathcal{I}(m, t, n')^{\theta}\right]^{\frac{1}{\theta}}, \tag{3}$$

[15] In a recent paper Kleven et al. (2018) estimate a persistent 20% fall in mother's labor income after their first birth using data from Denmark. They also find that half of this fall is explained by decreasing hourly wages.

[16] Differences in child's human capital by maternal education is increasing in age, but virtually 0 at age 6. Because of this, I do not allow the initial level of human capital to differ by maternal education, and all differences in $q$ are due to differences in parental investments.

where $\bar{q}$ is the average human capital of children in the household ($q$ for young children and $q_0$ for the newborn), and the function $\mathcal{I}(m, t, n')$ combines $t$ units of time and $m$ units of the final good to produce *new* human capital.[17] Parental investments, $\mathcal{I}$, takes the form:

$$\mathcal{I}(m, t, n) \;=\; A_{\mathcal{I}} \left[ \varsigma \left( \frac{m}{n^{\xi_1}} \right)^{\gamma} + (1 - \varsigma) \left( \frac{t}{n^{\xi_2}} \right)^{\gamma} \right]^{\frac{1}{\gamma}}, \tag{4}$$

where $A_{\mathcal{I}}$ is a productivity term, $\gamma$ controls the degree of substitutability between inputs in the production of new human capital, and $\xi_1$ and $\xi_2$ control the economies of scale for goods and time investments respectively. The parameter $\gamma$ is particularly important to discipline the parental investment behavior. Note that if $\gamma$ is positive, money and time investments would be negatively correlated as high-income families, for whom time is more costly, would spend less time with their children and spend more resources to compensate for that. However, the data show that these investments are positively associated: families investing more money also spend more time with their children. Thus, to be consistent with the data I restrict $\gamma$ to be nonpositive.

## 4.2 Government

The government taxes labor income to finance some exogenous expenditures, $G$, that provide no utility to households. The average tax rate is given by equation (1), estimated in section 2. Household income is also taxed by Social Security at a (flat) rate $\tau_{ss}$ to finance retirees' benefits. I assume that the social security and the government manage independent budgets. By assumption, both budgets are balanced in equilibrium. This implies that, in counterfactual exercises, both government' and social security's taxes should adjust.

## 4.3 Decision problem

There are two sources of utility for households. On the one hand, they enjoy consumption and leisure. This is captured by the individual-level utility function $U_g(c, l_g, t)$, where $c$ stands for per-capita consumption, $l_g$ is the labor supply of the gender-$g$ household member and $t$ is the amount of (total) time parents invest with their children. that depends on individual's gender. This function is:

$$U_g(c, l_g, t) \;=\; \frac{c^{1-\sigma_c}}{1 - \sigma_c} \;-\; \kappa_g \frac{(l_g + \alpha_g t)^{1+\frac{1}{\nu}}}{1 + \frac{1}{\nu}}, \tag{5}$$

[17] Although I refer to $m$ as education expenses, it should be thought of as a combination of different expenses such as schools fees, books, music lessons, museums and theatre tickets, etc. In general, $m$ capture any expenditures that positively affects children's skills.

where $\nu$ is the Frisch elasticity of labor supply and $\alpha_g$ is the fraction of time invested in children's human capital by the gender-$g$ household member. As usual in models with endogenous household size, consumption is a public good subject to congestion.[18] A household with $n$ children needs to buy $\Psi(n)c$ units of the final good to achieve a level of per-capita consumption of $c$, where $\Psi(n) = 1.7+0.5n$, which corresponds to the OECD equivalence scale.

On the other hand, parents enjoy having children and also derive utility from their children's human capital and from transfers made to adult children. This is captured by the utility function $U_k(n, q, b)$ that, as opposed to $U_g(c, l_g, t)$, is defined at the household level. In particular:

$$U_k(n,q,b) \;=\; \eta_n\left(\frac{n^{\sigma_n}}{\sigma_n}\right)+\eta_q n^{\varphi}\left(\frac{q^{\sigma_q}}{\sigma_q}\right) \;+\; \eta_b\left(\frac{b^{\sigma_b}}{\sigma_b}\right) \;-\; \eta_0\cdot\mathbf{1}_{\{n>0\}}\;, \tag{6}$$

where $\eta_x > 0$ and $\sigma_x \in (0, 1)$ for $x \in \{n, q, b\}$. The parameter $\varphi$ controls how families of different sizes value children's human capital. If $\varphi = 0$, they all value child's human capital equally, and if $\varphi > 0$ larger families derive more utility from each unit of child's human capital. More importantly, a positive value of $\varphi$ implies that, not only the marginal cost of children's human capital is increasing in the number children, but also the marginal utility. Finally, the parameter $\eta_0$ is a fixed cost of having children, standard in the literature to generate childless households. It captures utility cost such as quality of sleeping, not directly captured by model preferences.

### 4.3.1 Recursive problem

I now turn into the definition of the recursive problem of a working age household. The choice set of a household depends on its state, given by $\mathbf{s} = (e_m, e_f, z_m, z_f, a, q, n, n_0, n_I, j) \in \mathcal{S}$. In particular, every working age household decides on consumption, savings and labor supply of both spouses, $(c, a', l_m, l_f)$. Households with children decide how much time and goods to invest in their children's human capital, $(t, m)$. If there is a child aged $J_I$ in the household, parents need to decide how much to transfer to her before she leaves home, $b$. Finally, those households younger than $J_F$ decide whether they want to get pregnant and have another child next period, $k$. The problem reads as:

$$\begin{aligned} V(e_m,e_f,z_m,z_f,a,q,n,n_0,n_I,j) \;&=\; \max_{\mathbf{x}}\; U_m(c,l_m,t)\;+\;U_f(c,l_f,t)\;+\;U_k(n',q',b)\;+\\ &\quad +\beta\mathbb{E}_j[V(e_m,e_f,z'_m,z'_f,a',q',n',n'_0,n'_I,j+1)], \end{aligned} \tag{7}$$

where $\mathbf{x} = (c, a', l_m, l_f, b, t, m, b)$ is the choice vector, $n'_I = 1$ with probability $p_I(n - n_I, j)$, where $n - n_I$ is the number of children in the household excluding newborns and $n'_0 = 1$ with probability

[18] See for example Bick (2016) and Caucutt et al. (2002)

$p_0(j)$ if the household decides to get pregnant, $b = 1$. This problem is subject the budget constraint

$$\Psi(n')c + a' + m + b = y + (1 + r)a - T(y, n') - \tau_{ss}y, \tag{8}$$

where total labor income, $y$, is given by:

$$y = w_m(e_m, z_m, j)l_m + w_f(e_f, z_f - \delta_0 n_0, j)l_f. \tag{9}$$

The choice vector $\mathbf{x}$ is further restricted by

$$0 \leq l_g + \alpha_g t \leq 1, \quad g \in \{m, f\}, \tag{10}$$

$$k \in \{0, 1\}, \text{ with } k = 0 \text{ if } j \geq J_F, \tag{11}$$

$$t \geq 0, \text{ with } t = 0 \text{ if } n' = 0, \tag{12}$$

$$m \geq 0, \text{ with } m = 0 \text{ if } n' = 0, \tag{13}$$

$$b \geq 0, \text{ with } b = 0 \text{ if } n_I = 0. \tag{14}$$

### 4.3.2 Retired households

At age $J_R$, individuals retire and receive a pension equal to a fraction $p_R \in (0, 1)$ of their last wage, given by $w_g(e_g, \bar{z}_g, J_R)$, where $\bar{z}_g$ is the individual's labor productivity at retirement.[19]. Apart from the definition of income, the problem of a retired households is similar to (7) imposing $l_m = l_f = 0$. At age $J$ individuals die leaving no bequest so that $a' = 0$. I do not impose any restriction on the presence of children in retired households, whose aging is the only source of uncertainty for retirees.[20] However, if a household aged $J$ still have some children at home, they all become independent at the beginning of the period.

## 4.4 Independent children

Children stay at home until they reach the age of $J_I$. At this moment, they receive a transfer from their parents and become independent with an initial state given by $(g, q, a)$, where $a$ equals the transfer received from parents. The gender is assigned once children become independent, there is an equal probability of being male and female. This assumption implies that there is no gender-

[19]In the US, pensions are computed based on lifetime earnings. I simplify how pensions are computed and assume they are given by a constant fraction of the last wage. This assumption is not relevant for the results are the motive for having children is not old-age support, but altruism.

[20]Although there is no theoretical restriction on the presence of children in retired households, in practice, the parametrization of $p_I(n, j)$ avoid this to happen. See the calibration section for more details.

based discrimination on parental investments. Before forming a new adult household, they make an education choice, meet a spouse and get an initial labor productivity draw.

### 4.4.1 Education stage

The first choice an independent child has to make is whether to become high-educated. Individuals want to become highly educated for two reasons. First, they make higher wages as $\bar{w} > \underline{w}$. Second, they are more likely to meet high educated spouses, as explained in the next section. Let $E(g, q, a)$ denote the value function of a child aged $J_I$ before the education choice. This is given by:

$$E(g, q, a) \;=\; \mathbb{E}_{\xi_E} \max\left\{M(g, \bar{e}, a) - \xi_E(g, q),\; M(g, \underline{e}, a)\right\}, \tag{15}$$

where $M(g, e, a)$ is the value function before marriage and $\xi_E(g, q)$ is a utility cost that depends on gender and child's human capital.[21] This covers, among others, tastes, the cost of effort, etc. This shock is assumed to follow a log-normal distribution with unit variance and a mean $\mu_E(g, q)$:

$$\mu_E(g, q) = \mu_E^g \exp\left(-\mu_E^q q\right) \geq 0, \tag{16}$$

Children with higher human capital are more likely to become highly educated when adults. Accordingly, I restrict $\mu_E^q > 0$ so that the cost of attending college is decreasing in human capital. Despite female wages being substantially lower, females are as likely as males to attend college. To capture this, I restrict $0 < \mu_E^m \leq \mu_E^f$, so that for any given level of human capital, females face lower costs.

### 4.4.2 Marriage stage

After the education choice, individuals meet spouses. In the data, most couples are formed by spouses with the same level of education. Accordingly, I assume that individuals meet a spouse of the same level of education with probability $p_M \in [0, 1]$. Conditional on education, there is a pure random matching. The problem of a female is:

$$M(f, e_f, a_f) \;=\; \mathbb{E}_{e_m, a_m | e_f}\left[V^0(e_m, e_f, a_m + a_f)\right], \tag{17}$$

where $V^0$ is the value function before forming a new households. The problem of a male is analogous. Before forming a new household, couples draw a first labor productivity and chose whether they want

[21] This is the only source of cost from going to college. Keane and Wolpin (2001) and Keane (2002) show that differences in monetary resources account for a small fraction of the differences in college choices.

to start with a baby. Their value function reads as:

$$V^0(e_m, e_f, a) = \mathbb{E}\left\{\max_{n_0}\ V(e_m, e_f, z_m, z_f, a, q = 0, n = 0, n_0, n_I = 0, j = J_I)\right\}, \tag{18}$$

where $V$ is defined by equation (7) and the expected value is taken over $z_m$ and $z_f$.

## 4.5 Aggregate production function

The unique good of the economy is produced by a representative firm operating a CRS technology combining capital, low and high educated labor. This technology is:

$$Y = AK^\alpha \left[aL_0^b + (1-a)L_1^b\right]^{\frac{1-\alpha}{b}}, \tag{19}$$

where $L_0$ and $L_1$ are the aggregate labor supply from low and high educated individuals respectively, $K$ is aggregate capital and $A$ an aggregate productivity term.

## 4.6 Definition of equilibrium

The equilibrium of the economy consists of a distribution of households, a set of prices, a social security tax rate and a set of policy functions (consumption, savings, labor supply, parental investments, fertility, and transfers) such that maximizes households' utility, the representative firm maximizes its profits, social security's budget is balanced given benefits paid to the elderly, and the distribution is stationary. Government's budget is balanced by assumption: the only source of expenditures for the government is $G$, so I set the value of $G$ to the total revenues in steady state, and keep it fixed in the counterfactual exercises. Appendix B describes the solution algorithm.

# 5 Calibration

This section describes the calibration strategy. I proceed in three steps. First, I estimate some parameters and functions directly from the data. Then, some parameters are set exogenously, either to standard values or to values from related papers. Finally, I calibrate the remaining model parameters so that the steady state of the model replicates some key moments of the data related to fertility, children's human capital and parental investments.

### Data sources

The main data source used in this paper is the Panel Survey of Income Dynamics (PSID hereafter). This is a panel started in 1968 with a nationally representative sample of around 5,000 households, directed by faculty at the University of Michigan. Information of these households and their descendants has been collected over time. Among other things, it contains information on labor supply, income, wealth, marriage and childbearing histories, and education. As children and grandchildren of original PSID families grow, they become independent and form new households. These new households are included in subsequent waves, increasing the sample size every year. I use the 2000 to 2010 waves. Staring in 1997 the PSID offers biannual waves, so I use the 2001, 2003, 2005, 2007 and 2009 waves. I keep observation of married individuals older than 20, where marital status is defined by the presence, or not, of a spouse or partner, independently on whether they are legally married. Education in the model takes two values: high and low educated, so I identified high educated individuals as those with a college degree, a 28% of the sample. I end up with a sample of 44,917 households.

For children's information, I rely on the 2002 and 2007 waves of the Child Development Supplement to the PSID (CDS hereafter). Although the PSID has always collected some information about children, in 1997 they start a supplementary study covering children aged 0 to 12 from 1997 PSID families. These children, and their primary caregiver, were re-interviewed in 2002 when they were aged 5 to 18, and in 2007 when they were aged 10 to 19 (older children were excluded). Overall, I have information on 4,530 children aged 5 to 18. The CDS contains a wide range of measures of children's development, from physical to social or cognitive development. It includes child's scores in three of the Woodcock-Johnson Tests, which are standard measures of child's skills and are of particular interest for this paper. It also offers a detailed time diary with information on children's activity, including the nature of the activity, the duration or whether other people participate. Interestingly, the CDS contains individual identifiers for both the child and the primary caregiver (the mother in more than 90% of the cases). These individual identifiers can be used to match the CDS data to that from PSID. By doing so, I am able to link child's information with adult outcomes, as well as to parents characteristics. I can link both data sets for a total of 1,892 children.

### Life-cycle structure

The life-cycle is divided into 21 periods and the model period is set to 3 years. This is the median number of years between the first and second birth, as well as between the second and third. Accordingly, I set the first period as an adult, $J_I$, to ages 20-23, the last period of fertility, $J_F$, to ages 35-38, the retirement age, $J_R$, to ages 62-65 and the last period, $J$, to ages 80-82.

**Table 3:** Children's (normalized) scores in the Woodcock Johnson Tests

| | Obs. | Mean | Std | Min | Max |
|---|---|---|---|---|---|
| Applied Problem Solving | 4,125 | 0.608 | 0.144 | 0.050 | 1.000 |
| Passage Comprehension | 4,047 | 0.590 | 0.159 | 0.023 | 1.000 |
| Letter-Word | 4,125 | 0.741 | 0.170 | 0.086 | 0.983 |

### Measurement of children's human capital

The CDS provides information on children's scores in three of the Woodcock-Johnson Tests, a standard measure of a child's cognitive ability.[22] In particular, it includes scores to the Letter-Word test (LW), the Applied Problem Solving test (AP) and the Passage Comprehension test (PC). Table 3 presents summary statistics on the normalized score (share of correct answers) of these tests.

I make use of this information to measure children's human capital, following the strategy of del Boca et al. (2014). In particular, I assume that a child with human capital $q$ has a probability $p_i(q)$ of answering question $i$ correctly. This probability takes the form $p_i(q) = q/(1+q)$, independent of $i$, which implies that every question is of equal difficulty. Lets $d_i \in \{0, 1\}$ denote the outcome of question $i$, where $d_i = 1$ means that question $i$ is answered correctly. Assuming independence across questions, I can measure child's human capital as:

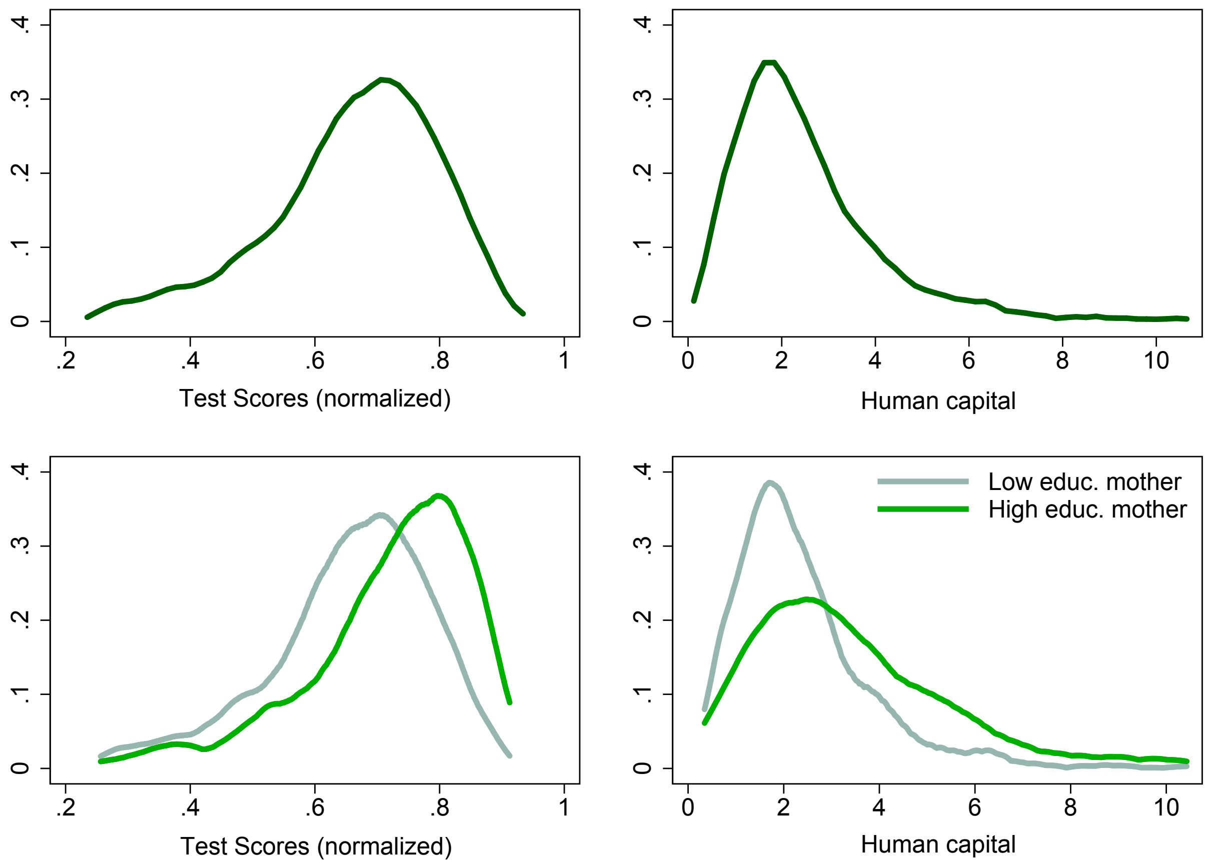
$$q = \frac{\bar{d}}{1-\bar{d}} \quad \text{with} \quad \bar{d} = N^{-1}\sum_{i}^{N} d_i, \tag{20}$$

There are three different measures of $\bar{d}$, one for each test. del Boca et al. (2014) uses only information on the LW test (i.e. $\bar{d}$ in equation (20) is the share of correct answers to the LW test). I take an agnostic view and compute child's human capital using the score of the three tests separately, and pooling all of them together (thus, assuming the three tests are equally informative about child's human capital).

One of the key features of the model is that child's human capital determine how likely it is that a child becomes high educated when adult. Therefore, to choose the measure of human capital I compute the correlation of each of the measures and the level of education. To do so, I use individual identifiers to match CDS data with information of children when they become independent from PSID. When measuring $\bar{d}$ as the share of correct answers to the AP test the correlation is of 0.449, higher than when I use the scores to the PC test (correlation of 0.300) and to the LW test (correlation of 0.336). Pooling the three tests together, the correlation between education and the resulting measure of human capital is 0.482, higher than with the any of the three tests separately. Therefore I chose

[22] For example, Daruich (2018) and del Boca et al. (2014) also use this information to measure skills. Alternative measure include, among others, the Peabody Individual Achievement Test (Agostinelli and Wiswal, 2016), or the AFQT scores (Juhn et al., 2015).

**Figure 4:** Distribution of test scores (left) and human capital (right)




Notes: In the left panel I plot the distribution of normalized test scores, defined as the share of correct answers in the three Woodcock Johnson Tests. In the right panel I plot the distribution of quality as defined by equation (20) using answers to the three Woodcock Johnson Tests. See main text for more details.

this as my measure of child's human capital. Figure 4 plots the distribution of test scores ($\bar{d}$) and human capital ($q$) for the whole population of children and by maternal education.

Children's human capital has a strong age component. In the distribution of child's scores and human capital, most of the children with scores lower than 0.6, or human capital lower than 1.73, are children younger than 10. However, I do not normalize $q$ by children's age, because human capital accumulation is key for the purpose of this paper. As expected, the distribution of $q$ for children with highly educated mothers is shifted to the right.[23] For example, the average human capital of children at age 15 is 3.13 and 4.77 for children with low and high educated mothers respectively. Furthermore, the gap in human capital between children with high and low educated mothers grows over time. While at age 6, children from low educated mothers have, on average, 86% of the human capital of children with high-educated mothers, this number reduces to 54% at age 18.

[23]These differences do not reflect differences in the age composition, as the share of children with high-educated mothers is constant around 20% for any age.

### Time investments

The CDS also contains an exhaustive time diary of activities, from household-related activities (laundry, repairs, gardening, etc.) to leisure activities (watching TV, reading, playing sports, etc.). For each activity, the survey contains, among other things, the duration of the activity, whether other people actively participate or were "around", and whether the activity takes place during the weekend or a weekday. I measure time investment as the total duration of all activities in which either the mother, the father, or both, actively participate with the child, weighting them by 2/7 if the activity takes places during the weekend, and by 5/7 otherwise. I restrict the analysis to those children with positive time investments, which mostly excludes older children. Figure A.2 plots the estimated density of time investments.

The average time investment is of 2 hours and 55 minutes per day. Mothers are the ones spending more time with children. On average, mothers spend 1 hour and 58 minutes per day with children, while fathers spend 1 hour and 4 minutes per day. Part of this time is spent by the two parents together. In particular, both the mother and the father spend 40 minutes per day with their children together. Overall, 82% of the time with children is spent by the mother, 45% on their own and 37% jointly with the father. Fathers participate in 55% of the time, with only 18% on their own.

### Labor income process

To calibrate the income process I make use of information from the PSID. I first compute wages for full-time workers using data on annual income and hours worked and normalize wages by the year-specific average of males. Therefore, the resulting wages for female wages should be read as relative wages. I fit a second-order polynomial in age by gender and education (college degree versus high school) and then use the estimated parameters to construct age profiles. Figure 5 plots the estimated age profiles. In the figure, (log) wages of males at age 21 are normalized to zero and differences between males and females profile capture the education- and age-specific gender wage gap.

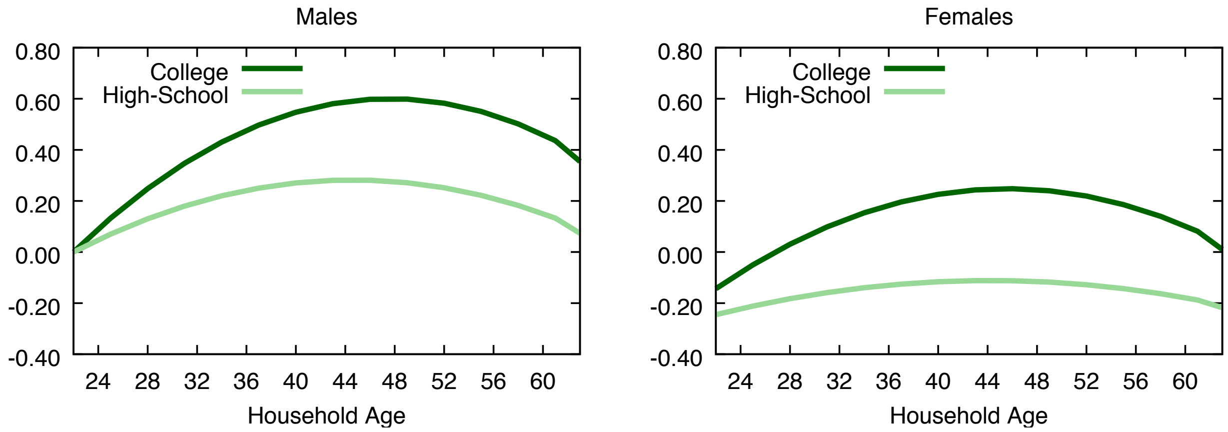
I take the residuals from fitting a second order polynomial in age to wages as the measure of labor productivity. I estimate a regression of labor productivity on its second lag by education by education category, using the forth lag as an instrument to control for potential measurement error.[24] The results from these regressions are collected in table 4.

**Table 4:** Labor productivity process estimation

| | Low educated | High educated |
|---|---|---|
| Autocorrelation, $\rho_e$ | 0.824 | 0.902 |
| Std of innovations, $\sigma_e$ | 0.406 | 0.392 |

[24] For the 2000's, the PSID offers biannual information.

**Figure 5:** Estimated age profiles of income




Notes: Estimated wage profiles by gender and education category. Males' profiles at age 21 are normalized to 0. See main text for details.

High educated workers have more persistent labor productivity than low educated ones, and less disperse innovation shocks. I discretize these processes using Tauchen's method.

## Fertility risk

The model features fertility risk in the form of a probability of childbirth for pregnant females lower than 1. I follow Sommer (2016), and assume that the probability of childbirth is given by $p_0(j) = 1 - \exp(\alpha_0 + \alpha_1 j)$, where $\alpha_1 > 0$ so that $p_0(j)$ is decreasing in age. I fit the function $p_0(j)$ to the share of infertile females at ages 20, 25, 30, ..., taken from the medical literature. The estimated parameters are $\alpha_0 = -4.452$ and $\alpha_1 = 0.097$. A positive value of $\alpha_1$ implies that the probability of birth is decreasing in female's age, as expected.

## Children independence

To discipline the process of children independence I relay on information from the PSID. in particular, I compute the probability that the number of children in a household is lower than that 3 years before, for different number of children and mother's age categories. More precisely,

$$p_I(n, j) = \frac{\sum_{i=1}^{N} \mathbf{1}\{n_{i,t} < n \wedge n_{i,t-3} = n \wedge \text{age} = j\}}{\sum_{i=1}^{N} \mathbf{1}\{n_{i,t-3} = n \wedge \text{age} = j\}}, \tag{21}$$

where $n_{i,t}$ is the number of children born to household $i$ before year $t$. Table 5 collects the results.

These probabilities imply that a child with no siblings in a household of age 1 stays at home, on average, 7 periods. Note that, although I do not impose any structure on the probabilities —apart from the period length of 3 years— this result implies the child becomes independent at age 21, in line with the life-cycle structure I used. Figure A.4 plots the average number of periods with children for

**Table 5:** Children independence process

| | Mother's age | | | |
|---|---|---|---|---|
| Age | 20-28 | 29-37 | 38-46 | >46 |
| Model age ($j$) | 1-3 | 4-6 | 7-9 | >9 |
| $p_I(n=1,j)$ | 0.029 | 0.037 | 0.288 | 0.501 |
| $p_I(n=2,j)$ | 0.025 | 0.041 | 0.309 | 0.579 |
| $p_I(n=3,j)$ | 0.049 | 0.105 | 0.399 | 0.718 |
| $p_I(n\geq 4,j)$ | 0.125 | 0.140 | 0.455 | 0.720 |

households of different age and number of children. For example, a household of age 5 with 3 children has children at home, on average, until age 15.

### Aggregate production function

I set the capital share $\alpha$ to the standard value of 0.33, the aggregate productivity parameter to $A = 47.9$, the share parameter to $a = 0.44$ and the elasticity parameter to $b = 0.65$. The values of $A$, $a$ and $b$ are such that, in equilibrium, the (annual) interest rate is 3%, the wage of low educated is 10 (normalization) and the college premium, $\overline{w}/\underline{w}$, is 1.28. The get the college premium, I normalize males' age profiles $\mu(m, \bar{e}, J_I)$ and $\mu(m, \underline{e}, J_I)$ to zero and set the value of the relative wage such that the age profiles in the model correspond to those estimated using PSID data.

## 5.1 Exogenous parameters

Some of the model parameters are taken exogenously, either set to standard values or directly taken from concrete papers. These parameters are collected in table 6. Some of them deserve a comment. The curvature in the utility from consumption is set to 0.8, lower than the standard value of 3. In most macroeconomic models $c$ is the only source of consumption expenditure of a single-earner household and thus, $\sigma_c$ measures the inverse of the intertemporal elasticity of substitution. This is no longer true in this model, as $c$ is per capita consumption —not household consumption— and children, and their human capital, are also consumption expenditures in the inter-temporal sense. In fact, a value of $\sigma_c = 0.8$ is common in models with endogenous fertility choices as Caucutt et al. (2002) and Córdoba et al. (2016). The child-penalty, the loss in maternal labor productivity from childbirth, is set to $\delta_0 = 0.10$ as estimated by Kleven et al. (2018) for Denmark. The share of parental time invested by each of the spouses $\alpha_m$ and $\alpha_f$ are set to 0.55 and 0.82 respectively as found in CDS data. The parameters driving the economies of scale in children's human capital are taken from Sommer (2016) who posit a similar investment function and calibrate them to match the elasticity of parental expenditures and time to the number of children. Due to lack of better estimates, I set the initial level of human capital to be equal to the 25th percentile in the distribution of child's human capital,

Table 6: Exogenous parameters

| Parameter | | Description | Source |
|---|---|---|---|
| $\beta$ | 0.98 | Discount factor (annual) | – |
| $\sigma_c$ | 0.80 | Curvature utility from consumption | Caucutt et al. (2002) |
| $\nu$ | 2.00 | Frisch elasticity of labor supply | Standard value |
| $\delta_0$ | 0.10 | Child penalty | Kleven et al. (2018) |
| $\alpha_m$ | 0.54 | % time invested by fathers | CDS |
| $\alpha_f$ | 0.82 | % time invested by mothers | CDS |
| $\xi_1$ | 0.92 | Economies of scale, money investments | Sommer (2016) |
| $\xi_2$ | 0.54 | Economies of scale, time investments | Sommer (2016) |
| $q_0$ | 1.42 | Initial level of human capital | 25th percentile of $q$ |
| $p_R$ | 0.13 | Replacement rate | 50% labor supply at ages 62-65 |
| $p_M$ | 0.75 | Share of household with $e_m = e_f$ | PSID |

which roughly coincides with the average human capital of the youngest children included in my CDS sample. The average labor supply at ages 63 to 65 is equal to 0.26, which corresponds to 30 hours per week. Consequently, I set $p_R = 0.13$ such that pensions approximate one half of an individual's last wage. Finally, the probability of meeting a spouse is equal to the share of equally educated couples in PSID data.

## 5.2 Calibrated parameters

I calibrate the remaining parameters internally. Those include the preference parameters, the parameters in the production function of child's human capital, the parameters in the investment function, and the parameters of the mean education costs. I allow the fixed cost of having children, $\eta_0$ to vary by maternal education to captures differences in childless rates. In sum, I calibrate 19 parameters.[25]

To set the parameter use I employ the Simulated Method of Moments. Let $\mathcal{P}$ be the vector of parameters and $\mathcal{M}(\mathcal{P})$ the vector of model generated moments given those parameter values. Then,

$$\mathcal{P}^* = \arg\min_{\mathcal{P}} \; (\mathcal{M}(\mathcal{P}) - \bar{\mathcal{M}})'(\mathcal{M}(\mathcal{P}) - \bar{\mathcal{M}}) \tag{22}$$

where $\bar{\mathcal{M}}$ is the vector of moments from the data. I minimize this problem numerically using the Levenberg-Marquardt algorithm, a Newton-based method, and numerical differentiation. Table 7 collects the estimated parameters.

### Targeted moments

The parameters of the utility from children and children's human capital $(\eta_n, \sigma_n, \eta_q, \varphi, \sigma_q)$ are calibrated to match the completed fertility and the average human capital of children in 2-child families,

[25] Since the results are sensitive to the value of the fixed cost, I find the pair of fixed cost parameters that replicates the childless rate by maternal education at each iteration.

**Table 7:** Calibrated parameters

| Parameter | | Description | Moment | Model | Data |
|---|---|---|---|---|---|
| $\eta_n$ | 1.05 | Utility from children | Completed fertility, HS mother | 2.41 | 2.52 |
| $\sigma_n$ | 0.51 | Utility from children | Share of households with 2+ children | 0.53 | 0.52 |
| $\eta_q$ | 0.96 | Utility from children's $q$ | Average human capital, HS mother | 2.75 | 2.67 |
| $\sigma_q$ | 0.76 | Utility from children's $q$ | Differential $q$ by maternal educ. | 0.44 | 0.56 |
| $\varphi$ | 0.16 | Utility from children's $q$ | Differential fertility by maternal educ. | -0.26 | -0.23 |
| $\kappa_m$ | 4.74 | Disutility of labor supply, males | Average labor supply, male | 0.36 | 0.35 |
| $\kappa_f$ | 4.32 | Disutility of labor supply, females | Average labor supply, female | 0.24 | 0.23 |
| $\eta_b$ | 0.40 | Utility from transfers | Rel. wealth at age $J_I$, HS mother | 0.11 | 0.11 |
| $\sigma_b$ | 0.51 | Utility from transfers | Rel. wealth at age $J_I$, CG mother | 0.16 | 0.17 |
| $\eta_0^0$ | 2.70 | Fixed cost, HS mothers | Share of childless HS mothers | 0.08 | 0.08 |
| $\eta_0^1$ | 2.80 | Fixed cost, CG mothers | Share of childless CG mothers | 0.12 | 0.13 |
| $\mu$ | 0.30 | Share param., human capital | Slope: $\Delta q = \alpha + \beta q + u$ | 0.22 | 0.25 |
| $\theta$ | -1.84 | Elasticity parameter | Slope: $\Delta q = \alpha + \beta \ln(y) + u$ | 0.18 | 0.14 |
| $A_{\mathcal{I}}$ | 6.31 | Productivity of investments | Average growth rate in $q$ | 0.28 | 0.28 |
| $\varsigma$ | 0.58 | Share param, goods investments | Time investment, HS mothers | 0.23 | 0.25 |
| $\gamma$ | -0.31 | Elasticity param, investments | Time investment, CG mothers | 0.25 | 0.28 |
| $\mu_E^f$ | 0.96 | Fixed cost of education, females | Share of high educated females | 0.27 | 0.26 |
| $\mu_E^m$ | 11.6 | Fixed cost of education, males | Share of high educated males | 0.29 | 0.27 |
| $\mu_E^1$ | 0.23 | Variable cost of education | Slope of $e = \alpha + \beta q + u$ | 0.11 | 0.12 |

Notes: I compute the data moments from PSID (fertility, share of households with 2 or more children, labor supply, relative wealth, share of childless, share of high educated) and CDS (human capital, time investment, growth of human capital and elasticity of education choice to human capital). Moments concerning children's quality are taken for families with two children unless otherwise stated. Completed fertility corresponds to the total number of children ever born at age $J_F$ (age 38 in the data). Differential fertility and differential human capital refers to the difference between high and low educated mothers.

and the share of household with 2 or more children. The parameter $\eta_n$ is particularly relevant to math the average completed fertility, while $\sigma_n$ allows us to match the share of households with 2 or more children. Note that a low value of $\sigma_n$ makes the marginal utility from children to decrease rapidly, inducing parents to space births children. In the extreme, a very low value of $\sigma_n$ would make parents wait until the first child is independent before having the second one. The parameter $\eta_q$ allows me to match the average human capital for families with two children, while $\sigma_q$ is identified by the difference in children's human capital by maternal education in households with two children. The parameter $\varphi$ allows me to match the difference in completed fertility between low and high educated mothers. Note that, a high value of $\varphi$ lowers the human capital cost of having more children by increasing the marginal utility from children's human capital. In other words, a low level of $\varphi$ implies that the cost of having a second child versus staying with one is very high, making high educated parents to lower the number of children they have. The disutility of labor supply of males and females are identified by the average labor supply by gender, where I normalized total available time to unity, corresponding to 5,824 hours (16 hours per day). The weight and curvature of the utility from transfers to adult children, $\eta_b$ and $\sigma_b$, are calibrated to match the relative household assets of young households by head's maternal education.

The law of motion for children's human capital has two parameters to be estimated, $\mu$ and $\theta$.

**Table 8:** Non-targeted moments

| | Data | Model | Source |
|---|---|---|---|
| Intergenerational persistence of education | 0.16 | 0.15 | PSID |
| Income elasticity of fertility, HS mother | -0.21 | -0.17 | PSID |
| Income elasticity of fertility, CG mother | -0.02 | -0.01 | PSID |
| Correlation time and goods investments | 0.88 | 0.87 | Daruich (2018) |
| Share of expenditures spent on children ($n = 1$) | 0.26 | 0.27 | Lino et al. (2015) |
| Share of expenditures spent on children ($n = 2$) | 0.39 | 0.41 | Lino et al. (2015) |

Notes: The intergenerational persistence of education is computed as the slope in a regression of individual's education at age 20-23 (age $J_I$ in the model) on mother's education. The income elasticity of fertility is computed as the slope in a regression of the number of children ever born in a family on log household income for households with at least 1 child and aged 36 to 38, which corresponding to age $J_F$ in the model. I exclude families with more than 6 children (which is the maximum number of children a household can have in the model).

I calibrate those by matching the slope in the regression of the change in children's human capital on past human capital and log family income respectively, for families with two children. The share parameter in the investment function, $\varsigma$, is calibrated to match the average time investments of low educated mothers with 2 children, while the elasticity parameter of the investment function, $\gamma$, to match the differential time investments by maternal education. Note that a large value of $\gamma$ makes it easier for high-educated families to substitute time for money. If $\gamma$ is sufficiently large, high-educated families would invest less time that low educated ones, as time is more costly for them, and use goods investments to compensate for it. The productivity of parental investments drives how time and goods investments translate into higher children's human capital. Thus, I calibrate $A_{\mathcal{I}}$ is calibrated to match the relative change in human capital by maternal education.

### Model evaluation: non-targeted moments

Table 8 shows a number of statistics not targeted in the calibration. The model generates an intergenerational persistence of education that is close to its data counterpart. I compute this measure as the slope in the regression of individuals education at age 21 (age $J_I$ in the model) on the education of individual's parent. The fact that the model replicates this number is particularly important given the focus of the paper. The income elasticity of fertility is also close to the empirical counterpart. In particular, it replicates the negative income elasticity for households with low educated females, while for highly educated mothers the income elasticity is statistically zero, as in the data.[26] The correlation between time and good investments is also very close to the one reported by Daruich (2018) who uses family expenditures on toys, school supplies, clothes, food, medical, and vacations as a proxy for monetary parental investments. I interpret this as a validation for the choice of the economies of scale parameters, $\xi_1$ and $\xi_2$, that are not internally calibrated. Finally, the model also generates

[26]This suggest that the model exhibits stronger quantity-quality trade-off for low-income families, as found by Juhn et al. (2015) in NLSY data.

shares of expenditures spent on children that are close to those reported in Lino et al. (2015) who uses data from the Consumer Expenditure Survey and report a number of estimates of these shares from different studies.

### Model evaluation: replicating results in González (2013)

This paper aims at quantifying the effects of fiscal policy on fertility and parental choices. While I discipline parental choices with the calibration exercises —where I explicitly target moments concerning the investment behavior of parents—, and validate them with the non-targeted moments shown before, I provide no evidence that the response of fertility to fiscal policy is reasonable. To validate the implications of the model in terms of such response, I replicate the findings in González (2013) using a model-generated sample of households. In this paper, the author evaluates the effects of a universal child-related transfer introduced in Spain, in July 2007, known in the media as "cheque-bebé" ("baby-check"). There are two reasons why I think this policy is appealing to validating my model. First, it identifies the causal fertility response to a fiscal program. Second, the policy is defined as a universal transfer per birth, and therefore, not mean-tested nor conditional on working. This makes the implementation of the "baby-check" policy in the model particularly easy and clean.

The policy consisted of a one-time subsidy of €2,500 per child born after July 1st, 2007. This amount was roughly equal to 2.10 times the median monthly wage of females at that time. González identifies the fertility effects by comparing the number of births before and after the policy was implemented, controlling for time trends and seasonality effects. The specification with the largest sample period, and the most complete set of controls, delivers an estimated increase in fertility of 6.13 log-points (6.32% increase). I replicate this policy in my model and check whether the increase in fertility is close to that number.

In order to replicate this policy with my model, I first compute the median female labor earnings, and then define the corresponding value of the transfer. Since labor earnings in the model are 3-year earnings, I scale the median of female labor earnings by 1/36, and define a transfer per birth to be equal to 2.10 the resulting value. Starting from the stationary distribution of the benchmark economy, I introduce the policy, iterate the distribution one period, and compare the number of births with and without the policy. Results are very close to González's findings. In particular, the "baby-check" policy increases the number of births in the model by 7.5%. This result is a bit larger than the 6.32% increase reported by González, although it is within the 95% confidence interval (3.8%-8.4%). In any case, my model is estimated to replicate the US economy, which may be very different from the Spanish one in many dimensions. Note, for example, that the Spanish fertility rate (1.3 children per female) is substantially lower than in US one (1.8 children per female).[27] Despite those differences, I

[27]Source: OECD Family Database.

think the results from this exercise are still informative and suggest that the fertility response to fiscal policy in the model is within reasonable values.

# 6 Results

What are the effects of tax benefits for families with children? Do they foster fertility? How are parental investments in children's human capital affected? In this section, I address these questions using the calibrated model as a laboratory economy to simulate an economy without child-related tax benefits. Later I evaluate an alternative policy. Namely, I asses the effects of subsidizing parental expenditures on children's education.

## 6.1 Child-related tax beneftis

In this section, I evaluate quantitatively the impact of child-related tax benefits in the US. In particular, I study their effects on fertility decisions of households and on parental investments. Through the lens of the quantity-quality trade-off, any policy lowering the implicit price of children —without affecting that of children's human capital— will induce parents to *substitute* children's human capital for more children, yielding an economy with higher fertility but lower levels of human capital. This section provides evidence on the magnitude of these effects. To do so, I use the model to simulate an economy with a tax rate function given by:

$$t^*(y) = \max\{t(y,0) - \tau_0, 0\}, \quad \forall n \tag{23}$$

where $t(y,0)$ is the tax rate that a childless household with income $y$ has to pay under the current US tax schedule. As childless families pay higher taxes (see table 2), this policy generates extra revenues for the government. In order to balance the government's budget, I introduce a tax discount, $\tau_0$, independent of income and the number of children. Therefore, this tax discount just shifts down the tax function until the government's budget is balanced again. In equilibrium, the discount that balances the government's budget is $\tau_0 = 0.05$. Note that, as the tax rate cannot be negative, not every family will enjoy the tax discount.[28]

Results are collected in table 9. The first column presents the results from simulating an economy without tax benefits and a tax function given by (23). The second column collects the results from simulating an economy with tax benefits as those currently in place in the US. Thus, this column

[28] Alternatively, I can assume that the government balances its budget by distributing lump-sum transfers, which would be enjoyed by every household, independently of their income. Results from this alternative policy are collected in Appendix C.

**Table 9:** Effects of child-related tax benefits

| | (1) No Benefits | (2) Tax Benefits (baseline) | (3) Effects of Tax Benefits (%) | (4) Partial Equil. |
|---|---|---|---|---|
| Wage, low educated | 11.51 | 10.00 | -13.15 | – |
| Wage, high educated | 13.76 | 12.85 | -6.63 | – |
| Interest rate ($\times$100) | 3.13 | 3.50 | 11.68 | – |
| Social security tax ($\times$100) | 1.93 | 1.51 | -21.63 | – |
| Average tax rate ($\times$100) | 8.03 | 9.47 | 17.92 | – |
| Completed fertility | 1.81 | 2.11 | 16.28 | 1.59 |
| Fertility of mothers | 2.08 | 2.32 | 12.00 | 2.14 |
| Share of mothers | 0.87 | 0.91 | 3.82 | 0.74 |
| Differential fertility | -0.12 | -0.32 | 166.76 | -0.09 |
| Human capital at independence | 6.11 | 5.07 | -17.10 | 5.50 |
| Differential human capital | 1.05 | 1.51 | 43.98 | 1.21 |
| College graduation rate | 0.37 | 0.28 | -25.01 | 0.32 |
| Inter. Persistence of education | 0.11 | 0.15 | 37.38 | 0.14 |

Notes: Differential fertility refers to the difference in the number of children ever born by age 38 between low and high educated females. Differential human capital refers to the difference in human capital at independence between children of high and low educated mothers. The intergenerational persistence of education corresponds to the slope in the regression of individual's education on her parent's education.

contains the results from the calibration exercise. The third column contains the effect of introducing tax benefits. Finally, the last column presents the results from simulating an economy without tax benefits but with the prices of the baseline economy. Thus, the only difference between the economy with tax benefits (column 2) and the partial equilibrium solution (column 4) is the elimination of tax benefits. This helps to disentangle the effects of changes in wages (wage effects) from those arising from the elimination of tax benefits in isolation (relative price effects).

### 6.1.1 Fertility

The results show that tax benefits significantly increase fertility. In particular, completed fertility, defined as the total number of children ever born by age $J_F$ —or 38 in reality—, increases by more than 16% when tax benefits for families with children are introduced. This increase combines two effects. First, the share of households that decide to have children increases by almost 4 p.p., from 0.87 to 0.91. Put it differently: the childless rate decreases from 13% to 9%, a 30% decrease. Second, completed fertility among mothers increases by 12%, from 2.1 to 2.3 children per household. The increase in fertility is mainly explained by the change in the tax scheduled. In particular, eliminating tax benefits explained more than 73% of the change in fertility among mothers, while changes in wages only account for 27% of the overall increase. While tax benefits distort the relative price between children and children's human capital, lower wages induces further substitution. Note that the economy with tax benefits exhibits a larger fertility rate, and therefore, the share of the working population also increases. As a consequence, the aggregate capital-labor ratio falls, inducing wages to decrease and the interest rate to increase. Therefore, household income falls and, as predicted by the quantity-quality theory, this induces parents to substitute children's human capital for more children.

When differentiating between maternal education, the results show that tax benefits have a particularly strong effect on low-income households. The differential fertility, defined as the difference in completed fertility between high and low educated mothers, more than doubles when tax benefits are introduced. In particular, completed fertility among low educated mothers increase by almost 19%, while among high educated ones it increases by less than 9%.[29] The share of high and low educated mothers increase by around 3.5 p.p., so the increase in the gap is entirely due to fertility decisions of mothers: the fertility of low educated mothers increases by 15% while that of highly educated increases by just 5%. As explained before for the aggregate fertility behavior, these heterogeneous effects are also explained by the change in the tax schedule. Indeed, changes in wages not only do not increase the gap but substantially reduce it by one third. This suggests that tax benefits have an important distortionary effect on the relative price between the number and human capital of children.

### 6.1.2 Children's human capital

The number of children is a crucial determinant of the cost of children's human capital. The quantity-quality trade-off predicts that, when fertility falls (rises), we should expect an increase (decrease) in children's human capital. The model is consistent with this prediction. In particular, the average level of human capital with which children become independent decreases by more than 17%. This fall results from a decrease in the number of goods and hours of time parents invest in children. In particular, money investments fall by 20%, mainly because of a lower household income. Given the low substitutability between inputs in the production of human capital, time investments also fall, although it does so by less than 10%. The fact that time investments decrease by much less than goods investments do is due to two forces. On the one hand, as households are now poorer, goods become relatively more scare. On the other hand, taxes are higher, and wages go down, so the opportunity cost of time falls substantially. Although goods investments decline significantly, the share of expenditures that parents devote to children's human capital is roughly unchanged for both high and low educated parents. This suggests that changes in wages may be of particular importance at explaining the fall in children's human capital. Indeed, changes in wages explain 57% of the decrease in human capital, while the other 43% is explained by the larger number of children families have, which also increases the cost of per-child human capital.

We have seen that tax benefits have stronger effects on fertility choices of low-income households. Thus, we should expect the fall in children's human capital to be larger among those children with low educated mothers. The results are consistent with this intuition. The differences in children's human

[29] This is line with the findings of Azmat and González (2010) who find that the introduction of a child-related tax credit for working mothers in Spain had positive effects on fertility, especially among low educated mothers.

capital at independence increase by 44% when tax benefits are used. Children with low educated mothers become independent with an average level of human capital which is almost 20% lower than in the absence of tax benefits. Those with high-educated mothers, move out from parental home with a 9% lower level of human capital. These differences are explained by two effects. First, now low-educated mothers have more children, relative to high educated ones, making the per-child cost of human capital to increase substantially more for them. Second, high-educated parents are less constrained on their investments decisions. In fact, while money investments of low educated parents fall by 21%, that of high-educated ones fall by less than 16%. However, the results suggest that the first effects dominate, since changes in wages explain less than 40% of the increase in the differential human capital at independence.

### 6.1.3 Education

Human capital of children at independence falls, and consequently, the share of high-educated individuals also goes down. In particular, the share of college-educated individuals decreases in 9 p.p., from 0.37 to 0.28. This fall is lower than expected given the fall in human capital. One of the targets in the calibration is the slope in the regression of education on human capital which, in our model, is 0.11. Using this result, a fall in human capital of $6.11 - 5.07 = 1.04$ would be associated with a fall in college graduation rate of 11.4 p.p., more than we observe in the model. This is due to the standard general equilibrium effect. As the share of the working population increases, wages fall. On top of this, taxes increase, lowering the returns to education. However, children become independent with a lower level of human capital, which increases the effort cost of going to college. These three factors induce more individuals to not got to college, making the high educated labor supply to fall relatively more than the low educated one. As a result, the wage rate of high-educated workers increases (relative to the initial fall), alleviating the decrease in college attendance. If we differentiate by maternal education, the results follow what we have already discussed for children's human capital. The difference in human capital at independence between children of low and high educated mothers increases, and so does the difference in the probability of going to college. If in the absence of tax benefits, children of high-educated mothers where 37% more likely to go to college than those with low educated mothers, when tax benefits are introduced, they are 66% more likely. As a result, the intergenerational persistence of education increases by 37%, from 0.11 to 0.15.

### 6.1.4 Discussion

The general conclusion from this experiment is that child-related tax benefits increase fertility, but significantly reduce the human capital of children. Moreover, as fertility effects are stronger for low-income households, their children are especially affected by the decrease in human capital, generating an increase in the intergenerational persistence of education.[30] Overall tax benefits explains around 14% of the fertility rate in the calibrated economy and almost 60% of the differential fertility.[31] The distortion to the relative price between the number of children and children's human capital is quantitatively important. Indeed, tax benefits can explain up to 50% of the differences in human capital between children with low and high educated mothers, and almost one-third of the intergenerational persistence of education.

### 6.1.5 Alternative policies

Appendix C collects the results from some alternative policies. In particular, I first consider the case in which the government balances its budget by distributing a lump-sum transfer to households. The results are very close to the case in which the government lowers taxes to balance its budget. However, as every household enjoys a lump-sum transfer (not as tax discounts that do not affect very low-income families), the differential fertility increases relative to the economy with no benefits and lower taxes. This is simply because the transfer is larger than the tax discount for low-income households, while the opposite is true for high-income ones. I then consider the case in which the government fosters fertility using transfers rather than taxes. In particular, the government gives a fixed transfer per child. This policy makes benefits to be more progressive and unrelated to income. This policy increases fertility by more than tax benefits do, but especially among the low-income households. In turns, this widens, even more, the differences in both fertility and children's human capital. As before, the reasons is that the transfer is larger than the tax benefits for low-income families and smaller for high-income ones.

## 6.2 Subsidies to education

Child-related tax benefits are effective at fostering fertility. However, they are so at the expense of lowering children's human capital. As tax benefits have stronger effects on low-income families, they generate an increase in the gap of initial conditions between children with low and high educated mothers. One question arises in light of these results: Is there a policy that effectively increases fertility without affecting intergenerational mobility? In this section, I test the implications of replacing tax benefits with subsidies to parental expenses in children's human capital. As opposed to tax benefits, that subsidize the cost of children *directly*, subsidies to parental expenditures in children's education lower the cost of having children through a reduction in the cost of providing them with human capital.

Assume that the government pays $\tau$ per unit of the final good spent on children's human capital.

[30] These heterogeneous effects are in line with the idea that the strength of the quantity-quality trade-off is higher for low-income families, as found by Juhn et al. (2015) find in NLSY data.

[31] In the calibrated economy the completed fertility rate is 2.11, while in the absence of tax benefits, this number reduces to 1.81. Thus, a fraction $(2.11 - 1.81)/2.11 = 0.142$ is explained by tax benefits.

**Table 10:** Education subsidies vs. tax benefits

| | (1) No Benefits | (2) Tax Benefits | (3) Education subsidies |
|---|---|---|---|
| Wage, low educated | 11.51 | 10.00 | 10.60 |
| Wage, high educated | 13.76 | 12.85 | 12.58 |
| Interest rate ($\times$100) | 3.13 | 3.50 | 3.59 |
| Social security tax ($\times$100) | 2.93 | 1.51 | 1.63 |
| Average tax rate ($\times$100) | 8.03 | 9.47 | 12.23 |
| Completed fertility | 1.81 | 2.11 | 2.01 |
| Fertility of mothers | 2.08 | 2.32 | 2.11 |
| Share of mothers | 0.87 | 0.91 | 0.95 |
| Differential fertility | -0.12 | -0.32 | -0.10 |
| Human capital at independence | 6.11 | 5.07 | 6.30 |
| Differential human capital at independence | 1.05 | 1.51 | 1.06 |
| College graduation | 0.37 | 0.28 | 0.38 |
| Interg. persistence of education | 0.11 | 0.15 | 0.10 |

Notes: The first column refers to an economy in which there are no tax benefits and the government introduces a tax discount to balance its budget (thus, this is the solution to the experiment presented in section 6.1) The second column refers to the baseline economy resulting from the calibration exercise. The last column refers to an economy in which tax benefits are replaced with subsidies to children's education expenses.

In this case, the investment function becomes:

$$\mathcal{I}(m,t,n) \;=\; A_{\mathcal{I}}\left[\varsigma\left(\frac{m(1+\tau)}{n^{\xi_1}}\right)^{\gamma}+(1-\varsigma)\left(\frac{t}{n^{\xi_2}}\right)^{\gamma}\right]^{\frac{1}{\gamma}}, \tag{24}$$

where $\tau$ is the relevant policy parameter, defined as independent of family income and the number of children they have. The policy is assumed to be revenue neutral, so the value of $\tau$ is such that this program is of equal aggregate size as the tax benefits program. Results are collected in table 10. In what follows, I take the economy without benefits as the starting point (the solution to the experiment presented in section 6.1) and consider tax benefits and education subsidies as alternative policies.

### 6.2.1 Fertility

As tax benefits, education subsidies are effective at fostering fertility, that increases by 11%. This increase is mainly explained by the increase in the share of families that decide to have children. In particular, the share of mothers grows by 8 p.p. relative to an economy with no benefits, doubling the effect of tax benefits. This suggests that the cost of providing children with human capital is crucial to understand the extensive margin of fertility. Fertility among mothers increases slightly, by just 1.5%. Overall, education subsidies are also an effective policy if the government wants to increase fertility, although not as much as using tax benefits. Note, however, that the aggregate size of the education subsidy is limited by the assumption that the policy should have the same aggregate size as the tax benefits program currently implemented in the US.

Fertility effects of education subsidies are relatively stronger among low-income parents. However, these fertility effects are much more similar than with tax benefits. While tax benefits generate an increase in completed fertility of 20% and 7% among low and high educated mothers, education subsidies generate an increase in fertility of 11% and 10% respectively. As a result, the difference in completed fertility between high and low educated mothers grows by much less than in the tax benefits case. This is due to a larger increase in the share of high-educated mothers, that goes from 0.86 in the economy without any benefit to 0.94 when education subsidies are introduced. Indeed, fertility among high-educated mothers is virtually unchanged at 2.06 children per woman.

### 6.2.2 Children's human capital

The most interesting result from this policy is that it generates an increase in fertility but, contrary to what happens with tax benefits, this increase in fertility does not come at the expense of lowering children's human capital. If the government uses education subsidies instead, human capital of children when they move out from parental home increases by 4%. This increase in human capital is mainly due to an increase in money investments made by both parents and the government. Parents invest around 39% of their total expenditures in children's human capital, 3p.p. more than in an economy without tax benefits. In absolute terms, this level of money investments is lower than in the economy without any benefit because average household income falls by 8%. However, the subsidy introduced by the government compensates for this loss. On average, parents invest 3.31 units of goods in their children's human capital, and the government provides an 18% of that amount, yielding a total money input of 3.89, slightly larger than in the economy without tax benefits.

The increase in human capital of children is very similar for those with high and low educated mothers, which in turn makes the differential human capital to be roughly unchanged. In particular, human capital at independence grow by 3% for children with low educated mothers and by 2.7% for those with high-educated mothers. Thus, education subsidies not only avoid the fall in human capital associated with tax benefits, but they also prevent differences in human capital by maternal education to grow when the government wants to foster fertility.

### 6.2.3 Education

The increase in human capital is small, and so is the increase in college graduation rates, that goes from 0.37 to 0.38. Although this effect is small, education subsidies not only do not reduce the share of high-educated individuals, as tax benefits do, but slightly increase it. Despite the fact that differences in human capital at independence are unchanged relative to an economy without child benefits, the intergenerational persistence of education falls by 7% relative to an economy without benefits. This is because returns to human capital are positive but decreasing. Thus, an increase in human capital for children with high-educated mothers, who already had a high level of human capital to start with, translates into a lower increase in college graduation. In particular, the share of children with low educated mothers that attend college grows by 28%, while that of children with high-educated ones grows by only 5.7%. Overall, children with high-educated mothers are 31% more likely to go to college than children with low educated mothers, while this number is 66% in the economy tax benefits and 34% in the economy without any benefit.

### 6.2.4 Discussion

The main conclusion for this experiment is that education subsidies are also effective at fostering fertility. Moreover, they do so without damaging (even improving) intergenerational mobility, as measured by the differential level of human capital at independence or the intergenerational persistence of education. Thus, this policy brakes the trade-off between fostering fertility and increasing children's human capital that is present when using tax benefits. This result is also important for the growing literature on the effects of public interventions on early childhood.[32] Papers in this literature typically assume that fertility is constant, and thus, they may be overestimating the effects of public subsidies to education, as they do not take the fertility effects of such policies into account.

# 7 Conclusions

This paper quantifies the fertility and inequality implications of child-related tax benefits in the US. I do so using a general equilibrium life-cycle model with overlapping generations of married households making consumption, savings and labor supply choices, augmented with endogenous fertility decisions and parental investments in children's human capital. The model is able to generate the negative income elasticity of fertility and delivers fertility and human capital profiles consistent with the prediction of the quantity-quality trade-off. I calibrate the model with US data to match several moments in terms of fertility and children's human capital, and show that the model is consistent with empirical findings on the effects of fiscal policy on fertility.[33]

The main result is that tax benefits are effective at fostering fertility, but they are so at the expense of lowering the human capital with which children become independent. In particular, tax benefits increase fertility by 16%, from 1.81 children per female to 2.11 children. In other words, tax benefits account for around 14% of the overall fertility rate in the baseline economy. At the same time, children's human capital at independence is reduced by 17% when tax benefits are introduced, generating a fall

[32] See for example Lee and Seshadri (2018) or Daruich (2018).

[33] In particular, I show that the model delivers an estimated fertility effect from introducing the "baby-check" policy, as the one introduced in Spain in 2007, very similar to the one estimated by González (2013).

in the share of high-educated individuals from 0.37 to 0.28. I also find that tax benefits affect relatively more to low-income households, as thus, they increase substantially the fertility differentials between high and low educated females. As a consequence, the gap in human capital between children with high and low educated mothers also increases. When tax benefits are introduced the human capital at independence of children with low educated mothers decreases by 20%, while that of children with high-educated mothers decrease by just 9%. These changes imply that tax benefits explain up to 50% of the differences in human capital by maternal education. As a result, tax benefits increase the intergenerational persistence of education, measured as the slope in the regression of one's education on his/her parent's education. In particular, the intergenerational persistence of education grows from 0.11 in the economy without tax benefits to 0.15 when tax benefits are introduced.

This paper also quantifies the effects of using subsidies to education, instead of the tax benefits program currently implemented in the US. This experiment is motivated by the fact that tax benefits increase fertility, but damage intergenerational mobility, as measured by differential human capital or the intergenerational persistence of education. By subsidizing education, the government can generate a fall in the implicit cost of having children by lowering the cost of providing these children with human capital. Indeed, the model shows that education subsidies do increase fertility, although they are not as effective as tax benefits. In particular, education subsidies achieve 65% of the increase in fertility generated by tax benefits. However, as opposed to tax benefits, education subsidies reduce the differentials in fertility choices of households, while keeping roughly constant the differential human capital. Moreover, the intergenerational persistence of education reduces by 7% relative to an economy with no benefits, and by 34% relative to an economy with tax benefits.

The results presented in this paper highlights that governments should pay attention to the effects that pronatalist policies may have on intergenerational mobility. The design of these policies should consider the differential effects these policies may have on low and high-income households, as well as the implications of the quantity-quality trade-off. I also show that one way of fostering fertility without damaging intergenerational mobility is to subsidize parental investments in children's education, which constitutes one of the main sources of cost from having children.

This paper focuses on the effects of pronatalist policies on fertility and parental investments. The next natural step would be to study how these effects translate into inequality latter in life. Doing so would require two extensions to the model presented here. First, one would need to use a much richer income process. This paper assumes a simplified process because of computational constraints. A more parsimonious modeling of the income process would thus require to simplify some other elements of my model. A second extension would be to allow child's skills to affect their income. In my model, child's skills only affect the education choice. Once children decide whether to go to college, skills play no role. Ideally, one would like to replicate the findings in Chetty et al. (2014), and study how much of the intergenerational persistence in earnings is explained by tax benefits. I leave this for future research.

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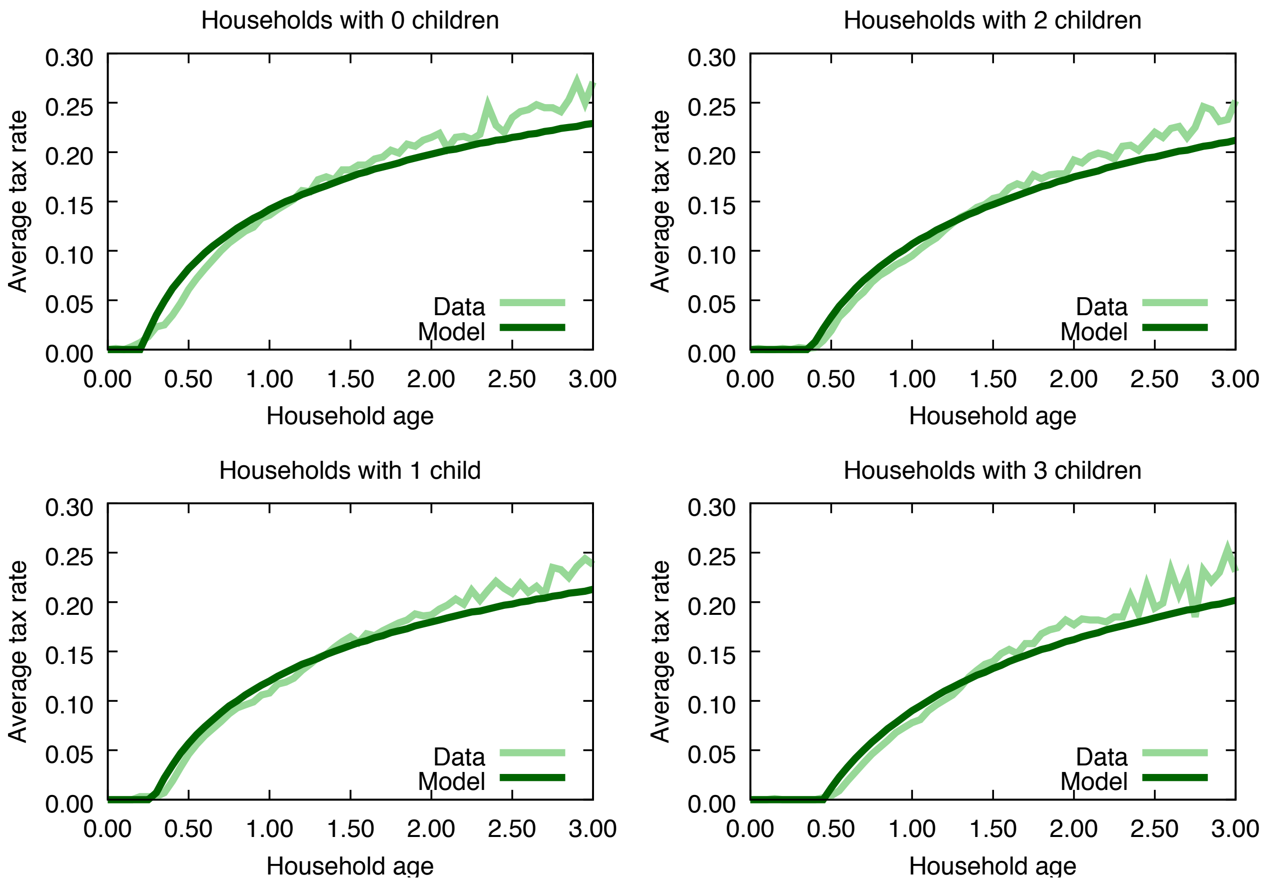
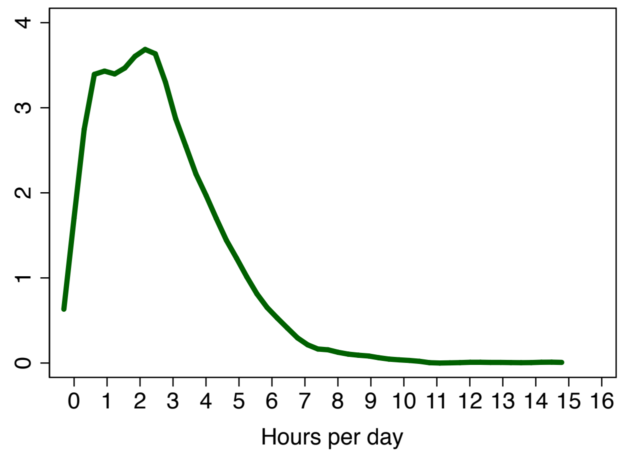
# A Figures

**Figure A.1:** Estimation of tax function - Model fit



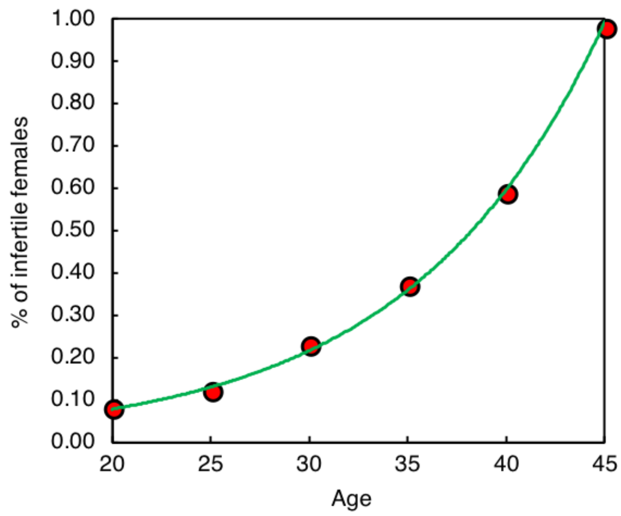

*Notes*: Light lines are data average for the different normalized income intervals, and dark lines are the estimated tax functions as shown in table 2.

**Figure A.2:** Distribution of time investments



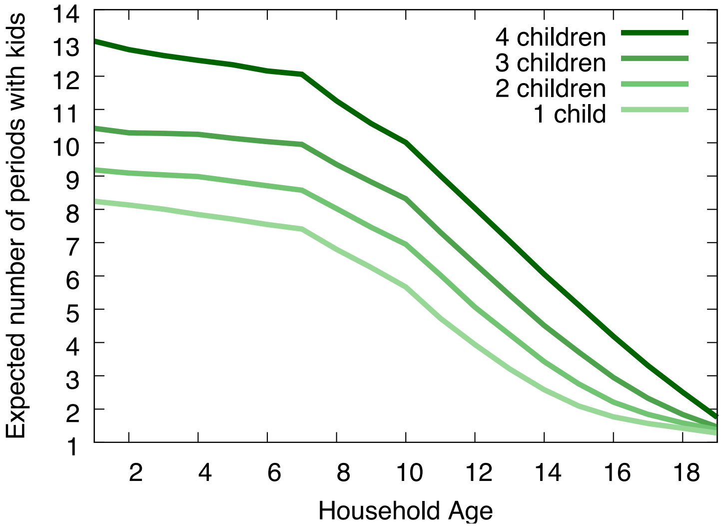

Notes: Only observations of children with positive time investments are considered. See main text for more details.

**Figure A.3:** Fertility risk




*Notes*: Red dots are the share of infertile females at different ages, taken from Sommer (2016). The green line are the fitted values of $1 - p_0(1, j)$.

**Figure A.4:** Average number of periods with children, by number of children and age




*Notes*: Lines represent the average number of periods with children at home for households of different age and number of children. The averages are computed over 10,000 simulations using the child ageing probabilities reported in table 5.

# B Solution algorithm

This section briefly describes the solution algorithm, first of the problem of a particular household, and then for the equilibrium. Solving the model is computationally very costly, both because of the size of the state space, and because of the large number of choices households make, most of which are continuous. Moreover, the number of choices depends on the state (i.e. household without children do not make investment choices), and the presence of discrete state variables makes the value function not differentiable, which further complicates the solution.

## B.1 Solving the household problem

In the model, households make consumption, savings, labor supply, fertility, investments, and transfer choices. Depending on the state, some of these choices are restricted to be zero, but some households need to make up to 8 choices, 7 of which are continuous (all except for the pregnancy choice). Abstracting from the consumption (which can be computed from making the budget constraint to hold with equality) and pregnancy choices, I define the choice vector as:

$$x = (a', l_m, l_f, t, m, b) \in \mathcal{X}(s) \tag{B.1}$$

where $s = (e_m, e_f, z_m, z_f, a, n, q, n_0, n_I)$ is the state vector of the household. These 6 choice variables not only are continuous but also differ in their bounds. Moreover, the value of some choices affect the bounds of others (for example, the choice of $l_m$ defines total income, and thus, affects the bounds of savings, good investments, and transfers). Because of this, solving for the optimal choice by nesting one-dimensional problems, apart from inefficient, makes the solution quite unfeasible. This paper proposes an alternative solution method, based on maximizing the value function with respect to a vector of normalized variables using a derivative-free algorithm.

Let's $\tilde{x} \in \mathbb{U}^6$ be a six-dimensional vector whose elements are all between 0 and 1. Lets also $\mathcal{U}(\cdot, s) : \mathbb{U}^6 \to \mathcal{X}(s)$ be a function mapping $\tilde{x}$ onto $x$ for a given household with state $s$. Defining the normalized vector as $\tilde{x} = (x_1, x_2, ..., x_6)$, this mapping is given by:

$$\begin{array}{rcllll} t &=& x_1 & \text{if } n' > 0, & t = 0 & \text{otherwise} \\ l_m &=& x_2 \times (1 - \alpha_m t) & \text{if } j \leq J_R, & l_f = 0 & \text{otherwise} \\ l_f &=& x_3 \times (1 - \alpha_f t) & \text{if } j \leq J_R, & l_m = 0 & \text{otherwise} \\ a' &=& x_4 \times Y(s, l_m, l_f) & \text{if } j < J, & a' = 0 & \text{otherwise} \\ m &=& x_5 \times (Y(s, l_m, l_f) - a') & \text{if } n' > 0, & m = 0 & \text{otherwise} \\ b &=& x_6 \times (Y(s, l_m, l_f) - a' - m) & \text{if } n_I = 1, & b = 0 & \text{otherwise} \end{array}$$

where $Y(s, l_m, l_f) = y+(1+r)a-T(y, n')-\tau_{ss}y$ is the total disposable income for a household with state $x$ and labor supply choices of $l_m$ and $l_f$, and consumption is given by $c = \Psi(n)^{-1}(Y(x, l_m, l_f) - a' - m - b)$. These functions simply say that the choice of time investment is left unchanged, labor supply choices are defined as a share of disposable time, savings is a defined as a share of total disposable income, good investments as a share of total disposable income minus savings, and transfers as a share of disposable income after subtracting savings and goods investment. Finally, consumption is equal to the remaining disposable income. Note that the function $\mathcal{U}(s, \tilde{x})$ not only transforms vector $\tilde{s}$ into $s$, but it also embodies equations (10)-(14).

I use this transformation to maximize household utility. Let $\tilde{V}(s, x)$ be the value of a household with state $s$ and choices $x$. Then, the algorithm solves:

$$x^* = \mathcal{U}(s, \tilde{x}^*), \qquad \text{with} \quad \tilde{x}^* = \arg\max_{\tilde{x}} \; \tilde{V}(s, \mathcal{U}(s, \tilde{x})) \tag{B.2}$$

where

$$\begin{aligned} \tilde{V}(s, x) \quad = \quad & U_m(c, l_m, t) + U_f(c, l_f, t) + U_k(n', q', b) + \\ & + \beta \mathbb{E}_j \left[ \max \left\{ V(s'|n'_0 = 0), p_0(j+1) V(s'|n'_0 = 1) + (1 - p_0(j+1)) V(s'|n'_0 = 0) \right\} \right], \end{aligned}$$

with $p_0(j) = 0$ for any $j > J_F$. Note that the max operator in the last term of this equation represents the pregnancy choice. I solve this non-linear problem using a Nelson-Melder algorithm. This method is robust, but is not well suited for constrained problems, as in this case. Thus, I simply maximize $\tilde{V}(s, x) - \Delta \sum_{i=1}^{6} \mathbf{1}\{x_i < 0 \vee x_i > 1\}$. That is: to the original problem I subtract a fixed (large) number, $\Delta$, per element of $\tilde{s}$ that lies outside the unit interval. This modification does not necessarily ensure that the optimal choice is within the unit interval. Because of this, I check that the optimal choices are feasible, and find no cases of unfeasible choices.

This algorithm requires some initial guess for the optimal choice vector. I also solve the model using different initial guesses, and the results fo not change.

## B.2 Solving the equilibrium

The equilibrium of the economy consists in distribution of households over the state space, a set prices (wage rates, interest rates and social security tax rate) and a set of policy function (consumption, savings, labor supply, parental investments, fertility and transfers) such that households maximize their utility, the representative firm maximizes its profits, social security revenues equal benefits paid to the elderly, and the distribution of households over the state space is invariant. In order to find the equilibrium vector of prices, $(\overline{w}, \underline{w}, r, \tau_{ss})$, I proceed as follow:

1. Solve the household problem.

   Using the terminal condition $V(\cdot, J+1) = 0$, I solve the household problem backwards starting with those aged $J$, using the algorithm described in the previous section.

2. Compute $V^0(e_m, e_f, a)$.

   Note that in order to compute $V^0(e_m, e_f, a)$ I just need to solve for the value functions of households aged $J_I$.

3. Find the stationary distribution.

   As in any model with endogenous fertility, the equilibrium can be such that fertility rates fall below replacement rates, making the population size to converge to zero. To avoid this, I simulate cohorts of 10,000 individuals and change the relative size of each cohort, normalizing the size of the youngest cohort to 1, at every iteration. Thus, I always have a population of 21,000 individuals (10,000 by cohort and 21 cohorts), although weights change to reflect the population age composition. The steps to find the equilibrium distribution are the following:

   (a) Initiate the algorithm simulating a cohort of 10,000 individuals drawing their initial conditions from an arbitrary distribution.

   (b) Iterate the distribution one period starting from households aged $J-1$, using the policy functions found in step 1.

   (c) Compute the distribution of initial conditions among old children over all cohorts.

   This is: go over all simulated cohorts, take those households with $n_I$, and compute the distribution of $q$ and $b$.

   (d) Simulate a new young cohort of 10,000 individuals, assigning gender with equal probability.

      i. Assume some initial distribution of assets by gender and education.

ii. Solve the educational choice problem in equation (15) given some distribution of assets by gender and education to compute $M(g, e, a)$.

iii. Check that the resulting distribution of assets by education and gender is equal to the one used in step (ii). If not, update the distribution and go back to (ii) until convergence.

(e) Check convergence. If not converged, go back to (b) until convergence.

4. Check first order conditions of the firm and the social security budget. If they do not hold, updated the vector of prices and go back to 1 until convergence.

I find the equilibrium vector of prices using a Newton-based method and numerical differentiation. This is particularly convenient. First, because this method provides a fast convergence towards the optimal prices, and also because it allows us to solve for the four *prices* at once, rather than nesting four different problems.

# C Alternative policies

I now turn into the analysis of three alternative policies. I first explore the effects of adjusting the government's budget through lump-sum transfers, rather than using lump-sum transfers. Then, I study the effects of using transfers, rather than taxes, to subsidize children. Results from these exercises are collected in table C.1.

**Table C.1:** Alternative policies

| | Tax Benefits | No Benefits (taxes) | No Benefits (transfers) | Transfer per child |
|---|---|---|---|---|
| Completed fertility | 2.11 | 1.81 | 1.83 | 2.19 |
| Fertility of mothers | 2.32 | 2.08 | 2.08 | 2.41 |
| Share of mothers | 0.91 | 0.87 | 0.88 | 0.91 |
| Differential fertility | -0.32 | -0.12 | -0.13 | -0.57 |
| Human capital at independence | 5.07 | 6.11 | 5.92 | 4.83 |
| Differential human capital | 1.51 | 1.05 | 1.05 | 1.67 |
| College graduation rate | 0.28 | 0.37 | 0.34 | 0.26 |
| Inter. Persistence of education | 0.15 | 0.11 | 0.11 | 0.18 |

Notes: The second column corresponds to the general equilibrium solution presented in section 6.1. The third to the solution adjusting government budget through lump-sum transfers instead of by lowering taxes. The last column refers to an economy in which child benefits are given in the form of a per-child transfer.

## C.1 Adjusting government's budget through lump-sum transfers

In this section, I eliminate child-related benefits and adjust government budget by distributing back the extra revenue in the form a lump-sum transfer. Thus, household income, $Y$, is given by:

$$Y = y - t(y,0)y - \tau_{ss}y + tr_0, \tag{C.3}$$

where $tr_0$ is positive. A value of $tr_0 = 0.51$ balances government's budget (around 4% of average income). The results from this experiment are collected in column 3 of table C.1. There are two main differences with the economy in which the government balances its budget by lowering taxes (column 2 of table C.1). First, average taxes are larger so returns to work and education will be smaller than in an economy in which the government's balances its budget by lowering taxes. Second, this lump-sum transfer is received by every household, independently of their income. I compare this economy to an economy where the government balances its budget by lowering taxes as two alternative ways of eliminating tax benefits.

Completed fertility falls relative to an economy with tax benefits in approximately the same amount as when balancing the government's budget by lowering taxes. I find similar results when differentiating by maternal education. This economy yields a level of differential fertility that is very similar to the economy in which taxes are lower. The effects on children's human capital are slightly more pronounced. In particular, the average human capital with which children become independent is around 3% lower now that it is in the economy in which the government lowers taxes. This larger fall in mainly due to lower parental investments, especially in terms of money, that falls by 5%.

Children become independent with lower human capital, and returns to education are lower (because of higher taxes). As a result, the share of high-educated individuals falls by 9% relative to the economy with lower taxes. This fall is slightly more pronounced among children of low educated mothers. Still, the intergenerational persistence of educations decreases by 2%. The education choice is affected by two elements. On the one hand, the utility cost of going to college, which is decreasing in the child's human capital. On the other hand, the difference in utility between a low and a high-educated individual. Since differences in human capital are very similar, but the relative wage is larger (due to a lower increase in college graduates), the utility cost of going to college is relatively less important in the decision, and thus, the intergenerational persistence of education falls relative to an economy in which the government balances its budget by lowering taxes.

## C.2 Child benefits through transfers

In this section, I explore the effects of using transfers to subsidize children. In particular, taxes are fixed at the level of a childless family, and the government distributes a fixed amount of resources per kid. In particular, household income $Y$ is given by:

$$Y \;=\; y - t(y,0)y - \tau_{ss}y + tr_n n, \tag{C.4}$$

where $tr_n$ is the amount of the transfer per kid paid by the government. The transfer that balances the government's budget is $tr_n = 0.12$ (around 1% of average household income). The results from this experiment are collected in column 4 of table C.1. I compare this economy with one in which the government implements tax benefits for families with children (column 1 in table C.1). There are two main differences between these two economies. First, child benefits are completely independent of income. Second, every family enjoys benefits, even the very poor. Low-income families did not enjoy any —or enjoy partial— child benefit when they are defined as tax benefits since the tax rate is forced to be nonnegative. This is no longer true in this economy.

Fertility in this new economy grows by almost 4%, which is entirely due to an increase in the fertility of mothers. This aggregate effect, however, combines a reduction in the fertility of high-educated mothers (by 5%) and an increase of low educated ones (by 7%). This is because the size of the transfer is larger than the tax discount enjoyed by low-income households but smaller than that enjoyed by high-income ones. Indeed, the transfer is not enough to compensate for the cost of childbirth for high-income families, and the share of high-educated mother falls by 4 p.p.

When using transfers instead of taxes to subsidize the cost of children, children's human capital at independence falls by 4.7%. If we differentiate by maternal education, we find that children of low educated mothers are those with a larger reduction in human capital: 4% versus the 1% fall for children with high-educated mothers. This is because, as opposed to tax benefits, very low-income households receive these transfers which induce them to increase the number of children they have. As they are the most constrained individuals, the human capital of their children falls comparatively more than for other households. The decrease in human capital generates a fall in the share of high-educated individuals from 28% in the economy with tax benefits, to 26%. Overall, the intergenerational persistence of education increases by in 3 p.p., from 0.15 in the baseline economy to 0.18. This increase is due to two effects. In the one hand, the larger decrease in human capital for children with low educated mothers increases the difference in effort costs faced by them and children of high-educated mothers. On the other, the transfers are independent of income (not as tax benefits), and thus the differences in utility from going to college and staying as low-educated drop. As a result, the effort cost becomes relatively more important when deciding on education, and differences in human capital translate into a higher intergenerational persistence of education.

# D More results

| | Tax benefits (Baseline) | No benefits (taxes) | (transfer) | Education subsidies | Transfer per child |
|---|---|---|---|---|---|
| Tax discount (x100) | – | 5.030 | – | – | – |
| Lump-sum transfer | – | – | 0.510 | – | – |
| Subsidy (% of $m$) | – | – | – | 0.177 | – |
| Transfer per child | – | – | – | – | 0.122 |
| Wage, low educated | 10.00 | 11.51 | 11.45 | 10.60 | 9.754 |
| Wage, high educated | 12.85 | 13.76 | 13.82 | 12.58 | 12.75 |
| Relative Wage | 1.285 | 1.195 | 1.208 | 1.186 | 1.308 |
| Interest rate (x100) | 3.500 | 3.134 | 3.223 | 3.586 | 3.540 |
| Social security tax (x100) | 1.514 | 1.932 | 1.947 | 1.625 | 1.462 |
| Completed Fertility | 2.110 | 1.815 | 1.834 | 2.006 | 2.191 |
| Low educated female | 2.214 | 1.863 | 1.882 | 2.048 | 2.369 |
| High educated female | 1.896 | 1.744 | 1.757 | 1.946 | 1.804 |
| Completed Fertility ($n > 0$) | 2.324 | 2.075 | 2.081 | 2.112 | 2.412 |
| Low educated female | 2.408 | 2.095 | 2.100 | 2.143 | 2.520 |
| High educated female | 2.145 | 2.044 | 2.051 | 2.067 | 2.150 |
| Share of mothers | 0.908 | 0.875 | 0.881 | 0.950 | 0.908 |
| Low educated female | 0.920 | 0.889 | 0.896 | 0.956 | 0.940 |
| High educated female | 0.884 | 0.853 | 0.857 | 0.942 | 0.839 |
| Human capital at independence | 5.066 | 6.111 | 5.920 | 6.299 | 4.827 |
| Low educated mother | 4.614 | 5.706 | 5.541 | 5.877 | 4.393 |
| High educated mother | 6.121 | 6.753 | 6.594 | 6.934 | 6.060 |
| Time investments | 0.206 | 0.228 | 0.227 | 0.229 | 0.202 |
| Low educated mother | 0.197 | 0.220 | 0.219 | 0.220 | 0.193 |
| High educated mother | 0.224 | 0.241 | 0.239 | 0.240 | 0.223 |
| Money investments | 3.051 | 3.827 | 3.619 | 3.309 | 2.897 |
| Low educated mother | 2.717 | 3.430 | 3.255 | 2.960 | 2.569 |
| High educated mother | 3.755 | 4.442 | 4.222 | 3.800 | 3.700 |
| Share of high educated | 0.281 | 0.374 | 0.340 | 0.380 | 0.260 |
| Low educated mother | 0.234 | 0.331 | 0.301 | 0.338 | 0.214 |
| High educated mother | 0.389 | 0.443 | 0.411 | 0.442 | 0.389 |
| Inter. Persistence of education | 0.154 | 0.112 | 0.110 | 0.104 | 0.176 |
| Male labor supply | 0.358 | 0.355 | 0.343 | 0.362 | 0.355 |
| Low educated male | 0.342 | 0.338 | 0.326 | 0.346 | 0.339 |
| High educated male | 0.389 | 0.380 | 0.371 | 0.384 | 0.390 |
| Female labor supply | 0.240 | 0.241 | 0.229 | 0.240 | 0.237 |
| Low educated mother | 0.216 | 0.217 | 0.205 | 0.217 | 0.211 |
| High educated mother | 0.287 | 0.277 | 0.267 | 0.271 | 0.294 |
| Maternal labor supply | 0.187 | 0.186 | 0.177 | 0.196 | 0.173 |
| Low educated mother | 0.163 | 0.159 | 0.152 | 0.168 | 0.150 |
| High educated mother | 0.238 | 0.227 | 0.219 | 0.236 | 0.229 |

Notes: Column 1 ("Baseline") contains the results from simulating the economy with child-related tax benefits as resulting from the calibration exercise. Column 2 ("No benefits (taxes)") contains the results from simulating an economy with no benefits and in which the government balances its budget by lowering taxes, as found in section 6.1. Column 3 ("No benefits (transfers)") presents the results from simulating an economy with no benefits and in which the government balances its budget by distributing lump-sum transfers, as found in section C.1. Column 4 ("Education subsidies") contains the results from simulating an economy with education subsidies instead of tax benefits, as found in section 6.2. Column 5 ("Transfer per kid") presents the results from simulating an economy in which child benefits are given in the form of a fixed transfer per child, as found in section C.2.