Rethinking the Welfare State

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Abstract

The U.S. spends non trivially on non-medical transfers for its working-age population in a wide range of programs that support low and middle-income households. How valuable are these programs for U.S. households? Are there simpler, welfare-improving ways to transfer resources that are supported by a majority? What are the macroeconomic effects of such alternatives? We answer these questions in an equilibrium, life-cycle model with single and married households who face idiosyncratic productivity risk, in the presence of costly children and potential skill losses of females associated with non-participation. Our findings show that a potential revenue-neutral elimination of the welfare state generates large welfare losses in the aggregate. Yet, most households support eliminating current transfers since losses are concentrated among a small group. We find that a *Universal Basic Income* program does not improve upon the current system. If instead per-person transfers are implemented alongside a proportional tax, a *Negative Income Tax* experiment, there are transfer levels and associated tax rates that improve upon the current system. Providing per-person transfers to all households is quite costly, and reducing tax distortions helps to provide for additional resources to expand redistribution.

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1 Introduction

In this paper, we focus on the set of means-tested government transfers available to households of working age in the United States. These transfers are sizable and cover a wide range of programs and tax credit provisions. We refer to them as the *welfare state* for short. We ask: to what extent households value the current welfare state in the U.S.? Are there simpler, welfare-improving ways to transfer resources that are supported by a majority? What are the macroeconomic effects of switching to such alternatives?

Several observations motivate our work. First, the welfare state is far from insignificant: excluding health-care transfers (Medicaid), spending in all different programs add up to nearly 2.5% of GDP.[1] The rules and details of various programs are routinely discussed as key in affecting labor supply, inequality and well being in different ways. Hence, reforms or expansions of the current scheme are expected to have significant aggregate, distributive and welfare effects. Second, most households are potentially two-earner households.[2] This matters as current transfers depend critically on marital status/gender differences and the presence of children. Furthermore, households with two potential earners can cope with labor market shocks better than single-person households. As a result, social insurance and redistribution policy recommendations for an economy with two (potential) earners are likely to be different than those for a single-earner economy. Lastly, marital status and gender differences are usually not considered in the analysis of tax and transfer policies. In particular, differences by marital status and gender in wage and earnings inequality over the life cycle are typically ignored. In this paper, we fill a void by providing a macroeconomic analysis that considers all these aspects. We do so by developing an equilibrium framework with uninsurable shocks, labor supply decisions in two-earner households, costly children, and a detailed representation of taxes and transfers.

We build an equilibrium life-cycle model suitable for policy analysis with a number of novel features. First, we introduce a rich degree of heterogeneity in our model economy. Individuals differ by skill (i.e., education levels), gender, and marital status. Skilled and

[1] To place this number in international perspective, note that OECD (2019) calculates that income support to working age population as a fraction of GDP was 1.9% in the US. The numbers for several European countries are much higher: Germany (3.5%), France (5.4%), Belgium (7.5%).

[2] More than 60% of the U.S. labor force between ages 25 and 54 is married (Current Population Survey, 2000-2018).

unskilled individuals face distinct wage rates and differ on how fast their skills evolve as they age. In addition, single and married individuals face permanent shocks at birth and uninsurable persistent shocks over their life cycle. Second, we allow for labor-supply decisions of spouses at the extensive and intensive margins. Third, in line with data, we jointly account for the presence of children across married and single households, the timing of their arrival, and the associated childcare costs. In particular, we account for the level and variation of childcare costs over the life cycle as crucial determinants of female labor supply. Finally, we model the dynamic costs and benefits of participation decisions by allowing the labor market skills of females to depreciate due to childbearing disruptions.

Our parameterized model takes into account the different programs that comprise the U.S. welfare state and the progressive income tax system, excluding health-care transfers (i.e. Medicaid and Medicare). Transfers in the model economy consist of three main components. The first is the Earned Income Tax Credit that provides a refundable tax credit to households with earnings. The second component relates to child-related transfers, e.g., the Child Tax Credit and childcare subsidies. The last part consists of the means-tested transfers, which are typically identified with the "welfare" system in the U.S., e.g., Temporary Assistance to Needy Families and Food Stamps. How much transfers households receive from different programs crucially depends on their marital status, earnings, number of children, and childcare expenses, and this dependence motivates our modeling choices. As such, a detailed description of the welfare state is a crucial input in the analysis. Any reform creates winners and losers, and the magnitude of these gains and losses critically depends on who benefits from the current system.

Given the welfare state and the tax system, we parameterize our model using U.S. aggregate and cross-sectional data. Our model economy is in line with how earnings inequality evolves over the life cycle (by gender, skill, and marital status), the levels and life-cycle changes in married females' participation rates, the life-cycle patterns of the gender wage-gap, and the rise in consumption dispersion with age. Altogether, our model economy presents a comprehensive macroeconomic model suitable to address the role and reforms to the welfare state.

Findings We conduct three sets of experiments. First, we consider the hypothetical complete elimination of the welfare state and concomitantly reduce the income taxes for all households to achieve budget balance. This allows us to gauge the aggregate effects of the welfare state, and the valuation of the welfare state vis-a-vis a reduction in the tax burden. Overall, eliminating the welfare state leads to an increase of hours worked and participation rates of married females of about 3% and 4.6%, respectively and an increase in output of about 1.8%. We find that eliminating the welfare state leads to a sharp aggregate welfare loss measured by a consumption compensating variation, of about 2.8% for a newborn individual under the veil of ignorance. Quite interestingly, a substantial majority of newborns support the hypothetical elimination of the welfare state (about 62.1%). This reflects the targeted nature of the current system, which is very valuable to poor households and in particular to poor single mothers with children, while the majority of households either do not benefit from it or do so marginally.

We then introduce two major reforms to the welfare state. First, we replace the entire welfare state with a single transfer per person. We dub this case a *Universal Basic Income*, or UBI for short. We search across steady states for the level of the transfer and the level of taxation that maximize ex-ante welfare (under the veil of ignorance) that keeps the budget balanced. We find that a generous transfer per person of about 2.7% of mean household income (about $2,600 per person or $10,400 for a family of four in 2019 dollars) maximizes the welfare of newborns.[3] Aggregate output is marginally lower in this case; -0.4%. However, even this welfare-maximizing level of transfers leads to an aggregate welfare *loss* of 1.4%. i.e. there is no UBI program that can improve upon the current system. Despite aggregate welfare losses, a move from the current system to a UBI has the majority support among newborns; 58.9% of newborn experience a welfare gain. The UBI is not able to compensate the loss of the current transfers to poor households. But it provides transfers to all households, which generates the majority support. If we introduce a UBI scheme on top of the current welfare state, as most proponents of a UBI advocate, the result is even a sharper welfare loss, with a majority of individuals against such a program. In other words, a UBI scheme is hardly a good idea in welfare terms.

In the second experiment, we replace all transfers and current income taxes with a single transfer per person and a proportional tax rate. We dub this case a *Negative Income Tax*, or NIT for short. This case then combines a drastic transfer reform with a drastic tax reform.

[3] The mean household income in 2019 was about $98,000.

Similarly to the UBI case, we search across steady states for the level of the transfer and the associated tax rate that maximize the ex-ante welfare of newborns and satisfy the budget balance. We find that a generous transfer of about 4% of mean household income (about \$3,900 per person or \$15,600 for a family of four in 2019 dollars) maximizes ex-ante welfare (the gain is 0.03%) and leads to strong majority support among newborns (about 73.5%). If a reform allows NIT transfers to differ between single and married households with more generous payments to singles, the welfare gains are larger (0.6%) and the program still has majority support of newborns (53.7%). All these positive effects on welfare and majority support occur alongside a massive increase in the resources devoted to redistribution, from 2.3% of output in the benchmark economy to about 7% of output under NIT variations.

Then, why a NIT scheme can achieve welfare gains and lead to strong majority support? The upshot is that a larger degree of redistribution is feasible given the smaller tax distortions that ensue with a NIT regime. As tax distortions are reduced with a proportional tax, the size of the aggregate economy grows in alongside the needed tax revenue to finance larger transfers. Therefore, a NIT scheme makes higher degrees of redistribution feasible.

Related Literature Our paper is closely related to the literature that studies the welfare and aggregate effects of taxes and transfers in dynamic, general-equilibrium models with heterogeneous agents. Recent papers in this literature include Guner, Lopez-Daneri and Ventura (2016), Heathcote, Violante and Storesletten (2017, 2021), Badel, Huggett and Luo (2020), Kindermann and Krueger (2020), and Boar and Midrigan (2021). Within this literature, Attanasio, Low, and Sánchez-Marcos (2005), Kaygusuz (2010, 2015), Guner, Kaygusuz and Ventura (2012, 2020), Ortigueira and Siassi (2013), Borella, De Nardi and Yang (2019), Holter, Krueger, and Stepanchuk (2019), and Krueger and Wu (2021), among others, consider environments with two-earner households.[4] Blundell, Pistaferri, and Saporta-Eksten (2016) provide empirical evidence on the importance of family labor supply for consumption smoothing.

The UBI and its close-cousin NIT have a long intellectual history (Moffitt, 2003), and gained support in recent public debate. Van Parijs and Vanderborght (2017) and Hoynes and

[4]See also Aiyagari, Greenwood and Guner (2000) and Regalia and Rios-Rull (2001) for early studies that explicitly model the formation and dissolution of two-person households. Greenwood, Guner and Vandenbroucke (2017) provide a recent review.

Rothstein (2019) provide excellent reviews. Within macro-public-finance literature, Lopez-Daneri (2019) finds that a NIT transfer of about 11% of mean income leads to a large, 2.1%, welfare gain despite sharp output losses. Luduvice (2019) and Conesa, Li and Li (2021) consider replacing current transfers with a UBI, and find that welfare gains are hard to achieve, as we find in this paper. Daruich and Fernandez (2020) study a UBI experiment within an overlapping generations model where the next generation's human capital depends on decisions of parents, and find that UBI is not a good idea when the welfare of future generations is taken into account.

Our analysis differs from these papers on three key aspects. First, we provide novel facts on how inequality along the life cycle changes for individuals and households of different marital status and skill levels and use them to discipline the benchmark economy. Second, the model economy features a comprehensive welfare state, necessary to identify winners and losers in any reform. Finally, the model economy consists of single and married households, and married females who make participation decisions. These features are critical to understanding the implications of any reform to the current transfer system since female labor supply responds significantly to changes in tax-transfer policies, and the current welfare system treats different households (married/single, with and without children) differently.

The paper is organized as follows. In section 2, we describe the different transfer programs and tax credits that constitute our description of the welfare state. In section 3, we document patterns of hours, earnings and consumption over the life cycle of individuals and household in the United States. Section 4 presents the model economy. In section 5 we describe the parameterization and calibration of the benchmark economy. Section 6 discusses the properties of the benchmark economy. In section 7, we present the main findings of our quantitative experiments. Section 8 concludes.

2 Transfers to Households in the United States

Means-tested transfers in the United States encompass a wide range of programs that are administered at the federal or state level. Individuals or households must have incomes or assets below certain thresholds to qualify for these programs. Some of them, such as the refundable portions of the Earned Income Tax Credit (EITC) or the Temporary Assistance for Needy Families (TANF), provide direct cash assistance. Others, such as the Supplemental

Nutrition Assistance Program (SNAP), provide in-kind transfers. Some programs, such as the EITC and the Child Tax Credit (CTC), are part of the federal tax system, while others have separate application processes. We refer to all these transfer and tax-credit schemes as the *welfare state*. We purposefully exclude health-related transfers (e.g. Medicaid) and focus on transfers that accrue to the working-age population.

Means-tested programs play an important role in the economic lives and well-being of low and middle-income families. Using data from the Survey of Income and Program Participation (SIPP) on non-medical means-tested transfers, Guner, Rauh and Ventura (2021) find that more than 50% of households in the bottom 10% of the income distribution receive some kind of transfer at some point in a given year. The numbers for households in the second and third deciles are 37 and 24%, respectively. They also show that these transfers reduce 90-10 and 50-10 income ratios from 12.5 to 9.2 and from 5.3 to 3.9. Along similar lines, Ben-Shalom, Moffitt, and Scholz (2012) calculate that the means-tested programs reduce the number of families below the poverty line from 29% to 13.5%.

In the Online Appendix, we provide a description of the various means-tested programs in the United States, who qualifies, and access to benefits in relation with household's marital status and number of children.[5] We divide these programs into three groups (i) the Earned Income Tax Credit; (ii) child-related transfers, that encompass the Child Tax Credit (CTC), the Child and Dependent Care Tax Credit (CDCTC) and childcare subsidies; and (iii) the amalgam of programs that provide cash or in-kind transfers that are routinely identified as the "welfare system", such as the Temporary Assistance to Needy Families (TANF) and the Supplemental Nutrition Assistance Program (SNAP). We calculate that expenditures in all these programs at all levels amounted to about 2.3% of GDP in 2019.[6]

[5] More extended discussions can be found, among others, in Moffitt (2003b), Guner, Kaygusuz and Guner (2020), and Guner, Rauh, and Ventura (2021).

[6] In 2019, the U.S. Federal government spent 361 billion dollars for non-medical means-tested transfer programs for the working-age population. This is about 8% of total federal budget and correspond to about 1.7% of the U.S. GDP. The total spending, federal and state-level, amounted to about 2.3% of the GDP and is expected to grow as we write. Total spending at all levels is calculated based on information from Rector and Menon (2018).

3 Earnings, Hours and Consumption: Life-Cycle Facts

In this section, we document how hourly wages, labor earnings, hours worked, labor force participation and household consumption, change along the life-cycle for individuals (males and females) and households (married and single). To this end, we use data from the Current Population Survey (CPS) and the Current Expenditure Survey (CEX). The CPS is a monthly survey that is the primary source of labor force statistics (employment, unemployment, the labor force participation, and hours) for the population of the United States. The Annual Social and Economic Supplement, also known as the March Supplement, provides additional information on income. The CEX provides data on expenditures on non-durables and services, income, and demographic characteristics of consumers in the United States.

To better capture the underlying differences across individuals and households, we divide individuals in two groups; *skilled (s)*, or those with at least four years of college education or more, and *unskilled (u)*, with strictly less than college education. Let $m^i_{j,t}$ be any statistic of interest for an age-j individual (or household) at time t, for $i = s, u$. We construct an age profile from repeated cross sections by regressing $m^i_{j,t}$ on a set of age and year dummies. We estimate

$$m_{j,t} = \beta'_j \mathbf{D}^i_j + \beta'_t \mathbf{D}_t + \varepsilon^i_{j,t},$$

where $\mathbf{D}^i_j$ is a set of age dummies and $\mathbf{D}_t$ is a set of time dummies. The age profiles of interest are given by the estimated β_j values.

We use the March Supplement of the CPS from 1980 to 2006 to document how hourly wages, earnings, inequality of hourly wages and earnings, and labor market statistics (hours and participation) change over the life cycle. Our measure of inequality is the variance of logs. The analysis is restricted to household heads and their spouses who are between ages 25 to 60. If a head or a spouse reports positive earnings or hours, we require that they work at least 520 hours in a year. To account for top-coded observations, we fit a Pareto distribution to the right tail, as in Heathcote, Perri and Violante (2010). Finally, we drop observations where the hourly wage rate (calculated as yearly earnings divided by yearly hours) is less than half of the federal minimum wage. Given the sensitivity of variance of logs to observations at the lower tail, we also trim the observations associated with the bottom 0.5% of hourly-wages. These restrictions are standard in the literature – see Heathcote, Perri, and Violante (2010) and Huggett, Ventura and Yaron (2011). We calculate total earnings, hours, and hourly wage rates for each individual in the sample. For households, we sum the head and spouse's earnings and assign the age of the head to the households. We then repeat an equivalent procedure using data from the CEX for consumption. We construct for each household a measure expenditure of non-durables and services, which includes food, clothing, gasoline, household operation, transportation, medical care, recreation, tobacco, and education. The analysis is again based on repeated cross-sections from the CEX between 1980 and 2006.

The key findings that emerge from the analysis are listed below.

1. For males, the variance of log-hourly wages increase non-trivially along the life-cycle as it is well known in the literature; see Figure 1 (left panel). This increase is more pronounced for skilled than for unskilled men. The increase is of nearly 30 log points for skilled men between ages 25-60, versus a corresponding increase of about 15 log points for unskilled men. Figure 1 displays these findings. These patterns largely hold for single vs. married men, and are mirrored when inequality in labor earnings rather on hourly wages is considered.

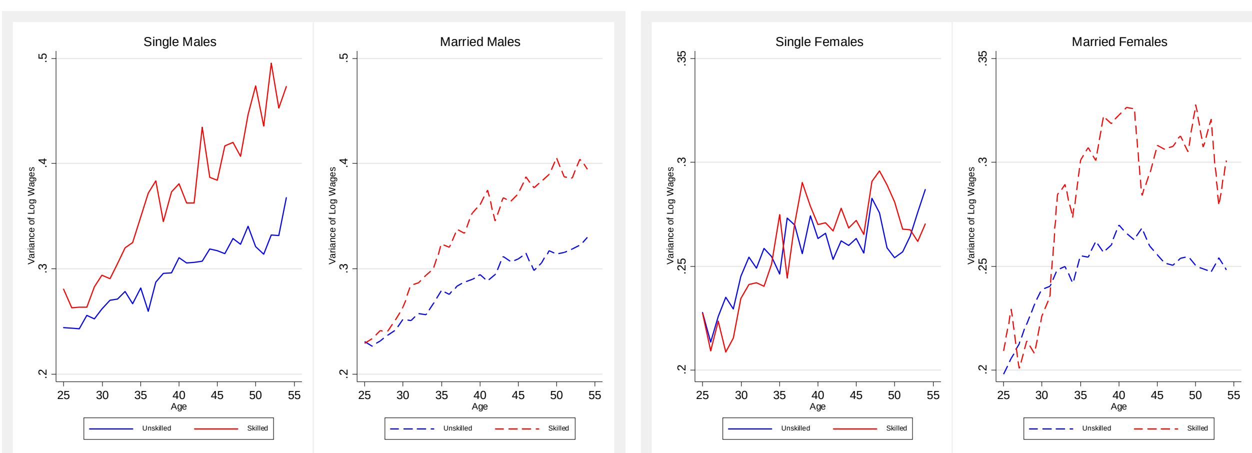

Figure 1 - Variance of Log Wages, Males (left) and Females (right)

2. For females, married or single, we *do not observe* a similar increase. This is largely independent of marital status and skill – see Figure 1 (right panel). The increase in dispersion in hourly wages for unskilled (skilled) females is of about five (ten) log points up to age 40,

and after that, the level of dispersion is roughly *constant*. This is in stark contrast with the increase in dispersion for males discussed in point 1 above.[7]

3. For both married and single households, the variance of log earnings increase non-trivially along the life-cycle, but the level of inequality is *much lower* among married households. At age 25 (45), variance of log earnings is about 0.37 (0.49) for all households, but only 0.28 (0.36) for married households.

4. The wage-gender gap, defined as the ratio of average hourly earnings of females relative to males, increases over the life cycle. These changes are sharper for skilled individuals, with a decline in this ratio from about 90% at age 25 to about 65% at age 45. For unskilled individuals, the corresponding change is smaller and of about 20 percentage points. Figure 2 (left panel) displays these patterns.

5. Over the life cycle, the participation rate of married females first declines and then rises up to ages 45-48, and then declines again. These changes are much more pronounced for married *skilled* females. Figure 2 (right panel) displays these patterns.

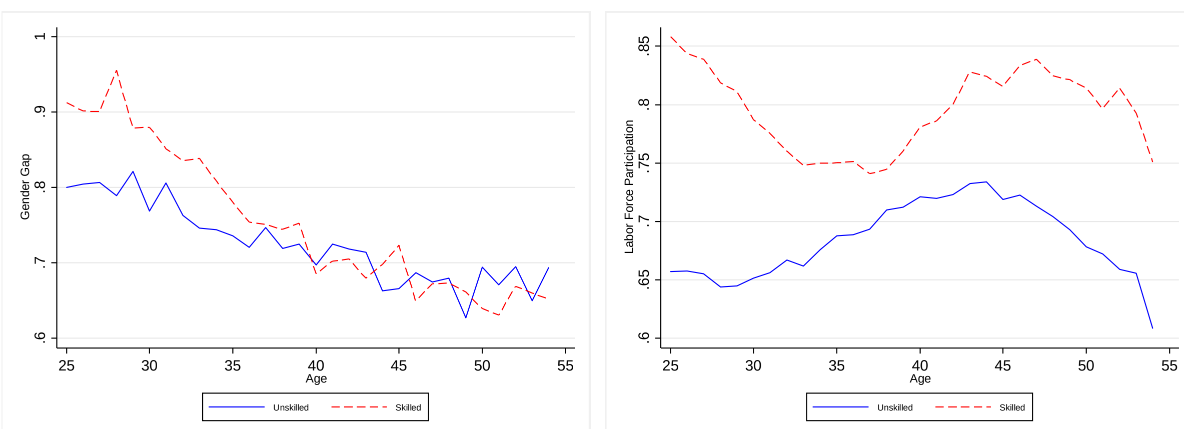

Figure 2 - The Gender Wage Gap (left); LFP of Married Females (right)

6. Conditional on work, there is significant variation in hours of work among married females, measured by the variance of log hours at each age. The level is, nevertheless, roughly constant over the life cycle, at around 0.15; see Figure 3 (left panel).

[7] Bayer and Kuhn (2020) document similar gender differences in life-cycle profiles of earnings inequality in Germany.

7. The correlation between earnings of husbands and wives is low, around 0.15 at ages 40-50, and slightly ∩-shaped early in the life–cycle. Figure 3 (right panel) displays these patterns.

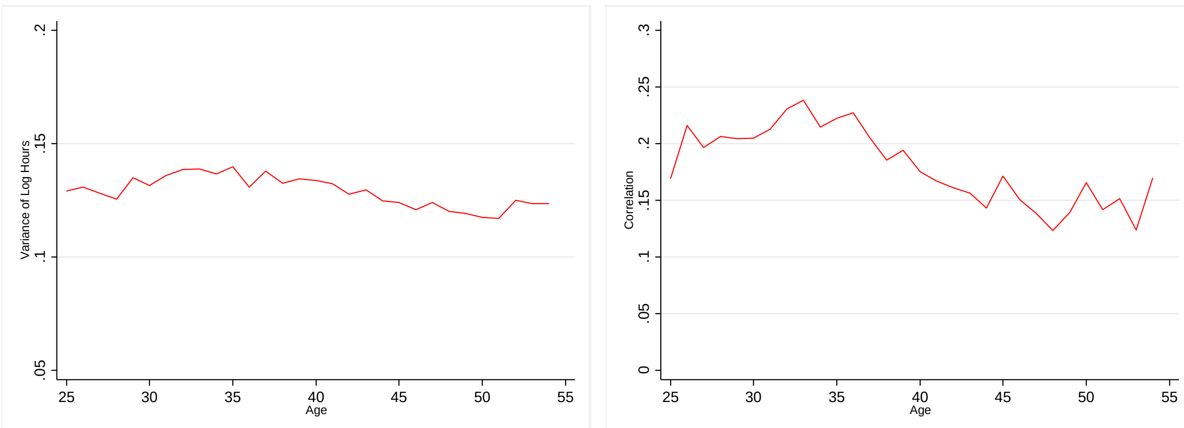

Figure 3 - Var. of Log Hours, Married Females (left); Correlation of Spouse Earnings (right)

8. The variance of log consumption increases along the life-cycle, but *much less than* the increase in the variance of household or individual earnings. The increase peaks at ages 50-55, at about 5 log points. This is a well-known fact by now, and documented in Aguiar and Hurst (2013) and Primiceri and Van Rens (2009), among others.

4 The Economic Environment

We study a stationary life-cycle economy populated by a continuum of males (m) and a continuum of females (f). Let $j \in \{1, 2, ..., J\}$ denote the age of each individual. Each model period is one year, and the first model period corresponds to age 25. Population grows at rate n. The life-cycle of agents is split into two parts. Each agent starts life as a worker and at age J_R, individuals retire and collect pension benefits until they die at age J.

Individuals differ in their marital status. We assume that they are born as either *single* or *married* and their marital status does not change over time. Each individual is also born with a given intrinsic type (education), that defines the rental rate for his/her labor services, and the growth of their labor endowment as they age. Married households are comprised by individuals who are of the same age.

Married households and single females also differ in terms of the number of children attached to them. They can be childless or endowed with a different number of children. These children appear either early or late in the life-cycle exogenously. Children affect the resources available to households for several periods, and this is mitigated partially or fully by government policies targeted to children. Children do not provide any utility.

Individuals also differ in terms of permanent shocks received at the start of life, which is correlated among spouses. Furthermore, each period, individuals experience uninsurable productivity shocks, which affect how much they can earn per hour. We assume that these shocks are persistent. We also assume that shocks that husbands and wives receive are correlated. Hence, heterogeneity among households arises due to different factors; their education level, the permanent and life-cycle shocks of their members, and who is married with whom. These forms of ex-post and ex-ante heterogeneity determine, in conjunction with labor supply and savings decisions, the degree of income, consumption and wealth inequality in the economy.

Production and Markets There is an aggregate firm that operates a constant returns to scale technology. The firm rents capital, skilled and unskilled labor services from households at the rate R, w_s and w_u, respectively. Using K units of capital and L units of the composite labor input, the firm produces

$$F(K, L_g) = K^{\alpha} L^{1-\alpha},$$

units of consumption (investment) goods, where

$$L \equiv \left(\xi L_s^{\rho} + (1-\xi) L_{u,g}^{\rho}\right)^{\frac{1}{\rho}},\ \rho \in (-\infty, 1),$$

where L_s and $L_{u,g}$ stand for the stock of skilled labor, and unskilled labor used in the production of goods, respectively. The elasticity of substitution between labor of different types is constant and given by $\sigma = \frac{1}{1-\rho}$.

We assume that capital depreciates at rate δ_k. Childcare services are provided using unskilled labor services only. Thus, the price of childcare services is the wage rate, w_u. As a result, unskilled labor services available are split between childcare services and in the production of consumption and investment goods, $L_{u,g}$. Households save in the form of a risk-free asset that pays the competitive rate of return $r = R - \delta_k$.

Ex-ante Heterogeneity and Demographics At the start of life, each male is endowed with an exogenous type z that remains constant over his life cycle: $z \in Z = \{u, s\}$. This type of heterogeneity defines whether the agent is *skilled* (s) or *unskilled* (u) that we later map to educational levels in the data. For females, we equivalently have $x \in X = \{u, s\}$.

Let $M_j(x, z)$ denote the fraction of marriages between an age-j, type-x female and an age-j type-z male, and let $\omega_j(z)$ and $\phi_j(x)$ be the fraction of single type-z males and the fraction of single type-x females, respectively. We assume that each cohort is $1 + n$ bigger than the previous one. These demographic patterns are stationary so that age-j agents are a fraction μ_j of the population at any point in time. The weights are normalized to add up to one, and obey the recursion, $\mu_{j+1} = \mu_j/(1 + n)$.

4.1 Labor Efficiency Units

We consider a general structure, where individuals differ at the start of the life cycle in their skills, permanent shocks, as well as uninsurable shocks experienced as they age. These shocks are dependent on the skill of individuals (u, s), their gender (m, f) and their marital status (M, S).

Singles Consider first single males. Their labor endowment (efficiency units) at age j is given by

$$\varpi_m(z, j) \exp(\upsilon^S_{m,z} + \eta^S_{m,z,j}), \quad z \in Z,$$

where the function $\varpi_m(., .)$ summarizes the combined effects of skill and age on the labor endowment. υ is a *permanent* shock and η is a *persistent* shock. We assume that the permanent shock is normally distributed:

$$\upsilon^S_{m,z} \sim N(0, \sigma^2_{\upsilon^S_{m,z}}), \quad z \in Z$$

We assume that for $j > 1$, the persistent shock is governed by a random walk, given by

$$\eta^S_{m,z,j+1} = \eta^S_{m,z,j} + \varepsilon^S_{m,z,j+1}, \quad z \in Z,$$

with $\varepsilon^S_{m,z,j+1} \sim N(0, \sigma^2_{\varepsilon^S_{m,z}})$ representing innovations over time. We furthermore assume that the initial value of η at the start of the life cycle is zero; i.e. $\eta^S_{m,z,1} = 0$, $z \in Z$.

The structure is different for single females, as their efficiency units evolve endogenously, with growth and depreciation rates that depend on intrinsic skills and labor market experience. Intrinsic skills determine their initial human capital: $h_1 = \varpi_f(x, 1)$, $x \in X$. For $j > 1$, we have

$$h' = \mathcal{H}(x, h, l, e) = \exp\left[\ln h + \alpha_x^e \chi(l) - \delta_x (1 - \chi(l))\right], \quad x \in X = \{u, s\}, \tag{1}$$

where e stands for labor market experience and $\chi(.)$ is an indicator function that is 1 if hours worked are positive and zero otherwise. The parameter α_x^e is the experience-skill growth rate and δ_x stands for the depreciation rate. It follows that for a single female of age-j who has human capital h, her realized labor efficiency is given by

$$h \times \exp(\nu_{f,x}^S + \eta_{f,x,j}^S), \quad x \in X$$

The permanent and the persistent shock obey the same representation as for males, with innovation variances that depend on marital status and skill.

Married Couples Married individuals draw permanent shocks at the start of their life cycle that are potentially *correlated*. They also draw values for their persistent shocks which are potentially correlated as well.

The labor endowment (labor efficiency) of a married male is given by

$$\varpi(z, j) \times \exp(\upsilon_{m,z}^M + \eta_{m,z,j}^M), \quad z \in Z.$$

The labor efficiency of a married female is correspondingly given by

$$h \times \exp(\upsilon_{f,x}^M + \eta_{f,x,j}^M), \quad x \in X.$$

where h follows the same law of motion for singles; equation (5).

As earlier, initial conditions are such that $\eta_{m,z,1}^M = 0$ and $\eta_{f,x,1}^M = 0$. For $j > 1$, $\eta_{m,z,j}^M$ and $\eta_{f,x,j}^M$ follow a bivariate process, given by

$$\eta_{m,z,j+1}^M = \eta_{m,z,j}^M + \varepsilon_{m,z,j+1}^M, \quad z \in Z,$$

and

$$\eta^M_{f,x,j+1} = \eta^M_{f,x,j} + \varepsilon^M_{f,x,j+1}, \quad x \in X,$$

with

$$(\varepsilon^M_{m,z,j+1}, \varepsilon^M_{f,x,j+1}) \sim N\left(\begin{array}{c} 0 \\ 0 \end{array}, \begin{array}{cc} \sigma^2_{\varepsilon^M_{m,z}} & \sigma_{\varepsilon_f \varepsilon_m} \\ \sigma_{\varepsilon_f \varepsilon_m} & \sigma^2_{\varepsilon^M_{f,x}} \end{array}\right), \quad z, x \in Z \times X.$$

The values of permanent shocks for married individuals are draws from a bivariate normal distribution as well. That is,

$$(\upsilon^M_{m,z}, \upsilon^M_{f,x}) \sim N\left(\begin{array}{c} 0 \\ 0 \end{array}, \begin{array}{cc} \sigma^2_{\upsilon^M_{m,z}} & \sigma_{\upsilon_f \upsilon_m} \\ \sigma_{\upsilon_f \upsilon_m} & \sigma^2_{\upsilon^M_{f,x}} \end{array}\right), \quad z, x \in Z \times X.$$

Note that we assume that while innovations depend on skills, the covariance structure for both permanent and persistent shocks does not. This parsimonious specification allows us to capture key correlations across married spouses, both at the start as well as in along the middle of the life cycle – see section 6

Labor Earnings We now summarize the notion of labor *earnings* resulting from our choices, taking into account skill prices (w_s and w_u), endowments and labor supply choices – described later. For an age-j single male of type z, earnings are given by

$$\underbrace{w_z}_{\text{wage by skill}} \underbrace{\varpi(z,j)\exp(\nu^S_{m,z} + \eta^S_{m,z,j})}_{\text{labor efficiency}} \underbrace{l_m}_{\text{labor supply}}$$

For a single female of skill $x \in X$ who has human capital h, age j, earnings are given by

$$\underbrace{w_x}_{\text{wage by skill}} \underbrace{h \ \exp(\nu^S_{f,x} + \eta^S_{f,x,j})}_{\text{labor efficiency}} \underbrace{l_f}_{\text{labor supply}}$$

Finally, for a married couple of skill $z, x \in Z \times X$, of age j, when she has h units of human capital, earnings are given by

$$\underbrace{w_x}_{\text{wage by skill}} \underbrace{h\exp(\nu^M_{f,x} + \eta^M_{f,x,j})}_{\text{labor efficiency}} \underbrace{l_f}_{\text{labor supply}} + \underbrace{w_z}_{\text{wage by skill}} \underbrace{\varpi(z,j)\exp(\nu^M_{m,z} + \eta^M_{m,z,j})}_{\text{labor efficiency}} \underbrace{l_m}_{\text{labor supply}}$$

4.2 Children and Childcare Costs

Children are assigned exogenously to married couples and single females at the start of life, depending on the education of parents. Each married couple and single female can be of three types: *without* any children, *early* child bearers, *late* child bearers. We denote this dimension of heterogeneity by $b = \{0, 1, 2\}$.

If $b \neq 0$, children appear deterministically at parents' age $\bar{j}(x, z, b)$ for married households and $\bar{j}(x, b)$ for single females. Married households have $k(x, z)$ children, while single females have $k(x)$ children. For married households, half of the children appear at age $\bar{j}(x, z, b)$ and the other half at age $\bar{j}(x, z, b) + 2$; i.e. children are spaced by two years. It is equivalent for single households: half of the children appear at age $\bar{j}(x, b)$ and the other half at age $\bar{j}(x, b) + 2$. Each child stays with their parents for N model periods.

We assume that if a female with children works, married or single, then the household has to pay for childcare costs. Childcare costs depend on the age of the child, t, and are priced at rate w_u. We assume that children in single female households require $d(x, t)$ units of childcare services per child, $t = 1, 2, ..., N$. Married households require $d(x, z, t)$ units of childcare services per child. Since competitive price of childcare services is the unskilled wage rate w_u, the cost of childcare services per child equals $w_u d(x, t)$ for single females and $w_u d(x, z, t)$ for married households.

4.3 Preferences

The momentary utility function for singles is given by

$$U^S(c, l) = \log(c) - B_i(l)^{1+\frac{1}{\gamma}}, \quad i = m, f$$

where c is consumption, l is time devoted to market work, and γ is the intertemporal elasticity of labor supply (Frisch elasticity). The parameter B_i captures potential gender-driven differences in the disutility of work.

Married households maximize the sum of their members utilities. We assume that when the female member of a married household works, the household incurs a utility cost q. We assume that at the start of their lives married households draw a $q \in Q$, where $Q \subset R_{++}$ is a finite set. These values of q represent the utility costs of joint market work for married couples. For a given household, the initial draw of utility cost depends on the type (education) of the husband. Let $\zeta(q|z)$ denote the probability that the cost of joint work is q, with $\sum_{q\in Q}\zeta(q|z) = 1$. We assume that for married households with children at home, the utility cost q is multiplied by a factor that depends on the age of the youngest child at home, t_{min} and the mother's skill level, $\vartheta_x(t_{\min})$, $x \in X$. This specification captures the idea that joint work becomes more costly with arrival of children, beyond childcare costs, and that this additional cost changes as children grow older.

Formally, if $b \in \{1, 2\}$ and the household age is such that $\bar{j}(x, z, b) \leq j \leq \bar{j}(x, z, b)+N+2$, i.e. children are at home (recall that the first child arrives at $\bar{j}(.)$ and the second one leave at $\bar{j}(.) + N + 2$), then the period utility of a married household is given by

$$U^M(c, l_f, l_m, \theta, q, j) = 2\log(c) - B_m\, l_m^{1+\frac{1}{\gamma}} - \theta B_f l_f^{1+\frac{1}{\gamma}} - \chi\{l_f\}q(1 + \vartheta_x(t_{min})). \tag{2}$$

where $\chi\{.\}$ denote the indicator function.[8] Otherwise, the utility of the married household is given by

$$U^M(c, l_f, l_m, \theta, q) = 2\log(c) - B_m l_m^{1+\frac{1}{\gamma}} - \theta B_f l_f^{1+\frac{1}{\gamma}} - \chi\{l_f\}q. \tag{3}$$

Note that consumption is a public good within the household. The variable θ captures heterogeneity in the disutility of work across married females. We assume that θ is realized at the start of life, and takes two values with equal probability; $\theta \in \{\theta_L, \theta_H\}$. Note also that the parameter $\gamma > 0$, the intertemporal elasticity of labor supply, is common for all individuals; males or females, married or single.

4.4 Taxes and Transfers

There is a government that taxes labor and capital income, and uses tax collections to pay for government consumption, tax credits, transfers to individuals. It also runs a pay-as-you-go social security system, so it collects payroll taxes and pays retirement benefits.

Transfers Households in the model have access to transfers that depend on gender, marital status and household income. Income for tax and transfer purposes is labor plus asset income. For a household with income level I, number of children k, childcare expenses D, the

[8] Note that if x, z and j are known, the age of the youngest child can be readily calculated.

transfers are represented by functions $TR_f^S(I,k,D)$, $TR_m^S(I)$ and $TR^M(I,k,D)$, for a single-female, single-male and married-couple households, respectively. This generic formulation of transfers allows us to capture a host of transfers and tax credit programs in the United States. We describe below how these functions are parameterized in light of data.

Taxation and Social Security The total income tax liabilities of married and single households, before any tax credits, are affected by the presence of children in the household, and are represented by tax functions $T^M(I,k)$ and $T^S(I,k)$, respectively, where k stands for the number of children at the household. These functions are continuous in I, increasing and convex. This representation captures the effective variation in tax liabilities associated to income, marital status and the presence of children in households.

There is a (flat) payroll tax that taxes individual labor incomes, represented by τ_p, to fund social-security transfers. Moreover, each household pays an additional flat capital income tax for the returns from his/her asset holdings, denoted by τ_k. Retired households have access to social security benefits. The social security benefits depend on agents' education types, i.e. initially more productive agents receive larger social security benefits. This allows us to capture in a parsimonious way the positive relation between lifetime earnings and social security transfers, as well as the intra-cohort redistribution built into the system. Let $p_f^S(x)$, $p_m^S(z)$, and $p^M(x,z)$ indicate the level of social security benefits for a single female of type x, a single male of type z and a married retired household of type (x,z), respectively. The social security system has to balance its budget every period.

4.5 Decision Problem

We now present the decision problem for different types of agents in the recursive language. We leave the formal definition of a stationary equilibrium to the Appendix. We focus on single females and married couples, since the problem of single males is rather standard. For ease of notation, the dependence of shocks on type, gender and marital status is suppressed whenever possible. For single females, the individual state is $(a,h,e,x,\upsilon_{f,x}^S,\eta_{f,x}^S,b,j)$, where a stands for asset holdings. For married couples, the state is given by $(a,h,e,x,z,\theta,\upsilon_{m,z}^M,\upsilon_{f,x}^M,\eta_{m,z}^M,\eta_{f,x}^M,q,b,j)$.

Note that the dependency of transfers and taxes on the presence of children in the household is summarized by age (j) and childbearing status (b), in conjunction with x for single females and the pair (x,z) for married couples. The same reasoning applies for childcare costs, or the utility costs of joint participation for married couples when children are present. That is, if we know the intrinsic type of a single female or a married household, the age of parents (j) and fertility type (b), we know the age of each child and the childcare costs. Given parents' types, the half of children appear at parents' age $\bar{j}(.)$ and the other half at $\bar{j}(.)+2$. Then, when their parents are of age j, young and old children at home have ages $j-\bar{j}(.)+1$ and $j-\bar{j}(.)+3$.

For expositional purposes, we collapse the permanent/exogenous characteristics in the household problems in a single vector of state variables. For single females, let $\mathcal{S}_f^S \equiv (x, \upsilon_{f,x}^S, b)$ be the vector of variables that do not change along the life-cycle for single females and single males, respectively. For married households, let $\mathcal{S}^M \equiv (x, z, \theta, \boldsymbol{\upsilon}, q, b)$ be the vector of such states for married households, with $\boldsymbol{\upsilon} = (\upsilon_{f,x}^M, \upsilon_{m,z}^M)$. In similar fashion, for the case of married couples, we summarize the pair of persistent shocks by $\boldsymbol{\eta} \equiv (\eta_{f,x}^M, \eta_{m,z}^M)$. Likewise, for expositional purposes, we denote by $\mathcal{E}_f^S(x, h, \eta_{f,x}^S, \nu, l_f)$ and $\mathcal{E}^M(x, z, h, \boldsymbol{\eta}, \boldsymbol{\nu}, l_m, l_f, j)$, the labor earnings of single females and married couples, respectively, as defined in Section 4.1.

The Problem of a Single Female Household In contrast to a single male, a single female's decisions also depend on her current human capital h, child bearing status b, and labor market experience, e. Given her current state, $(a, h, e, \mathcal{S}_f^S, \eta, j)$ the problem of a single female is

$$V_f^S(a, h, e, \mathcal{S}_f^S, \eta, j) = \max_{a', l}\{U^S(c, l) + \beta \mathbf{E}_{\eta'|\eta} V_f^S(a', h', e', \mathcal{S}_f^S, \eta', j+1)\},$$

subject to

(i) <u>With kids:</u> if $b = \{1, 2\}$, $j \in \{\bar{j}(x,b), \bar{j}(x,b)+1, ..., \bar{j}(x,b)+N+2\}$

$$c + a' = \left\{ \begin{array}{l} a(1 + r(1-\tau_k)) + \mathcal{E}_f^S(x, h, \eta, \nu, l)(1-\tau_p) \\ +TR_f^S(I, \mathcal{K}, D) - T^S(I, \mathcal{K}) - w^u D \chi(l) \end{array} \right. ,$$

where $I = \mathcal{E}_f^S(x, h, \eta, \nu, l) + ra$. $\mathcal{K}$ is the number of children present in the household, either old, born at $\bar{j}(x,b)$, or young, born at $\bar{j}(x,b)+2$. It is given by

$$\mathcal{K} = \frac{k(x,b)}{2}\left[\underbrace{\chi(\bar{j}(x,b) \le j \le \bar{j}(x,b)+N)}_{\text{old children}} + \underbrace{\chi(\bar{j}(x,b)+2 \le j \le \bar{j}(x,b)+2+N)}_{\text{young children}}\right].$$

Meanwhile, D stands for the childcare expenses incurred:

$$
\begin{aligned}
D &= \frac{k(x,b)}{2}\, d(x, j - \bar{j}(x,b) + 1)\chi(\bar{j}(x,b) \leq j \leq N) + \\
&\quad \frac{k(x,b)}{2}\, d(x, j - j(x,b) + 3)\chi(\bar{j}(x,b) + 2 \leq j \leq \bar{j}(x,b) + 2 + N).
\end{aligned}
$$

(ii) <u>Without kids but not retired:</u> if $b = 0$, or $b = \{1, 2\}$ and $j \notin \{\bar{j}(x,b), ..., N + 2\}$, then there are no children at home and

$$
\begin{aligned}
c + a' &= a(1 + r(1 - \tau_k)) + \mathcal{E}_f^S(x, h, \eta, \nu, l)(1 - \tau_p) \\
&\quad + TR_f^S(I, 0, 0) - T^S(I, 0).
\end{aligned}
$$

(iii) <u>Retired:</u> if $j \geq J_R$, then there are no children and

$$c + a' = a(1 + r(1 - \tau_k)) + p_f^S(x) - T^S(ra, 0) + TR_f^S(ra, 0, 0).$$

In addition,

$$h' = \mathcal{H}(x, h, l_f, e) = \exp\left[\ln h + \alpha_e^x \chi(l_f) - \delta^x(1 - \chi(l_f))\right], \tag{4}$$

$$e' = e + \chi(l) \text{ and } l \geq 0,\ a' \geq 0 \text{ (with strict equality if } j = J + 1).$$

The Problem of Married Households Like singles, married couples decide how much to consume, how much to save, and how much to work. They also decide whether the female member of the household should work, talking into account the evolution of her skills, experience and childcare costs. Note that in the formulation below, we make the current utility of married households to depend on (x, z, b, j), as these variables fully determine the age of children present in the household that may affect the disutility of joint market work, $q(1 + \vartheta_x(t_{min}))$ term above. Formally, the problem is given by

$$V^M(a, h, e, \mathcal{S}^M, \boldsymbol{\eta}, j) = \max_{a',\, l_f,\, l_m} \{U^M(c, l_f, l_m, q, x, z, b, j) + \beta \mathbf{E}_{\boldsymbol{\eta}'|\boldsymbol{\eta}} V^M(a', h', e', \mathcal{S}^M, \boldsymbol{\eta}', j + 1)\},$$

subject to

(i) With kids: if $b = \{1, 2\}$, $j \in \{\bar{j}(x, b), ..., N + 2\}$, then

$$c + a' = \left\{ \begin{array}{l} a(1 + r(1 - \tau_k)) + \mathcal{E}^M(x, z, h, \boldsymbol{\eta}, \boldsymbol{\nu}, l_m, l_f, j)(1 - \tau_p) \\ -T^M(I, \mathcal{K}) + TR^M(I, \mathcal{K}, D) - w^u D\chi(l), \end{array} \right\},$$

where $I = \mathcal{E}^M(x, z, h, \boldsymbol{\eta}, \boldsymbol{\nu}, l_m, l_f, j) + ra$.

In this formulation, $\mathbf{E}_{\boldsymbol{\eta}'|\boldsymbol{\eta}}$ now represents the joint expectation over the shocks that husbands and wives face. The number of children present and childcare expenses are now given by

$$\mathcal{K} = \frac{k(x, z, b)}{2} \left[\underbrace{\chi(\bar{j}(x, z, b) \leq j \leq \bar{j}(x, z, b) + N)}_{\text{old children}} + \underbrace{\chi(\bar{j}(x, z, b) + 2 \leq j \leq \bar{j}(x, z, b) + 2 + N)}_{\text{young children}} \right],$$

$$\begin{aligned} D \quad = \quad & \frac{k(x, z, b)}{2} \; d(x, z, j - \bar{j}(x, z, b) + 1)\chi(\bar{j}(x, , z, b) \leq j \leq \bar{j}(x, z, b) + N) + \\ & \frac{k(x, z, b)}{2} \; d(x, z, j - \bar{j}(x, z, b) + 3)\chi(\bar{j}(x, z, b) + 2 \leq j \leq \bar{j}(x, z, b) + 2 + N. \end{aligned}$$

In addition,

$$h' = \mathcal{H}(x, h, l_f, e) = \exp\left[\ln h + \alpha_e^x \chi(l_f) - \delta^x(1 - \chi(l_f))\right], \tag{5}$$

$$e' = e + \chi(l) \text{ and } l_m \geq 0, \;\; l_f \geq 0, a' \geq 0 \text{ (with strict equality if } j = J).$$

The budget constraints when the household is not retired but without any children and when the household is retired, cases (ii) and (iii), are defined accordingly.

4.6 Sources of Inequality in the Model

What are the determinants of inequality at a point in time and over the life cycle across individuals and households in the model? This question is essential to assess the effects of transfer policies.

First, individuals differ in their intrinsic skills and that experience permanent and persistent shocks at birth. Permanent and persistent shocks are common in life-cycle models with heterogeneous individuals. Different from most of the work in the area, differences in skill type at birth determine (i) potentially different growth rates in labor productivity between skilled and unskilled individuals, and (ii) between-group differences as individuals face different rental rates for labor services depending on their skill type. Point (i) implies that our model encompasses a mixture of traditional parameterization of heterogeneity (usually referred to as Representative Income Processes or RIP), with a human capital view of differences of individuals as they age, as emphasized in Guvenen (2009) and Huggett, Ventura and Yaron (2011), among others (Heterogeneous Income Processes or HIP)

The second layer of heterogeneity determining inequality concerns marital status. At birth, some individuals are single, some are married, and married ones are assigned to spouses according to their skill type. Besides, within a given skill pair, permanent and persistent shocks are potentially correlated between spouses. Overall, as in Greenwood et al. (2016) and others, marriage can amplify existing differences between individuals and contribute to propagating shocks over the life cycle.

Finally, differences in individuals by gender, coupled with children's presence, help define the level of gender premia in wages at birth and its evolution over the life cycle. As children appear and women leave the workforce, skill depreciation kicks in, and thus, the gender gap in wage rates grows over time. As children require fewer resources as they age, some women return to work, accumulate skills again and the gender-wage gap moderates its growth. As we describe below in our analysis of the benchmark economy, women's behavior regarding participation over time, in conjunction with uninsurable shocks, determines gender differences in the life-cycle profile of earnings inequality.

5 Parameter Values

This section describes how we select parameter values to compute a stationary equilibrium. We relegate multiple details to the Appendix. Tables A1 and A2 in the Online Appendix summarize our parameter choices.

The model period is one year. Agents start their life at age 25, work for forty years, retire at age 65 ($j = J_R$), and then live until age 80 ($j = J$). The population grows at the annual rate of 1.1%. *Skilled* individuals are those with at least four-year college degree. The marital structure (who is single, who is married and who is married with whom), childbearing status, and the number of children for different types of households are taken directly from the data.

Endowments For males, following the procedure described in Section 2, we construct age profiles of mean hourly wages for each skill group using data from 1980-2006 CPS March Supplement, and set $\varpi_m(z, j)$, $z = u, s$, to these profiles (Figure A1 in the Appendix). For females, we use age-25 wage levels to calibrate their initial human capital levels, $h_1 = \varpi_f(x, 1)$. After age 25, female skills evolve according to equation (5).

We select the parameter α_x^e so that if a type-x female works for one more period, her wage grows exactly at the same rate as a male of the same type with the same experience level (e). Hence, if a female works in every period, her labor market productivity evolves exactly like a male, except for the observed age-25 wage gender gap. Figure A2 in the Appendix shows the calibrated values for the growth factors. For depreciation rates, we select each one so that the model is consistent with the evolution of the wage-gender gap for the first decade of the life cycle (ages 25-35). The resulting values are $\delta_u = 0.025$, and a non-trivially higher value for skilled females, $\delta_s = 0.059$. These values are required to reproduce the faster increase in the wage-gender gap with age for skilled females documented in section 3.[9]

Productivity Shocks There are in total *eighteen* parameters that determine the productivity shocks: eight variances for permanent shocks (by skill, gender, and marital status), eight innovation variances for persistent shocks (again by skill, gender, and marital status, plus two covariances (for permanent shocks and innovations to persistent shocks). Table A2 presents these parameters. For permanent shocks (ν), we match the observed variances of log-wages at age 25 by skill, gender and marital status. To pin down the value of covariance term for married individuals, $\sigma_{\nu^f \nu^m}$, we target the correlation in log-wages among all spouses at age 25. For the variances of innovations to persistent shocks (ε), we target the observed variances of log-wages towards the end of the life cycle (age 54) for each group. For the covariance of innovation in persistent shocks across spouses, $\sigma_{\epsilon^f \epsilon^m}$, we target the correlation of wages between husbands and wives by middle age (ages 40-45). Overall, the variances of innovations for persistent shocks for men are substantially larger than for females, while the corresponding variances for skilled individuals, male or female, are larger than for unskilled ones. Overall, not surprisingly, the innovation variances are smaller than in related

[9]Blundell et al (2016) find similar results for the UK.

estimates, e.g. Heathcote, Storesletten, and Violante (2010) and Huggett et al (2011). This reflects the division of individuals between skilled –who experience faster growth in labor efficiency with experience– and unskilled ones, as well as the distinction of individuals by gender and marital status.

Government To compute the tax functions, i.e. $T^S(I,k)$ and $T^M(I,k)$, we adopt a parametric form for the average tax rate:

$$\tau(I) = 1 - \lambda I^{-\tau},$$

where I (income) is measured in multiples of mean household income and $\tau(I)$ is the average tax rate. The parameter τ determines the progressivity of the tax scheme and λ determines its level. The parameters τ and λ depend on marital status and the number of children, and are estimated from IRS micro data on tax returns.

Transfers, $TR^S_f(I,k,D), TR^S_m(I)$, and $TR^M(I,k,D)$, the main object of this paper, consist of three components. The first component is the Earned Income Tax Credit (EITC). The second part is child-related transfers, which consists of Child Tax Credit (CTC), the Child and Dependent Care Tax Credit (CDCTC), and childcare subsidies. All tax credits are modelled exactly as they appear in the tax code, which were summarized in Section 2. Following the discussion in Guner, Kaygusuz and Ventura (2020), the government covers 75% of the childcare costs for households whose income is below a threshold. We chose the threshold so that the poorest 5% of children receive the subsidy. Details are provided in the Appendix.

The final component is the means-tested transfers. Following Guner, Rauh and Ventura (2021), we use data from the Survey of Income and Program Participation to estimate an effective transfer schedule that relates transfers received by different household types to their income. The welfare payments include the main means-tested "welfare" programs from Section 2. We assume that these functions take the following form

$$W(I) = \begin{cases} \omega_0 \text{ if } I = 0 \\ \max\{0, \omega_1 - \omega_2 I\} \text{ if } I > 0 \end{cases},$$

where ω_0 is the transfers for a household with zero income and ω_2 is the benefits reduction rate. Our estimates show that a single female with two children receives about 12% of mean household income in the economy in terms of welfare transfers (about \$12,000 in 2019).

Transfers decline gradually with income and vanish at around 1.1 times mean income for a single female with two children (about \$108,000 in 2019). A single female with two children and half of mean household income (about \$44,000 in 2019) receives about \$5,800 per year. A married couple with two children who has zero income, gets about \$8,800. Transfers decline to zero, as they do for a single mother, at around 1.1 times the mean income. The details are again in the Appendix.

Figure 4 shows how the total transfers (the sum of these three components) vary by household income in the benchmark economy. Households without any income receive transfers in excess of \$8,000 per year. The transfers decline sharply for household with positive but very low income. After that, transfers bounce back to around \$8,000 and decline smoothly with household income and amount to about \$1,000 for households with 1.5 times the mean household income in the economy.

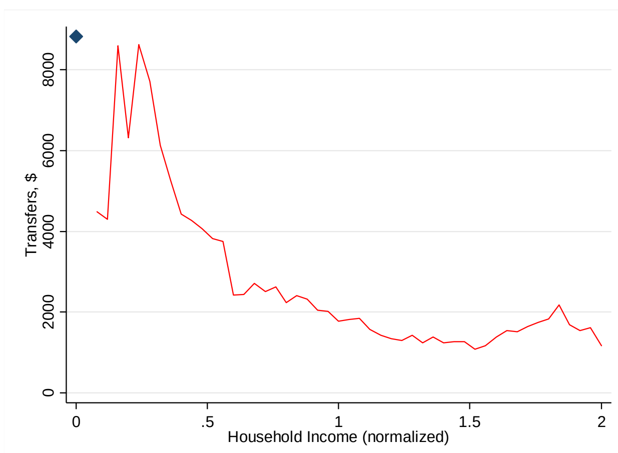

Figure 4 - Total Transfers in the Benchmark Economy

Childcare Costs To determine the requirement of efficiency units for childcare, $d^M(x, z, t)$, and $d^S(x, t)$, we use data on total spending (as a fraction of household income) on childcare and the relation between children's age and childcare spending (as shown in Figure A4). In particular, we use data from the Survey of Income and Program participation (SIPP), and estimate a relationship between spending in childcare per child and the average age of children, conditional of the mother's skill and marital status. Given the price of unskilled labor services, we recover the efficiency units required at each age in stationary equilibrium. We provide details in the Online Appendix.

Remaining Parameters We select the remaining parameters to match jointly several targets in stationary equilibrium. This includes parameters on technology, preferences, taxation and social security taxes and benefits. We provide all relevant details in the Online Appendix.

6 The Benchmark Economy

In Table 1, we show summary statistics on how the model performs regarding targeted and non-targeted moments. Total transfers in the model are about 2.3% of the GDP, which (endogenously) matches the data counterpart. The model reproduces the growth in dispersion in hourly wages for married individuals by skill, the correlation of wages of married couples at the start and the end of the life cycle, and married females' participation rates. Differently from other papers in the literature, the model is in line with the earnings premia by skill. Among other factors, this is driven by the fact that rental rates for labor services differ by skill as skilled and unskilled efficiency units are not perfect substitutes in production.

Importantly, the model is in line with the (non-targeted) growth in household consumption dispersion over the life cycle – which is empirically much lower than the growth in earnings dispersion for males or for households as we noted in section 3. A central reason for this finding is that several factors contributing to dispersion in earnings with age are anticipated as of the start of the life cycle. In this sense, this finding is similar to the findings in Huggett et al (2011). In that paper, the growth in earnings dispersion for males with age is in line with data and concomitant to a much lower growth in consumption dispersion.

The bottom panel of Table 1 shows earnings inequality measures in the model and the data for households with heads between ages 25 and 65. The model captures the 90-10 and 90-50 ratios very well, and is able to produce earnings shares of the bottom 10%, 20% and 40% of households, which is critical for the analysis at hand.[10] Not surprisingly, taxes and

[10] Inequality measures in the data is based on 2010 CPS under the sample restrictions detailed in Section 3.

transfers reduce income inequality significantly in our model; the 90-10 ratio for after-tax and transfer household income is only 5.9, while for household earnings, it is 7.2.

Table 1: Model and Data

Aggregates	Data	Model
Capital Output Ratio	2.9	2.9
Total Transfers (% of GDP)	2.3	2.3
Skill Premium	1.8	1.8
LFP of Married Females (%), 25-54		
Unskilled	68.2	68.6
Skilled	77.4	76.6
Total	71.8	71.8
Life-Cycle Inequality		
Variance log-wages (Married Males, age 54, S)	0.40	0.41
Variance log-wages (Married Males, age 54, U)	0.33	0.33
Variance log-wages (Married Females, age 54, S)	0.25	0.25
Variance log-wages (Married Females, age 54, U)	0.30	0.30
Variance log-hours (Married Females, age 40)	0.13	0.13
Correlation Between Wages of Spouses (age 25)	0.27	0.27
Correlation Between Wages of Spouses (age 40)	0.31	0.31
Variance log-consumption (Age 50-54 vs 25-29)	0.08	0.07
Earnings Inequality (25-64)		
90-10 ratio	7.8	7.2
90-50 ratio	2.6	2.5
Share, bottom 10%	1.8	2.1
Share, bottom 20%	4.5	5.6
Share, bottom 40%	13.2	16.0

Note: Entries summarize the performance of the benchmark model in terms of empirical targets and key aspects of data. The data for aggregate inequality statistics takes into account the same data restrictions used in the empirical analysis in Section 3.

Life-cycle statistics Our model environment is consistent with a host of observations over the life cycle. We start by noting that our economy generates the observed growth in dispersion in hourly wages by skill, gender, and marital status. Figure 5 illustrates this. We now concentrate on three, interconnected life-cycle statistics. First, we note that our economy generates the pattern life-cycle pattern of the wage-gender gap, as Figure 6 (left panel) demonstrates. The model, parameterized to generate the decline in the gender gap by skill in the early ages of the life cycle, captures quite well the slow opening of the gap for unskilled workers over the entire life cycle. The model generates the gradual opening of the gap for skilled workers but leaves a portion unaccounted for towards the end of the working life cycle. At age 50, skilled females earn 64% on average relative to men in the data, while the model implies a gender gap of 75%.

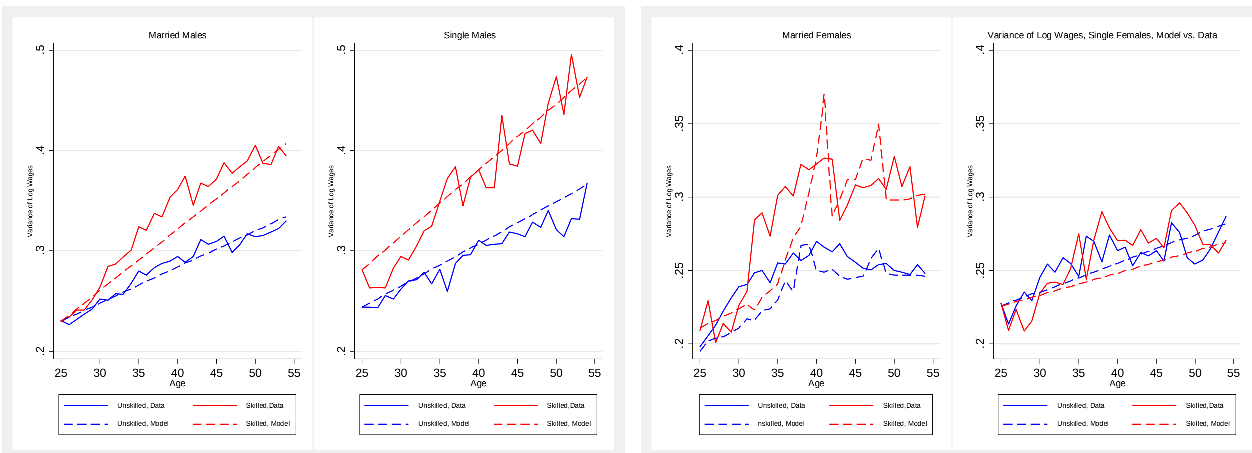

Figure 5 - Variance of Log Wages, Model vs. Data, Males (left), Females (right)

Figure 6 (right panel) shows the performance of the model regarding participation rates of married females as they age. The reader should recall that the economy is parameterized to reproduce the aggregate levels of participation rates by household type, and their levels as of age 40. The endogenous forces inside the model – costly children and utility costs of joint participation that vary with the age of children – lead to the horizontal S-like pattern of participation rates of married females in the data, as the figure demonstrates. The model environment also captures well the initial rise and slow decline of unskilled married females. Overall, this leads the model economy to reproduce well the aggregate pattern of participation rates as individuals age.

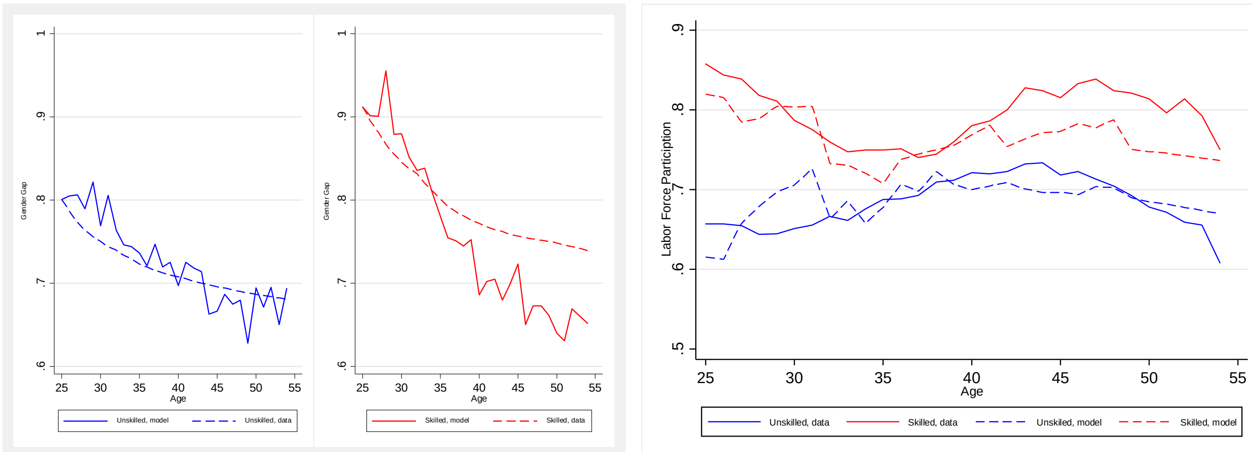

Figure 6 - Gender Wage Gap (left); LFP of Marr. Females (right), Model vs. Data

Overall, as a result of all the forces of our economy operating in tandem, our model implies an age pattern of dispersion in earnings for married females that is broadly consistent with observations. Recall from section 3 that dispersion in earnings of married females first rises, and unlike the case of men, it flattens out as of age 35. As Figure 5 shows, our model generates the same patterns. Why? Early in the life-cycle, skilled females increase their skills faster as a group relative to their unskilled counterparts. This, in conjunction with life-cycle shocks, leads to the overall increase in earnings inequality. In the meantime, some women gradually return to work – given the gradual reduction in childcare and utility costs of joint participation as children age – and start increasing their skills by acquiring experience. Since their skills are lower but accumulate faster, inequality first grows but subsequently starts leveling off. Eventually, all differential rates in skill formation become less and less important as individuals age, and females become more homogenous. The net result is a flat profile of earnings dispersion after middle age, as the figure shows.

Children and Childcare Costs What is the quantitative importance of children and childcare costs? To answer this question, we set all childcare costs to zero, while keeping all other parameters constant. We find that childcare costs matter critically in determining the levels of participation rates, and how inequality in wages and earnings evolve over the life-cycle for married females. When childcare costs are set to zero, the participation rate of unskilled married females is 80.9%, while for skilled, it is 84.8%. The values in the benchmark model are 68.6% and 76.6%, respectively. The model cannot generate the decline in the labor force participation associated with childcare requirements either. Furthermore, without children, the variance of log wages grows linearly along the life cycle for women, exactly as it does for men. Figures 7 illustrates these for skilled married females.

If depreciation rates are zero, the wage-gender gap at age 45 becomes 75.8% for unskilled individuals and just 84.5% for skilled individuals; the values in the benchmark model are 69.6% and 75.7%. The depreciation has a larger impact for skilled individuals, since the estimated depreciation rates are higher for skilled females and they experience higher wage growth conditional participation.[11]

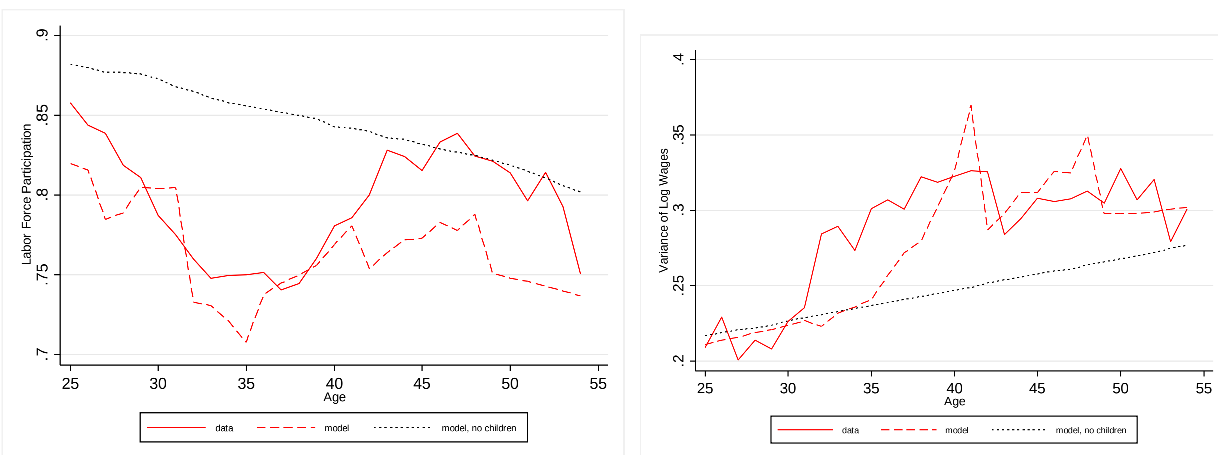

Figure 7 - LFP (left); Var. of Log Wages (right), Married Skilled Females

6.1 How Valuable is the Welfare State?

How much do households value the current transfer scheme? What would be the effects of abolishing the welfare state? To answer these questions we proceed by fully eliminating all transfers as described in Section 2. We balance the budget by lowering the 'level' parameter of the tax function (λ) in a proportional and symmetric way for all households. Further, as in all subsequent experiments that we conduct, we assume that the rate of return on capital does not change across steady states.

[11] Further details are provided in the working paper version – see Guner, Kaygusuz and Ventura (2021).

Table 2 presents the main aggregate findings. Hours worked increase across the board, and these increases are concentrated among the unskilled. The participation rate of married females increases by 6.3% for unskilled women and by 2.4% for skilled ones. All this translates in a total increase in labor hours of about 3.0% and an increase in aggregate output of 1.8%. Concomitantly, tax rates drop across the board. Note that the average tax rate at mean income falls substantially, from about 9.2% to 4.8% for a married household with two children, and from about 7.7% to about 3.3% for a single female with two children, respectively.[12]

Table 2: Eliminating Transfers (% changes relative to benchmark)

	Eliminating All Transfers	Eliminating Welfare Programs	Eliminating EITC Program	Eliminating Child-Related Programs
Output	1.8	1.2	0.5	0.2
Aggregate Hours	3.0	1.9	0.9	0.2
Hours per worker (All Females)	1.8	1.6	0.3	0.8
Hours per worker (All Males)	1.6	0.9	0.2	0.2
Participation of Married Females:				
Unskilled	6.3	4.2	4.0	-1.5
Skilled	2.4	1.7	1.2	-0.4
Total	4.6	3.1	2.8	-1.0

Note: Entries in the top panel show the effects (percentage changes) across steady states on selected variables driven by the elimination of different transfer programs, and all of them simultaneously (the entire 'welfare state').

When all transfers are eliminated, labor supply increases for low and middle-income, typically less skilled, households as they disproportionately benefit from these transfers. These changes in labor supply take place due to income effects, and as part of the incentives to increase labor supply for insurance purposes as transfers are no longer in place. These changes occur despite the removal of programs that provide incentives for labor supply (e.g. childcare subsidies via the CCDF) or include provisions that subsidize work (e.g. EITC).

[12] With this reform, to balance the budget we multiply λ values in Table A8 in Appendix by 1.0485 (recall that $1-\lambda$ is the tax rate at the mean income).

These incentives to increase labor supply are magnified by the reduction in tax rates for all households. Overall, changes in labor supply lead to changes in aggregate capital and result in the positive output changes for the economy in the aggregate that the table illustrates.

Welfare Table 3 shows sharp and negative effects on aggregate welfare, with a compensating variation of about 2.8% for all newborn households. This is expected; benchmark transfers are substantial and concentrated at the bottom of the skill distribution. Hence, their elimination leads to significant welfare losses in a utilitarian sense. Nonetheless, since tax rates fall substantially, a majority of adults benefit from their elimination – about 62.1% of households benefit as Table 3 demonstrates.

Married and skilled individuals tend to be winners from eliminating transfers, whereas single and unskilled individuals tend to lose, as Table 5 illustrates. We find that a newborn, married household comprised of two skilled individuals experiences a 1.8% of consumption gain, whereas their counterpart with two unskilled individuals faces a loss of 0.05% of consumption. Single females bear the brunt of the transfer elimination. A newborn, single unskilled female experiences a loss of 5.1% on average, while an equivalent single skilled female faces a loss of 0.25%.

Eliminating Programs: One at a Time What components of the welfare state have the biggest impact on aggregates? Table 2 provides the answers in detail. As the table shows, the elimination of means-tested transfer programs or traditional 'welfare' programs, has the largest impact. This elimination leads to an increase in output in the long run of 1.2% – about two thirds of the increase when all programs are eliminated. Hours worked increase by 1.9% and participation rates of unskilled (all) married women goes up by 4.2% (3.1%).

The aggregate findings associated to the elimination of individual programs have a counterpart in terms of welfare effects. The elimination of traditional welfare programs leads to an ex-ante welfare loss of 0.9%, with unskilled single females experiencing a large loss of 3%. Nonetheless, there is a concomitant majority support as taxes as reduced for the majority. Interestingly, the elimination of child-related transfers has the second-largest welfare loss but *without* majority support for its elimination. This occurs as its elimination impacts multiple types of households with children.

Summary Overall, these findings highlight and anticipate trade-offs associated with reforming the welfare state. The welfare state target transfers to low and middle-income households. As a result, while they depress participation, hours, and output, they are highly valuable for some households and translate into substantial losses for all newborns associated with its elimination – even when tax rates are sharply reduced. These losses mask gains for many agents, resulting in a significant majority of newborns in favor of this hypothetical move. The significant majority in favor of elimination of the system (62.1%) illustrates the trade-offs involved in an economy with substantial heterogeneity like ours.

Table 3: Eliminating Transfers – Welfare Effects (Newborns, %)

	Eliminating All Transfers	Eliminating Welfare Programs	Eliminating EITC Program	Eliminating Child-Related Programs
Single F				
Unskilled	-5.1	-3.0	-0.9	-0.6
Skilled	-1.2	-0.9	-0.1	-0.1
Married				
Unskilled, Unskilled	0.05	1.0	-0.0	-0.7
Unskilled (f), Skilled (m)	0.4	0.4	0.1	-0.0
Skilled, Skilled	1.8	1.4	0.3	0.1
Skilled (f), Unskilled (m)	0.7	0.6	0.2	-0.0
All Newborns	-2.8	-0.9	-0.2	-0.7
Winning Households	62.1	67.8	82.2	48.7

Note: Entries show the welfare effects (consumption compensation) driven by the elimination of different transfer programs, and all of them simultaneously (the entire 'welfare state'). The calculations report welfare gains across steady states under the assumption that the rental rate of capital (and interest rate) is constant across steady states.

7 Rethinking the Welfare State

We now conduct several quantitative experiments in which we provide answers to the questions that motivate the paper. In all experiments, the rate of return of capital is constant across steady states – but rental prices for labor services change in order to be consistent with equilibrium conditions. All experiments are *revenue neutral* in the ways we specify in each case. We first consider replacing the current transfer scheme with a Universal Basic Income scheme (UBI) and then with a Negative Income Tax (NIT).

7.1 A Universal Basic Income

In our first experiment, each household receives a transfer per household member (including children) in all dates and states. The current welfare state is abolished while the tax system is unchanged. We dub this experiment a *Universal Basic Income* scheme (UBI). Specifically, we search across steady states for the level of the UBI transfer that maximizes the ex-ante welfare of all newborns. We balance the budget by adjusting the 'level' parameter of the tax function (λ) proportionally.

Our findings are presented in Tables 4 and 5. We find that a per-person transfer of about 2.7% of mean household income maximizes the welfare of newborns. This corresponds to about \$2,600 per person in 2019 dollars (\$10.400 for a married household with two children at home). To balance the budget, tax rates need to increase non trivially; for a married household with two children at mean income, the average rate increases to 12.8% from 9.2% in the benchmark.[13] This occurs as at the welfare-maximizing level, the aggregate expenditure on transfers substantially increases relative to the benchmark; from 2.3% in the benchmark case to 4.9%. The UBI transfers, coupled with higher taxes, depress hours, participation and output across steady states. Total hours decline by 0.4% and participation rates of unskilled and skilled married females decline by 2.6% and 1.4%, respectively. On the other hand, hours worked per worker among females increase, as Table 4 shows.

Table 5 illustrates the welfare consequences of the UBI policy. Even at the best policy, ex-ante welfare for all newborns declines, with a compensating variation of -1.4%. But a majority of newborns, 58.9%, support a UBI program. As it was the case with eliminating the current welfare system, lifetime-poor households suffer under the UBI, since it does not fully replace the transfers they were getting in the benchmark economy. This contributes to an overall welfare loss. Unskilled single females experience a welfare loss at birth of about 2.8%, and skilled ones a loss of about 0.8%. On the other hand, unskilled married households are strong winners as Table 5 demonstrates, with a welfare gain of about 1.8% for

[13] The λ values in Table A8 are multiplied by 0.9605 to balance the government's budget.

a married couple with two unskilled adult members. This reflects that some low-to-middle income households, who did not receive transfers in the benchmark economy, now get the UBI transfer, contributing to generating majority support.

At welfare maximizing level of the NIT, aggregate hours are slightly below the benchmark case and output is marginally above. Participation rates for married females are lower than in the benchmark economy. Since hours worked for those away from the margin of indifference do not change much relative to the benchmark, per-worker hours for females increase as in the case of the UBI transfer. Therefore, there are no significant changes in steady-state aggregates when comparing the best transfer case with the benchmark economy.

Table 4: Aggregate Findings (% changes relative to benchmark)

	Elimination of Transfers	UBI Maximum Welfare	NIT Maximum Welfare	NIT (2) Maximum Welfare
Output	1.8	-0.4	0.1	-0.3
Aggregate Hours	3.0	-0.4	-0.1	-0.5
Hours per worker (All Females)	1.8	1.1	1.1	-0.8
Hours per worker (All Males)	1.6	-0.5	0.0	-0.2
Participation of Married Females:				
Unskilled	6.3	-2.6	-2.8	-0.4
Skilled	2.4	-1.4	-1.0	-0.3
Total	4.6	-2.1	-2.0	-0.4
Proportional Tax Rate (%)	-	-	17.3	16.7
Transfer (% Household Income)	-	2.7	4.0	6.0, 3.0
Transfers (% Output)	-	4.9	7.3	7.9

Note: Entries in the top panel show effects (percentage changes) across steady states on selected variables driven by the different quantitative experiments. The values for 'maximum welfare' UBI (Universal Basic Income) and NIT (Negative Income Tax) correspond to the transfers and corresponding taxes that maximize ex-ante welfare for all. In the first NIT experiment, all adults and children receive the same transfer. In the second NIT experiment, transfers are differentiated by marital status.

A UBI on top of the Welfare State? It is worth noting that the welfare-maximizing transfer level is substantially below the magnitudes advocated in policy discussions. For instance, some advocate a UBI transfer of $1,000 per month, which is a much higher transfer than what we find as optimal. Indeed, we found that with higher transfer levels, welfare losses non-trivially increase, and popular support dissipates.

A natural next question is: what if the UBI transfer is given on top of the existing welfare state? We find large welfare losses and no popular support for it. For instance, if the transfer is 1% of the mean household income per person, an ex-ante welfare loss emerges of 0.15% and 56.1% of adults oppose it. Aggregate hours decline by 1.4% and output declines by 0.9%. If instead, we impose the transfer that maximizes welfare under the UBI reform, output losses are not surprisingly more significant (-2.8%); aggregate welfare declines by 1.26% and 60.6% of adults oppose this idea.

Summary Overall, our findings indicate that a UBI policy reform is hard to justify on ex-ante welfare grounds as a replacement for the current welfare state. Yet, it is supported by a majority despite its macroeconomic magnitude and the additional tax revenue it requires. A UBI policy on top of the current welfare state is more clearly *not* a good idea, as ex-ante welfare declines and there is clear majority against the move.

7.2 A Negative Income Tax

We now evaluate a more drastic reform that eliminates the current welfare state *and* the progressive income taxation. Specifically, we introduce a proportional income tax combined with a transfer for all, adult and children. Following Friedman (1962) and the literature that followed, we dub this linear income tax a *Negative Income Tax* system, or NIT for short. We again search for the welfare-maximizing per household member transfer and balance the budget by adjusting the proportional tax rate that applies to all households.

Table 4 shows the effects on aggregates. The transfer at the welfare-maximizing level is about 4% of mean household income, or $3,900 in 2019 dollars ($15,600 for a married couple with two children). Thus, the welfare-maximizing NIT transfer is significantly more generous than the best one in the UBI case, and involves a drastic increase in resources devoted to redistribution – about 7.3% of output. The proportional tax rate that supports the welfare-maximizing NIT is 17.3% (a married household with two children at around mean income faces an average tax rate of about 9.2% in the benchmark economy). The reform leads to a marginal increase in aggregate output, as Table 4 demonstrates.

Table 5 shows that at the welfare-maximizing level, married households enjoy substantial welfare gains while single households as a group experience ex-ante losses. Overall, there are ex-ante welfare gains in the best case scenario, albeit marginal, accompanied by substantial majority support for the reform among newborns – nearly three-fourths of newborns support the reform at birth.

Table 5: Welfare Effects (Newborns, %)

	Elimination of Transfers	UBI Maximum Welfare	NIT Maximum Welfare	NIT (2) Maximum Welfare
Single F				
Unskilled	-5.1	-2.8	-2.5	-0.05
Skilled	-1.2	-0.8	0.8	0.15
Married				
Unskilled, Unskilled	0.05	1.8	2.3	-0.5
Unskilled (f), Skilled (m)	0.4	0.2	0.4	0.03
Skilled, Skilled	1.8	0.3	1.1	0.3
Skilled (f), Unskilled (m)	0.7	0.3	0.5	0.04
All Newborns	-2.8	-1.4	0.03	0.6
Winning Households	62.1	58.9	73.5	53.7
Change in Variance log-consumption (relative to benchmark economy)	0.109	0.070	0.041	-0.043

Note: Entries show the welfare effects (consumption compensation) driven by the reform of the welfare state, for newborn households of different marital status and educational types. The calculations report welfare gains across steady states under the assumption that the rental rate of capital (and interest rate) is constant across steady states.

Different Tax-Transfer Levels It is illustrative to visualize the main findings in terms of aggregate output, ex-ante welfare for all and majority support as the NIT transfer increases. Figures 8 display these findings. When the transfer equals zero, the tax system is simply a proportional tax, and output is about 3.2% higher than in the benchmark case.

As transfers increase, tax rates, welfare and popular support increase as well, but changes in output relative to the benchmark case become gradually lower and eventually become negative. Figure 8 shows that as the lump-sum transfer increases, both welfare and support for the reform first sharply increase and then decline. For a transfer level of about 6% of mean income, there are ex-ante welfare gains but no majority support since the tax rate required is much higher than at the welfare-maximizing level (about 23.8%).

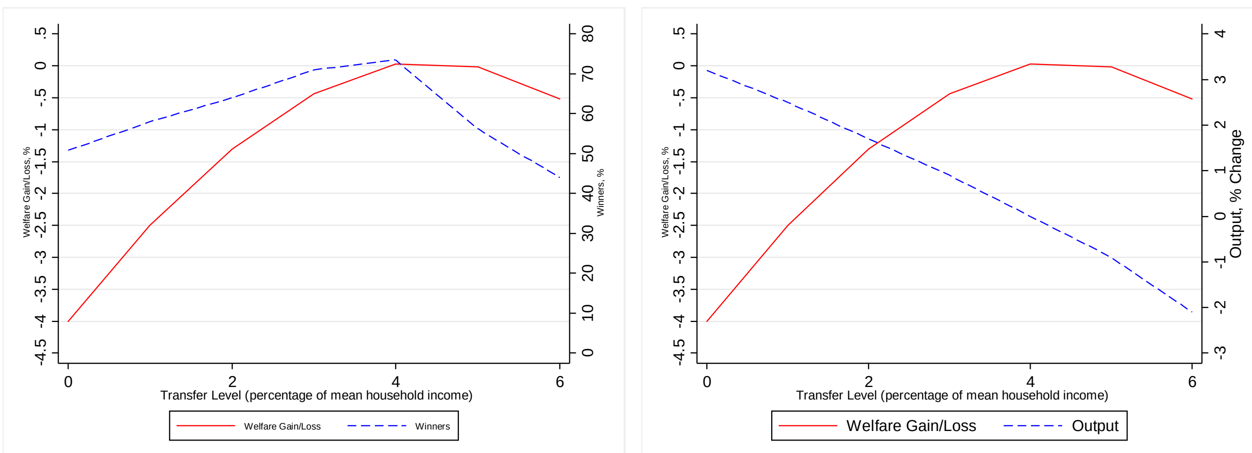

Figure 8 - Welfare Gains and Winners, NIT (left); Welfare Gains and Output, NIT (right)

Comparison with a Proportional Income Tax How different are the findings of NIT regime when compared to the case of a simple proportional tax that leaves the welfare state in place? We find that in this case, aggregate hours and output increase by 1.6% and 1.5%, respectively, requiring a supporting tax rate of 10.7%. Note that the increase in output is this case is less than half of the increase shown in Figure 8 (right panel) for the case of no transfers (3.2%). This highlights the depressing effects of the current welfare state on aggregates, and the need of a higher rate to finance the associated transfers.

In terms of welfare, we find in this case an ex-ante welfare gain for newborns of about 0.26% of consumption. Not surprisingly, there are sharp differences between winners and losers. We find that skilled married couples have a welfare gain of 1.2%, whereas unskilled single females experience a loss of about 0.4%. Overall, a simple proportional tax is not too popular. We find a strong majority of newborn households *against* this case; about 62.3%.

Differentiated Transfers Since welfare gains from a NIT reform are unevenly distributed between married and single households and small in the aggregate, we consider a NIT regime with transfers differentiated by the marital status of adults but with a common tax rate. Specifically, we search for a transfer and ratio of transfers to individuals in married households relative to single households that maximize ex-ante welfare *and* preserve majority support.

We find a significant ex-ante welfare gain of about 0.6%, with 53.7% of adults supporting the reform. The transfer per person in single households is about 6% of the mean household income, while about 3% in married households (about \$6,000 and \$3,000 in 2019 dollars). The tax rate that supports this arrangement is 16.7%. Output and aggregate hours decline by 0.3% and 0.5% relative to the benchmark economy.

This reform effectively means that a single female with 2 children, under an income level of one-half mean household income, would receive a net transfer after taxes of about 9.65% of mean household income (about \$9,465 in 2019 dollars). The net transfer for a married couple with the same income and two children would be about 3.65% of mean household income (about \$3,580 in 2019 dollars).

Summary Overall, what accounts for the relative success of a Negative Income Tax in terms of ex-ante welfare and majority support? The upshot is that a larger degree of redistribution is feasible given the smaller tax distortions under a NIT regime; i.e. elimination of increasing marginal tax rates and lower taxes on secondary earners. As tax distortions are reduced with a proportional tax, the size of the aggregate economy grows and collecting the tax revenues that are necessary to finance transfers becomes easier. The net result is that a higher transfer level becomes feasible under a NIT relative to a UBI scheme. Put differently, a drastic tax reform that reduces marginal tax rates makes more extensive redistribution possible. This also allows households to better cope with idiosyncratic labor market risk. Table 5 shows the overall variance of log-consumption for different economies compared to the benchmark. The variance of log consumption is about 10.9 log points higher than its benchmark value when the entire welfare system is eliminated. The variance of log consumption also increases non-trivially when the UBI replaces the welfare system. However, the increase is smaller with the NIT. In contrast, with a NIT in which transfers are differentiated by marital status and singles get relatively larger transfers, the variance of log consumption declines by 4.3 log points.

8 Concluding Remarks

Three main points emerge from our analysis so far. First, it is hard to improve upon the current structure of the welfare state via simple transfer schemes. Transfers to poorer households are highly valued, and thus, any reform to the current system needs to confront the fact that non-trivial resources accrue to poorer households. As a result, reforms that maximize ex-ante welfare relative to the status quo are difficult to find.

Second, a UBI scheme is generically not a good idea and is dominated by a NIT. Why? Considerable resources need to be transferred to poorer households for their welfare not to fall. And since transfers would accrue to all individuals, taxes need to increase substantially, leading to lower output, and ex-ante welfare losses. And if a UBI scheme is imposed on top of the current welfare state, ex-ante welfare losses can be substantial for moderate values of the associated transfer. It follows that in our economy, a UBI scheme, as portrayed in popular discussions, is not a good idea.

Lastly, an NIT arrangement can generate ex-ante welfare gains and lead to popular support due to the associated reduction in distortions and the concomitant increase in output and revenues. These arrangements require much larger levels of transfers to the working-age population than in the status quo. As a fraction of output, we find that transfers to working-age households need to be *more than triple* relative to the benchmark case to maximize ex-ante welfare.

We end this paper with three comments. First, the administrative costs of running a welfare state can be large. Isaacs (2008), for example, calculates that the cost of running Food Stamps, Housing Subsidies and the TANF programs are as high as 15 cent per each dollar benefit issued. Our analysis abstracts from such administrative costs, and hence might underestimate the potential benefits of moving to a simpler system like the NIT. Second, a variant to the NIT system could use a consumption tax instead of a flat-rate income tax. As a consumption tax does not distort capital accumulation, this implementation could lead to larger gains in output, labor supply and welfare than we found in our analysis. Finally, we have abstracted from transitions between steady states due to the large state space in our model. This abstraction is unlikely to affect our main findings for two reasons. First, all working-age households would potentially benefit from the transfers in a NIT or UBI scheme, as they do under the current welfare state, rendering differential effects for working-age households alive at the start of a hypothetical transition of second order. Second, we conjecture that changes in rates of return along a transition would be small in the extreme case of a closed economy. This is due to the fact that the optimal NIT or UBI do not fundamentally alter the incentives to accumulate capital, and keep the overall size of the labor input composite constant. We leave this and other issues for further research.

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Online Appendix

(not for publication)

1 Transfers to Households in the United States

In this section of the Appendix, we provide a brief description of various means-tested programs.

1.1 The Earned Income Tax Credit

The EITC is a fully-refundable tax credit that subsidizes low-income working families. The EITC is a fraction of a family's earnings until earnings reach a certain threshold. Then, it stays at a maximum level, and when the earnings reach a second threshold, the credit starts to decline so that the individual does not receive any credit beyond a certain earnings level. The maximum credits, income thresholds, and the rate at which the credits decline depend on the household's tax filing status (married vs. single) and the number of children. By design, the EITC only benefits working families, and families with children receive a much larger credit than workers without qualifying children. For 2019, households with earnings up to 41,000 to 56,000 qualified for the EITC. For a married couple or a single parent with two children, the maximum credit, which applied for earnings around 15 to 20,000$, was 5828$ (a subsidy of more than 25%). The maximum credit for households without children was much smaller, only 529$. In 2019 about 25 million taxpayers received an average EITC of $2,476.[1]

1.2 Child-Related Transfers

Child Tax Credit The CTC provides households a tax credit for each child, independent of parents' childcare expenditures and labor market status. Until the 2017 Tax Cuts and Jobs Act (TCJA), the CTC started at $1,000 per qualified children under age 17 and stayed at this level up to a household income of $75,000 for singles and $110,000 for married couples. Beyond this limit, the credit declines by 5% for each dollar earned until it is completely phased out when the household income is $115,000 for singles and $150,000 for married couples. The 2017 tax reform increased the maximum credit to 2000$ per child and allowed households with much higher income to qualify for the maximum credit ($200,000 for single parents and $400,000 for married couples). The CTC is partly refundable: if the credit exceeds taxes owed, taxpayers can receive up to $1,400 per child, known as the additional child tax credit (ACTC). To qualify for the ACTC, a household must have minimum

[1] See https://www.eitc.irs.gov/eitc-central/about-eitc/about-eitc for further details.

earnings of 2500$.[2]

The Child and Dependent Care Tax Credit The Child and Dependent Care Tax Credit (CDCTC) is a non-refundable tax credit that allows parents to deduct a fraction of their childcare expenses from their tax liabilities. To qualify for the tax credit, both parents must work. The maximum qualified childcare expenditure is \$3,000 per child, with an overall maximum of \$6,000. Parents receive a fraction of qualifying expenses as a tax credit. This fraction starts at 35%, remains at this level up to a household income of \$15,000, and then declines with household income. The lowest rate, which applies to families with a total household income above \$43,000, is 20%.[3] Since the CDCTC is not refundable, only households with positive tax liabilities benefit from it.

Childcare Subsidies The main program that provides childcare subsidies for low-income families in the US is the Child Care Development Fund (CCDF). The program was created as part of the 1996 welfare reform and consolidated an array of programs. To qualify for a subsidy, parents must be employed, in training, or in school. The program targets low-income households. In 2010, 1.7 million children (ages 0-13) were served by the CCDF, which is about 5.5% of all children (ages 0-13) in the US, and the average income of those receiving a subsidy was about \$20,000 (28% of the mean household income) - Guner, Kaygusuz, and Ventura (2020). Families receiving assistance must make a co-payment, which is about 25% of childcare costs, while the remaining 75% constituted the subsidy.

1.3 Welfare System

Another group of means-tested programs consist of programs provide cash or in-kind transfers to poor households, and that are routinely identified with "welfare" system in the US.

Temporary Assistance to Needy Families The TANF was created by the 1996 welfare reform and replaced the Aid to Families with Dependent Children program (AFDC). Under TANF, the federal government provides a block grant to the states, which use them to operate their own programs. To receive federal funds, states must also spend some of their own dollars. The TANF provides monthly cash payments to families, which differ significantly across states. The average maximum monthly payments for a family of three was 462$ in 2018. The most and least generous states' payments were 170$ (Mississippi) and 1039$ (New Hampshire).[4] In contrast to the AFDC, the TANF has a 5-year life-time

[2] See https://www.irs.gov/newsroom/the-child-tax-credit-benefits-eligible-parents and https://www.taxpolicycenter.org/briefing-book/what-child-tax-credit for further details.

[3] See http://www.taxpolicycenter.org/briefing-book and https://www.irs.gov/uac/Ten-Things-to-Know-About-the-Child-and-Dependent-Care-Credit.

[4] The Urban Institute's Welfare Rules Database, TANF Policy Tables, Table II.A.4 https://wrd.urban.org/wrd/tables.cfm. See also Congressional Research Service (2020).

participation limit and a stronger emphasis on encouraging recipients to work. As a result, less than 50 percent of TANF spending goes to cash assistance (CBO 2013). The rest pays for various services for low-income families with children, including child care, transportation to work, and other types of work-related assistance.

Supplemental Nutrition Assistance Program The SNAP is a federal program that supports low-income households through electronic benefit transfer cards that can be used to buy food. To be eligible, household income, before any of the program's deductions, must be at or below 130 percent of the poverty line. For a family of three in 2021, this is $1,810 a month (about $28,200 a year). A family of three with no income receives the maximum benefit of 535$ a month. Maximum benefits are reduced by 30% for each dollar of monthly household income. On average, SNAP households received about $246 a month in the fiscal year 2020 (Center on Budget and Policy Priorities, 2020).

Supplemental Nutrition Program for Women, Infants, and Children (WIC) Pregnant, postpartum, and breast-feeding women, infants, and children up to age 5 are eligible to the WIC if they are poor and an appropriate professional determines them to be at nutritional risk. An applicant who already receives SNAP, Medicaid, or TNAF is automatically considered income-eligible for WIC. Applicants who receive no other relevant means-tested benefits must have a gross household income at or below 185 percent of the federal poverty level (currently $37,296 annually for a family of three) to qualify. WIC provided an average value of $61.24 in food per participant per month in the fiscal year 2016 (Center on Budget and Policy Priorities, 2017).

Supplemental Security Insurance The SSI is a federal program that provides monthly cash assistance to disabled, blind, or elderly who have little or no income and few assets. The monthly maximum Federal amounts for 2021 are $794 for an eligible individual, $1,191 for a qualified individual with an eligible spouse. In 2019, 79% of payments were for disabled individuals under age 65 (Social Security Administration, 2020).

Housing Subsidies Several federal programs provide rental assistance to families with low income. These programs are administered by the Department of Housing and Urban Development and the U.S. Department of Agriculture and take two forms: i) Public Housing and ii) Vouchers. In 2017, about 4.6 million households (3.8% of all households in the U.S.) received some form of federal rental assistance (Mazzara 2017). The amount of aid can be substantial. Guner, Rauh, and Ventura (2021) calculate that households at the bottom decile of the income distribution receive about $7,000 per year (about $5,000 for the second and third lowest deciles).

2 Equilibrium

In this section of the Appendix, we define a stationary equilibrium for the model economy. For all j, let $M_j(x,z) = M(x,z)$ denote the fraction of marriages between age-j, type-x females and age-j, type-z males, and let $\phi_j(x) = \phi(x)$ and $\Phi_j(x) = \Phi(x)$ be the fraction of single type-z males and the fraction of single type-x females, respectively. The fraction of type-z males and type-x females are then given by

$$\Omega(z) = \sum_{x \in X} M(x,z) + \omega(z), \tag{1}$$

and

$$\Phi(x) = \sum_{z \in Z} M(x,z) + \phi(x). \tag{2}$$

Let let $\mathcal{S}^M \equiv (x, z, \theta, \boldsymbol{\upsilon}, q, b)$ be the vector of states that *do not change* along the life-cycle for married households, with $\boldsymbol{\upsilon} = (\upsilon^M_{f,x}, \upsilon^M_{m,z})$. For married couples, also summarize the pair of persistent shocks by $\boldsymbol{\eta} \equiv (\eta^M_{f,x}, \eta^M_{m,z})$. Similarly, let $\mathcal{S}^S_f \equiv (x, \upsilon^S_{f,x}, b)$ and $\mathcal{S}^S_m \equiv (z, \upsilon^S_{m,z})$ be the vector of exogenous variables for single females and single males, respectively. In equilibrium, factor markets clear. The aggregate state of the economy consists of distribution of households over their types, labor productivity shocks, assets, labor market experience, and human capital levels. Let the function $\psi^M_j(a, h, e, \boldsymbol{\eta}, \mathcal{S}^M)$ denote the number of married individuals of age j with assets a, human capital level h, female labor market experience e, current persistent shocks $\boldsymbol{\eta}$, and exogenous state $\mathcal{S}^M$. The function $\psi^S_{f,j}(a, h, e, \eta^S_{f,x}, \mathcal{S}^S_f)$, for single females, and the function $\psi^S_{m,j}(a, \eta^S_{m,z}, \mathcal{S}^S_m)$, for single males, are defined similarly. Note that household assets, a, and female human capital levels, h, are continuous decisions. Let $a \in A = [0, \overline{a}]$ and $H = [0, \overline{h}]$ be the sets of possible assets and female human capital levels. Let the set for possible values of the market experience be denoted by $E = [0, \overline{e}]$. By construction, $M(x,z)$, the number of married households of type (x,z), must satisfy for all j

$$M(x,z) = \sum_{\theta, \boldsymbol{\upsilon}, q, b} \int_{A \times H} \psi^M_j(a, h, e, \boldsymbol{\eta}, \mathcal{S}^M) dh \; da \; de \; d\boldsymbol{\eta}.$$

Similarly, the fraction of single females and males must be consistent with the corresponding measures $\psi^S_{f,j}$ and $\psi^S_{m,j}$, i.e. for all ages, we have

$$\phi(x) = \sum_{\upsilon, b} \int_{A \times H \times E} \psi^S_{f,j}(a, h, e, \eta, \mathcal{S}^S_f) dh \; da \; de \; d\eta,$$

and

$$\omega(z) = \sum_{\upsilon} \int_A \psi^S_{m,j}(a, \eta, \mathcal{S}^S_m) da \; d\eta.$$

For married couples, let $\lambda_b^M(x,z)$ be the fraction of type-(x,z) couples who have childbearing type b (where $b \in \{0,1,2\}$ denotes no children, early childbearing and late childbearing, respectively), with $\sum_b \lambda_b^M(x,z) = 1$. Similarly, let $\lambda_b^S(x)$ be the fraction of type-x single females who have childbearing type b, with $\sum_b \lambda_b^S(x) = 1$. Let the decision rules associated with the dynamic programming problems outlined in Section 4.5 of the paper be denoted by $a_m^S(a, \eta_{m,z}^S, \mathcal{S}_m^S, j)$ and $l_m^S(a, \eta_{m,z}^S, \mathcal{S}_m^S, j)$ for single males, by $a_f^S(a,h,e,\eta_{f,x}^S, \mathcal{S}_f^S, j)$ and $l_f^S(a,h,e,\eta_{f,x}^S,\mathcal{S}_f^S,j)$ for single females, and by $a^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j)$, $l_f^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j)$ and $l_m^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j)$ for married couples. Finally, let the functions $\mathfrak{h}^S(a,h,e,\eta,\mathcal{S}_f^S,j)$ and $\mathfrak{h}^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j)$ describe the next period's human capital for a single and married female, respectively. They are defined as

$$\mathfrak{h}^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j) = \mathcal{H}(x,h,l_f^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j),e),$$

and

$$\mathfrak{h}^S(a,h,e,\eta,\mathcal{S}_f^S,j) = \mathcal{H}(x,h,l_f^S(a,h,e,\eta,\mathcal{S}_f^S,j),e),$$

where $\mathcal{H}$ is the human capital accumulation function. Let $\chi\{.\}$ denote the indicator function. Summarize the transition functions for persistent shocks by $\Gamma^M(\boldsymbol{\eta}'|\boldsymbol{\eta})$, $\Gamma_f^S(\eta'|\eta)$ and $\Gamma_m^S(\eta'|\eta)$ and the initial draws for permanent shocks by $\Pi^M(\boldsymbol{\upsilon})$, $\Pi_f^S(\upsilon)$, and $\Pi_m^S(\upsilon)$.

In equilibrium, the distribution functions $\psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M)$, $\psi_{f,j}^S(a,h,e,\eta_{f,x}^S,\mathcal{S}_f^S)$, and $\psi_{m,j}^S(a,\eta_{m,z}^S,\mathcal{S}_m^S)$ must obey the following recursions:

Married agents

$$\begin{aligned} \psi_j^M(a',h',e',\boldsymbol{\eta}',\mathcal{S}^M) &= \int \Gamma^M(\boldsymbol{\eta}'|\boldsymbol{\eta})\psi_{j-1}^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M)\times \\ \chi\{a^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j-1) &= a',\ \mathfrak{h}^M(a,h,e,\mathcal{S}^M,\boldsymbol{\eta},j-1)=h'\}dh\ da\ de\ d\boldsymbol{\eta}, \end{aligned} \tag{3}$$

for $j>1$ with

$$e' = \begin{cases} e, \text{ if } l_f^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j-1)=0 \\ e+1, \text{ otherwise} \end{cases}.$$

For $j=1$,

$$\psi_1^M(a,e,h,\boldsymbol{\eta},\mathcal{S}^M) = \begin{cases} M(x,z)\lambda_b^M(x,z)\pi_\theta\Pi^M(\boldsymbol{\upsilon})(\zeta(q|z) \text{ if } a=0, e=0, \boldsymbol{\eta}=\mathbf{0},\ h=\varpi_m(x,1), \\ 0, \text{ otherwise} \end{cases},$$

where $\varpi_m(x,1)$ is a function that maps female types their initial human capital, $\zeta(q|z)$ is the fraction of households that draw q (given z), and π_θ is the probability of drawing θ.

Single female agents

$$\begin{aligned} \psi_{f,j}^S(a',h',e',\eta',\mathcal{S}_f^S) &= \int \Gamma_f^S(\eta'|\eta)\psi_{f,j-1}^S(a,h,e,\eta,\mathcal{S}_f^S)\times \\ \chi\{a_f^S(a,h,e,\eta,\mathcal{S}_f^S,\ j-1) &= a',\ \mathfrak{h}^S(a,h,e,\eta,\mathcal{S}_f^S,j-1)=h'\}dh\ da\ de\ d\boldsymbol{\eta}, \end{aligned} \tag{4}$$

for $j > 1$, with again

$$e' = \begin{cases} e, \text{ if } l_f^S(a,h,e,\eta_{f,x}^S,\mathcal{S}_f^S,j-1) = 0 \\ e+1, \text{ otherwise} \end{cases},$$

and

$$\psi_{f,1}^S(a,h,e,\eta,\mathcal{S}_f^S) = \begin{cases} \phi(x)\Pi_f^S(\upsilon)\lambda_b^S(x) \text{ if } e=0, \eta=0, \; h=\varpi_f(x,1) \\ 0, \text{ otherwise} \end{cases}.$$

Single male agents

$$\psi_{m,j}^S(a,\eta,\mathcal{S}_m^S) = \int \Gamma_f^S(\eta'|\eta)\psi_{m,j-1}^S(a,\eta,\mathcal{S}_m^S)\chi\{a_m^S(a,\eta,\mathcal{S}_m^S,j-1) = a'\}da\; d\eta, \tag{5}$$

for $j > 1$, and

$$\psi_{m,1}^S(a,\eta,\mathcal{S}_m^S) = \begin{cases} \varpi_m(z,1)\Pi_m^S(\upsilon) \text{ if } a=0, \; \eta=0 \\ 0, \text{ otherwise} \end{cases}.$$

Given distribution functions $\psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M)$, $\psi_{f,j}^S(a,h,e,\eta_{f,x}^S,\mathcal{S}_f^S)$, and $\psi_{m,j}^S(a,\eta_{m,z}^S,\mathcal{S}_m^S)$, the aggregate capital stock is given by

$$\begin{aligned} K &= \sum_j \mu_j[\sum_{\mathcal{S}^M}\int a\psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M)dh\; da\; de\; d\boldsymbol{\eta} + \sum_{\mathcal{S}_m^S}\int a\psi_{m,j}^S(a,\eta,\mathcal{S}_m^S)da\; d\eta \\ &+ \sum_{\mathcal{S}_f^S}\int a\psi_{f,j}^S(a,h,e,\eta,\mathcal{S}_f^S)dh\; da\; de\; d\eta]. \end{aligned} \tag{6}$$

The skilled labor input, L_s, is given by

$$\begin{aligned} L_s &= \sum_j \mu_j[\sum_{\mathcal{S}^M:x=s}\int(h\exp(\nu+\eta)l_f^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j)\psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M)dh\; da\; de\; d\boldsymbol{\eta} \\ &+ \sum_{\mathcal{S}^M:z=s}\int(\varpi(z,j)\exp(\nu+\eta)l_m^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j)\psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M)dh\; da\; de\; d\boldsymbol{\eta} \\ &+ \sum_{\mathcal{S}_m^S:z=s}\int \varpi(z,j)\exp(\nu+\eta)l_m^S(a,\eta,\mathcal{S}_m^S,j)\psi_{m,j}^S(a,\eta,\mathcal{S}_m^S)da\; d\eta \\ &+ \sum_{\mathcal{S}_f^S:x=s}\int h\exp(\nu+\eta)l_f^S(a,h,e,\eta,\mathcal{S}_f^S,j)\psi_{f,j}^S(a,h,e,\eta,\mathcal{S}_f^S)dh\; da\; de\; d\eta]. \end{aligned} \tag{7}$$

In turn, the (total) unskilled labor input, is given by

$$
\begin{aligned}
L_u &= \sum_j \mu_j [\sum_{\mathcal{S}^M : x=u} \int (h \exp(\nu+\eta) l_f^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j) \psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M) dh\ da\ de\ d\boldsymbol{\eta} \\
&+ \sum_{\mathcal{S}^M : z=u} \int (\varpi(z,j) \exp(\nu+\eta) l_m^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j) \psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M) dh\ da\ de\ d\boldsymbol{\eta} \\
&+ \sum_{\mathcal{S}_m^S : z=u} \int \varpi(z,j) \exp(\nu+\eta) l_m^S(a,\eta,\mathcal{S}_m^S,j) \psi_{m,j}^S(a,\eta,\mathcal{S}_m^S) da\ d\eta \qquad (8) \\
&+ \sum_{\mathcal{S}_f^S : x=u} \int h \exp(\nu+\eta) l_f^S(a,h,e,\eta,\mathcal{S}_f^S,j) \psi_{f,j}^S(a,h,e,\eta,\mathcal{S}_f^S) dh\ da\ de\ d\eta],
\end{aligned}
$$

Furthermore, unskilled labor used in the production of goods, $L_{u,g}$, equals the total supply of unskilled labor net of its usage in the production of childcare services:

$$
\begin{aligned}
L_{u,g} &= L_u - [\sum_{\mathcal{S}^M} \mu_j \int \chi\{l_f^M\} D(x,z,b,j) \psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j) dh\ da\ de\ d\boldsymbol{\eta} \\
&+ \sum_{\mathcal{S}_f^S} \mu_j \int \chi\{l_f^S\} D(x,b,j) \psi_{f,j}^S(a,h,e,\eta,\mathcal{S}_f^S,j) dh\ da\ de\ d\eta].
\end{aligned}
$$

In equilibrium, total taxes must cover government expenditures, G, total government spending and total transfers, TR, i.e.,

$$
\begin{aligned}
G + TR &= \sum_j \mu_j [\sum_{\mathcal{S}^M} \int T^M(I,\mathcal{K}(.)) \psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M) dh\ da\ de\ d\boldsymbol{\eta} \qquad (9) \\
&+ \sum_{\mathcal{S}_m^S} \int T^S(I,0) \psi_{m,j}^S(a,\eta,\mathcal{S}_m^S)\ da\ d\eta \\
&\quad + \sum_{\mathcal{S}_f^S} \int T^S(I,\mathcal{K}(.)) \psi_{f,j}^S(a,e,h,\eta,\mathcal{S}_f^S)\ dh\ da\ de\ d\eta] + \tau_k r K,
\end{aligned}
$$

where I represents a household's total income and $\mathcal{K}$ the number of children as as defined in the description of the individual and household problems in Section 4.5 of the paper. The aggregate transfers are given by

$$
\begin{aligned}
TR &= \sum_j \mu_j [\sum_{\mathcal{S}^M} \int TR^M(I,\mathcal{K}(.),D) \psi_j^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M) dh\ da\ de\ d\boldsymbol{\eta} \\
&+ \sum_{\mathcal{S}_m^S} \int TR_m^S(I) \psi_{m,j}^S(a,\eta,\mathcal{S}_m^S)\ da\ d\eta \\
&+ \sum_{\mathcal{S}_f^S} \int TR_f^S(I,\mathcal{K}(.),D) \psi_{f,j}^S(a,e,h,\eta,\mathcal{S}_f^S)\ dh\ da\ de\ d\eta],
\end{aligned}
$$

where D stands for childcare expenditures, as defined in Section 4.5 of the paper.

Finally, the social security budget must balance

$$\begin{aligned}
& \sum_{j\geq J_R}\mu_j[\sum_{\mathcal{S}^M}\int p^M(x,z)\psi_j^M(a,h,e,\mathbf{0},\mathcal{S}^M)dh\ da\ de+\sum_{\mathcal{S}_f^S}\int p_f^S(x)\psi_{f,j}^S(a,e,h,0,\mathcal{S}_f^S)dh\ da\ de \\
& +\sum_{\mathcal{S}_m^S}\int p_m^S(z)\psi_{m,j}^S(a,0,\mathcal{S}_m^S)\ da] \qquad (10)\\
= \ & \tau_p[w_sL_s+w_uL_u].
\end{aligned}$$

Equilibrium Definition For a given government consumption level G, social security benefits $p^M(x,z)$, $p_f^S(x)$ and $p_m^S(z)$, tax functions $T^S(.)$, $T^M(.)$, a payroll tax rate τ_p, a capital tax rate τ_k, transfer function $TR_f^S(.)$, $TR_m^S(.)$, $TR^M(.)$, and an exogenous demographic structure represented by $\Omega(z)$, $\Phi(x)$, $M(x,z)$, and μ_j, a *stationary equilibrium* consists of prices r and (w_s,w_u), aggregate capital (K), aggregate labor $(L_s,L_u,L_{u,g})$, household decision rules $a_m^S(a,\eta_{m,z}^S,\mathcal{S}_m^S,j)$ and $l_m^S(a,\eta_{m,z}^S,\mathcal{S}_m^S,j)$ for single males, by $a_f^S(a,e,h,\eta_{f,x}^S,\mathcal{S}_f^S,j)$ and $l_f^S(a,e,h,\eta_{f,x}^S,\mathcal{S}_f^S,j)$ for single females, and by $a^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j)$, $l_f^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j)$ and $l_m^M(a,h,e,\boldsymbol{\eta},\mathcal{S}^M,j)$ for married couples., and distribution functions $\psi_j^M(a,e,h,\boldsymbol{\eta},\mathcal{S}^M)$, $\psi_{f,j}^S(a,e,h,\eta_{f,x}^S,\mathcal{S}_f^S)$, and $\psi_{m,j}^S(a,\eta_{m,z}^S,\mathcal{S}_m^S)$, such that

1. Given tax and transfer rules, and factor prices, the decisions of households are optimal.
2. Factor prices are competitively determined; i.e. $w_s=\frac{\partial F(K,L_g)}{\partial L_s}$, $w_u=\frac{\partial F(K,L_g)}{\partial L_{u,g}}$ and $r=\frac{\partial F(K,L_g)}{\partial K}-\delta_k$.
3. Factor markets clear; i.e. equations (6) and (7) hold.
4. The functions ψ_j^M, $\psi_{f,j}^S$, and $\psi_{m,j}^S$ are consistent with individual decisions, i.e. they are defined by equations (3), (4), and (5).
5. The government and social security budgets are balanced; i.e. equations (9) and (10) hold.

3 Parameter Values

In this section of the Appendix, we provide details on how we assign parameter values to the endowment, preference, and technology parameters of the benchmark economy. To this end, we use aggregate as well as cross-sectional data from multiple sources.

Heterogeneity The model period is a year. Individuals start their life at age 25 as workers and work for forty years, corresponding to ages 25 to 64. The first model period ($j = 1$) corresponds to age 25, while the first model period of retirement ($j = J_R$) corresponds to age 65. After working 40 periods, individuals retire at age 65 and live until age 80 ($J = 56$). The population grows at the annual rate of 1.1%, the average values for the U.S. economy between 1960-2000.

There are 2 education types of males. Each type corresponds to an educational attainment level: *less than college* (u), and *college or more* (s). We use the March Supplement of the CPS from 1980 to 2006 to calculate age-efficiency profiles for each male type as detailed in Section 3 of the paper. Within a skill group, efficiency levels correspond to mean weekly wage rates, which we construct using annual wage and salary income and weeks worked, normalized by the mean weekly wages for all males and females between ages 25 and 64. Figure A1 (left panel) shows the third degree polynomials that we fit to the raw wage data. In the quantitative exercises, the male efficiency units, $\varpi_m(z, j)$, correspond to these fitted values.

There are also 2 education types for females. Table A1 reports the initial (age 25) efficiency levels for females together with the initial male efficiency levels and the corresponding gender wage gap. We use the initial efficiency levels for females to calibrate their initial human capital levels, $h_1 = \varpi_f(x, 1)$. After age 25, the human capital level of females evolves endogenously according to

$$h' = \mathcal{H}(x, h, l, e) = \exp\left[\ln h + \alpha_x^e \chi(l) - \delta_x(1 - \chi(l))\right], \quad x \in X = \{u, s\},$$

where e stands for labor market experience and $\chi(.)$ is an indicator function that is 1 if hours worked are positive and zero otherwise. Parameter α_x^e is experience-skill growth rate and δ_x stands for the depreciation rate.

We calibrate the values for δ_x and α_x^e as follows. First, we select α_x^e so that if a female of a particular type works in every period, her wage profile has exactly the same shape as a male of the same type. This procedure takes the initial gender differences as given, and assumes that the wage growth rate for a female who works full time will be the same as for a male worker with the same level of experience; hence, it sets α_x^e values equal to the growth rates of male wages at each age. Figure A1 (right panel) shows the calibrated values for α_x^e. We then select two values of δ_x so that we match the level of gender gap for skilled and unskilled women by age 25-35 as closely as possible.[5]

[5] We target the gender gap in hourly wages *all* married females in the model. We impute wages for females who do not participate using a standard Heckman (1979) selection correction. For the population equation for wages, we assume a standard Mincer equation, i.e. log wages of women depend on years of education, age, and age squared. For the selection equation, we assume that the probability of participation in the labour market for a female depends on her marital status, number of children younger than age 5, and the variables in the population equation.

Demographics We determine the distribution of individuals by productivity types for each gender, i.e. $\Omega(z)$ and $\Phi(x)$, using data from the 2008 American Community Survey (ACS). For this purpose, we consider all household heads or spouses who are between ages 30 and 39 and for each gender calculate the fraction of population in each education cell. For the same age group, we also construct $M(x,z)$, the distribution of married working couples, as shown in Table A2. Given the fractions of individuals in each education group, $\Phi(x)$ and $\Omega(z)$, and the fractions of married households, $M(x,z)$, in the data, we calculate the implied fractions of single households, $\omega(z)$ and $\phi(x)$, from accounting identities (1) and (2). The resulting values are reported in Table A3. About 75% of households in the benchmark economy consist of married households, while the rest (about 25%) are single. Since we assume that the distribution of individuals by marital status is independent of age, we use the 30-39 age group for our calibration purposes. This age group captures the marital status of recent cohorts during their prime-working years, while being at the same time representative of older age groups.

Preferences and Technology There are three utility functions parameters to be determined: the intertemporal elasticity of labor supply (γ), the parameter governing the disutility of market work for males and females, B_m and B_f, and the disutility shock of market work for married females, θ. We set the Frisch elasticity parameter γ to 0.2. This value is on the low side of recent available estimates, but via other choices in our economy, the macro elasticity is broadly consistent with estimates. We set γ to 0.2. Given γ, we select the parameter B_f and B_m to reproduce average market hours per worker observed in the data, about 42.7% and 37.0% of available time for males and females in 2008.[6] Finally, the disutility shocks are specified as $\theta_L = 1 - \triangle$ and $\theta_H = 1 + \triangle$. The parameter $\triangle$ is set so as to reproduce the observed variance of log-hours of married females at age 40. As it is the standard in the literature, we select the discount factor β, so that the steady-state capital to output ratio matches the value in the data (2.93).

Utility costs associated to joint work allow us to capture the residual heterogeneity among couples, beyond heterogeneity in endowments and childbearing status, that is needed to account for the observed heterogeneity in participation choices. We assume that the utility cost parameter of joint participation is distributed according to a (flexible) gamma distribution, with parameters k_z and θ_z. Thus, conditional on the husband's type z,

$$q \sim \zeta(q|z) \equiv q^{k_z-1}\frac{\exp(-q/\theta_z)}{\Gamma(k_z)\theta_z^{k_z}},$$

where $\Gamma(.)$ is the Gamma function, which we approximate on a discrete grid. This procedure allows us to exploit the information contained in the differences in the labor force participa-

[6] The numbers are for people between ages 25 and 54 and are based on data from the CPS. We find mean yearly hours worked by all males and females by multiplying usual hours worked in a week and number of weeks worked. We assume that each person has an available time of $5,000$ hours per year.

tion of married females as their own wage rate changes with skill. In this way, we indirectly control the 'slope' of the distribution of utility costs, which is potentially key in assessing the effects of changing incentives for labor force participation.

Using the Census data, we calculate that the employment-population ratio of married females between ages 25 and 54, for each of the educational categories defined earlier.[7] Table A4 shows the resulting distribution of the labor force participation of married females by the productivities of husbands and wives for married households. The aggregate labor force participation for this group is 71.8%, and it increases from 68.2% for the unskilled group to 77.4% for the skilled. Our strategy is then to select the two parameters governing the gamma distribution, for every husband type, so as to reproduce each of the rows in Table A4 as closely as possible. This process requires estimating four parameters (i.e. a pair (θ, k) for each husband educational category). Given the estimated values for k_z and θ_z, we determine the loading factors $\vartheta_x(t_{min})$ so that the model is consistent with the participation rate of mothers by the age of their youngest child present at home, shown in Figure A2 (lef panel). To compute the participation rate of married females by skill by the age of their youngest child at home, we use data from the 2008 ACS.

Finally, we set the capital share to $\alpha = 0.343$ and the depreciation rate of capital to $\delta^k = 0.055$.[8] To select the parameter governing the elasticity of substitution, ρ, we use standard estimates of this elasticity that suggest a value of 1.5 – see Katz and Murphy (1992) and Heckman, Lochner and Taber (1998). This dictates $\rho = 1/3$. To calibrate the share parameter ξ, we force the model to reproduce the aggregate *skill premium* in the data, defined as per-worker earnings of workers in the skilled category to per-worker earnings of workers in the unskilled category. For this statistic, we target a value of 1.8.[9]

Tables A12 and A13 shows full set of parameters.

4 Children

In the model each single female and each married couple belong to one of three groups: *without* children, *early* child bearer and *late* child bearer. We use information on the age of last birth of mothers by skill to determine who is each category. The unskilled early child

[7] We consider all individuals who are *not* in armed forces.

[8] We calibrate the capital share and the depreciation rate using a notion of capital that includes fixed private capital, land, inventories and consumer durables. For the period 1960-2000, the resulting capital to output ratio averages 2.93 at the annual level. We estimate the capital share and the capital to output ratio following the standard methodology; see Cooley and Prescott (1995). The data for capital and land are from Bureau of Economic Analysis (Fixed Asset Account Tables) and Bureau of Labor Statistics (Multifactor Productivity Program Data).

[9] The empirical target for the skill premium is from our calculations using data from the 2005 American Community Survey (ACS). We restrict the sample to the civilian adult population of both sexes, between ages 25 and 54 who work full time, and exclude those who are unpaid workers or make less than half of the minimum wage. Full time workers are defined as those who work at least 35 hours per week and 40 weeks per year. We estimate a value tightly centered around 1.8, when we include self-employed individuals or not.

bearers have all children at age 1 (age 25). Skilled early-child bearers have children at age 1 (25) and at age 3 (27). Late child bearers have their children at ages 8 and 10, corresponding to ages 32 and 34. This particular structure captures the fact that births occur within a short time interval, mainly between ages 25 and 29 for unskilled households and between ages 30 and 34 for skilled households in the 2008 CPS June supplement.[10]

For singles, we use data from the 2008 CPS June supplement and calculate the fraction of 40 to 44 years old single (never married or divorced) females with zero live births. This provides us with a measure of lifetime childlessness. Then we calculate the fraction of all single women above age 25 with a total number of two live births who were below age 30 at their last birth. This fraction gives us those who are early child bearers, and the remaining fraction are assigned as late child bearers. The resulting distribution is shown in Table A5.

We follow a similar procedure for married couples, combining data from the CPS June Supplement and the U.S. Census. For childlessness, we use the larger sample from the U.S. Census.[11] The Census does not provide data on total number of live births but the total number of children in the household is available. Therefore, as a measure of childlessness we use the fraction of married couples between ages 35-39 who have no children at home.[12] Then, using the CPS June supplement we look at all couples above age 25 in which the female had a total of two live births and was below age 30 at her last birth. This gives us the fraction of couples who are early child bearers, with the remaining married couples labeled as the late ones. Table A6 shows the resulting distributions. Table A7 displays the number of children for single mothers by skill, and the corresponding ones for married couples.

Childcare Costs We use the U.S. Bureau of Census data from the Survey of Income and Program Participation (SIPP) to calibrate childcare costs. We estimate a relation that represents the relation between the average age of children at home and per-child childcare, conditional on mother's skills and marital status. We estimate:

$$\widehat{d}(x, t; mar) = a_x^{mar} + b_x^{mar} \ln(t),$$

where $mar \in \{M, S\}$ stands for marital status, and t is the average age of children at home. The childcare spending per children in the data, $\widehat{d}(x, t; mar)$, reflects effective spending, so captures differences among household in access to informal care or quality of childcare chosen. Figure A2 (right panel) shows the estimated values. Our estimates imply that

[10] The CPS June Supplement provides data on the total number of live births and the age at last birth for females, which are not available in the U.S. Census.

[11] The CPS June Supplement is not particularly useful for the calculation of childlessness in married couples. The sample size is too small for some married household types for the calculation of the fraction of married females, aged 40-44, with no live births.

[12] Since we use children at home as a proxy for childlessness, we use age 35-39 rather than 40-44. Using ages 40-44 generates more childlessness among less educated people. This is counterfactual, and simply results from the fact that less educated people are more likely to have kids younger, and hence these kids are less likely to be at home when their parents are between ages 40-44.

childcare costs are non-trivially larger for skilled mothers, while they decline fast as children age. The annual rate of decline is about 11-12% when the child age is five for skilled mothers. For unskilled mothers, the corresponding rate of decline is about 10-11%

Given the price of unskilled labor services, we recover the efficiency units required for each age in each case. That is, childcare costs of a married couple where the wife is of skill x are given by $w^u d^M(x,t) = \widehat{d}(x,t;M)$ for each t, while for a single woman are given by $w^u d^S(x,t) = \widehat{d}(x,t;S)$. The resulting values for efficiency units are scaled so that the total childcare expenditure for children between ages 0 to 5 is in line with the data. The total yearly cost for employed mothers, who have children between 0 and 5 and who make childcare payments, was about \$6,414.5 in 2005, which is about 10% of average household income. In the benchmark economy, this choice of parameter values results in 1.2% of the total labor input being used to produce childcare services. This is broadly in line with the share of employment in the childcare sector in the U.S., which was about 1.1% in 2012.[13]

5 Taxes

Income Taxes To construct income tax functions for married and single individuals, we follow Guner et al (2014) and estimate *effective tax rates* as a function of reported income, marital status and the number of children. The underlying data is tax-return, micro-data from Internal Revenue Service for the year 2000 (Statistics of Income Public Use Tax File). For married households, the estimated tax functions correspond to the legal category *married filing jointly.* For singles without children, tax functions correspond to the legal category of *single* households; for singles with children, tax functions correspond to the legal category *head of household.*[14] To estimate the tax functions for a household with a certain number of children, married or not, the sample is further restricted by the number of dependent children for tax purposes.

Since the EITC, CTC and CDCTC are explicitly modelled in the benchmark economy, we consider tax liabilities in the absence of these credits. To this end, let I stand for multiples of mean household income in the data. That is, a value of I equal to 2 implies an actual level of income that is twice the magnitude of mean household income in the data, and we denote by $\widetilde{t}(I)$ the corresponding tax liabilities after any tax credits. Tax credits reduce the tax liability first to zero and if there is any refundable credit left, the household receives a transfer. Let $credit(I)$ be the total credits without any refunds, which we can identify in the

[13] Total employment in childcare services (NAICS 6244) was about 1.6 million in 2012. This number is the sum of total paid employment and the number of establishments without paid employees. See http://thedataweb.rm.census.gov/TheDataWeb_HotReport2/econsnapshot/2012/snapshot.hrml?NAICS=6244.

[14] We use the 'head of household' category for singles with children, since in practice it is clearly advantageous for most unmarried individuals with dependent children to file under this category. For instance, the standard deduction is larger than for the 'single' category, and a larger portion of income is subject to lower marginal tax rates.

IRS micro tax data. Taxes in the absence of credits is then given by $t(I) = \widetilde{t}(I) + credit(I)$. The incomes tax functions, i.e. $T^S(I,k)$ and $T^M(I,k)$,take the following form

$$\tau(I) = 1 - \lambda I^{-\tau},$$

where I is measured in multiples of mean household income, $\tau(I)$ is the average tax rate, parameter τ determines the progressivity of taxes and λ determines the taxes at the mean household income ($I = 1$). Parameters τ and λ depend on marital status and the number of children. The total tax liabilities amount to $\tau(I) \times I \times$ *mean household income*.

Estimates for λ and τ are contained in Table A8 for different tax functions we use in our quantitative analysis. Given the number of children that different types of households have in Table A7, we estimate tax functions for households with zero, two and three children. We then round the number of children from Table A7 to the nearest integer and assign the appropriate tax function to each household. Figure A3 (left panel) displays estimated average and marginal tax rates for different multiples of household income for married and single households with two children. Our estimates imply that a married household with two children at around mean income faces an average tax rate of about 9.2% and marginal tax rate of 14.6%. As a comparison, a single household with two children around mean income faces average and marginal tax rates of 7.73% and 10.96%, respectively. At twice the mean income level, the average and marginal rates for a married household amount to 12.89% and 18.09%, respectively, while a single household at the mean income level has an average tax rate of 9.95% and a marginal tax rate of 13.11%.

Social Security and Capital Taxation We calculate $\tau_p = 0.086$, as the average value of the social security contributions as a fraction of aggregate labor income for 1990-2000 period.[15] Using the 2008 ACS, we calculate total Social Security benefits for all single and married households.[16] Tables A9 and A10 show Social Security benefits, normalized by the level corresponding to single males of the lowest type, $p_m^S(z_1)$. We treat $p_m^S(z_1)$ as a free parameter, and determine all other benefit levels according to Tables A11 and A12. Then, given τ_p, choose $p_m^S(z_1)$ to balance the budget for the social security system. Hence, while the relative values social security benefits come from the data, the absolute level of one, $p_m^S(z_1)$, is adjusted to balance the budget of the system. The implied value of $p_m^S(x_1)$ for the benchmark economy is about 18.1% of the average household income in the economy.

We use τ_k to proxy the U.S. corporate income tax. We estimate this tax rate as the one that reproduces the observed level of tax collections out of corporate income taxes after the

[15] The contributions considered are those from the Old Age, Survivors and DI programs. The Data comes from the Social Security Bulletin, Annual Statistical Supplement, 2005, Tables 4.A.3.

[16] Social Security income is all pre-tax income from Social Security pensions, survivors benefits, or permanent disability insurance. Since Social Security payments are reduced for those with earnings, we restrict our sample to those above age 70. For married couples we sum the social security payments of husbands and wives.

major reforms of 1986. Such tax collections averaged about 1.92% of GDP for 1987-2000 period. Using the technology parameters we calibrate in conjunction with our notion of output (business GDP), we obtain $\tau_k = 0.097$.

6 Welfare State

Transfers, $TR_f^S(I,k,D), TR_m^S(I)$, and $TR^M(I,k,D)$, consist of three components. The first component is the Earned Income Tax Credit (EITC). The second part is child-related transfers, which consists of Child Tax Credit (CTC), the Child and Dependent Care Tax Credit (CDCTC), and childcare subsidies. The final component is the means-tested transfers.

Earned Income Tax Credits (EITC) The Earned Income Tax Credit is a fully refundable tax credit that subsidizes low income working families. The EITC amounts to a fixed fraction of a family's earnings until earnings reach a certain threshold. Then, it stays at a maximum level, and when the earnings reach a second threshold, the credit starts to decline, so that beyond a certain earnings level the household does not receive any credit. The amount of maximum credits, income thresholds, as well as the rate at which the credits declines depend on the tax filing status of the household (married vs. single) as well as on the number of children. To qualify for the EITC, the capital income of a household must also be below a certain threshold, which was \$2,650 in 2004. In 2004, for a married couple with 0 (2 or 3) children, the EITC started at \$2 (\$10) and increased by 7.6 (39.9) cents for each extra \$ in earnings up to a maximum credit of \$3,900 (\$4,300). Then the credit stays at this level until the household earnings are \$7,375 (\$15,025). After this level of earnings, the credit starts declining at a rate of 7.6 (21) cents for each extra \$ in earnings until it becomes zero for earrings above \$12,490 (\$35,458). The formulas for a single household with 0 (2 or 3) children are very similar. We calculate the level of $EITC$ as a function of earnings with the following formula,

$$\begin{aligned} EITC &= \max\{CAP\text{-}\max\{slope_1 \times (bend_1 - earnings), 0\} \\ &\quad - \max\{slope_2 \times (earnings - bend_2), 0\}, 0\}, \end{aligned}$$

where CAP, the maximum credit level, $bend_1$ and $bend_2$, the threshold levels, and $slope_1$ and $slope_2$, the rate at which credit increase and decline are given by (as a fraction of mean household income in 2014):

	CAP	$slope_1$	$bend_1$	$slope_2$	$bend_2$
Married					
No ch.	0.006	0.076	0.085	0.076	0.122
2 or 3 ch.	0.071	0.399	0.178	0.21	0.248
Single					
No ch.	0.006	0.076	0.085	0.076	0.105
2 or 3 ch.	0.071	0.399	0.178	0.21	0.232

Figure A4 (left panel) shows the EITC as a function of household income and the tax filing status.

Child Tax Credits We also model the Child Tax Credits (CTC), or simply *child credits*, as closely as possible to how they are present in the U.S. tax code. Child credits operate as a means-tested transfer to households with children. If a household's income is below a certain limit, $\widehat{I}_{CTC}$, then the potential credit is $d_{CTC} = \$1,000$ per child in 2004. If the household income is above the income limit, then the credit amount declines by 5% for each additional dollar of income. In the current tax code, $\widehat{I}_{CTC}$ is \$110,000 for a married couple and \$75,000 for singles. As a result, a married couple with two children whose total household income is below \$110,000 has a potential child credit of \$2,000, a household with two children whose total household income is \$120,000 can only get \$1,500. The child credit becomes zero for married couples (singles) whose total household income is above \$150,000 (\$115,000). As the CTC is not fully refundable, the actual CTC that a household gets depends on the total tax liabilities of the household and other child-related credits that the household might qualify.

For a household with income level I (again indicated as a multiple of mean household income in the economy) and k children, the *potential CTC* is given by

$$CTC_{potential}(I) = \max\{[k \times 0.0165 - \max(I - \widehat{I}_{CTC}, 0) \times 0.05], 0\}, \tag{11}$$

with

$$\widehat{I}_{CTC} = \begin{cases} 1.819, & \text{if married filing jointly} \\ 1.240, & \text{if single} \end{cases},$$

where again the maximum amount of credit per child, 0.0165, and income limits, 1.819 and 1.240, are in multiples of mean household income in the U.S. in 2004. Both the CTC and the CDCTC are *non-refundable*, as a result, how much of the potential credit a household actually gets depends on its total tax liabilities and total tax credits (CTC plus CDCTC). Let $Credit_{potential}(I) = CTC_{potential}(I) + CDCTC_{potential}(I)$ and $Taxes(I)$ be the total potential tax credits and the tax liabilities of the household. Then,

$$CDCTC_{actual}(I) = \begin{cases} CDCTC_{potential}(I), \text{ if } Taxes(I) > Credit_{potential}(I) \\ \max\{Taxes(I) - CDCTC_{potential}(I), 0\}, \text{ if } Taxes(I) < Credit_{potential}(I) \\ \qquad\qquad \text{and } CDCTC_{potential}(I) > Taxes(I) \\ \\ CDCTC_{potential}(I), \text{ if } Taxes(I) < Credits_{potential}(I) \\ \qquad\qquad \text{but } CDCTC_{potential}(I) < Taxes(I) \end{cases},$$

and

$$CTC_{actual}(I) = \begin{cases} CTC_{potential}(I), \text{ if } Taxes(I) > Credits_{potential}(I) \\ 0, \text{ if } Taxes(I) < Credits_{potential}(I) \\ \qquad\qquad \text{and } CDCTC_{potential}(I) > Taxes(I) \\ \\ Taxes(I) - CDCTC_{potential}(I), \text{ if } Taxes(I) < Credits_{potential}(I) \\ \qquad\qquad \text{but } CDCTC_{potential}(I) < Taxes(I) \end{cases}$$

Hence, if the tax liabilities of a household are larger than the total potential credit implied by the CTC and the CDCTC, the household receives the full credit and its tax liabilities are reduced by $CTC_{potential} + CDCTC_{potential}$. If the total potential credits are larger than tax liabilities, then the household only receives a credit up to its tax liabilities. As a result, the households with low tax liabilities do not benefit from the CTC or CDCTC. This is partially compensated by the Additional Child Tax Credit (ACTC), which gives a household additional tax credits if its potential child tax credit is higher than the actual child tax credits it receives. In order to qualify for the ACTC, however, a household must have earnings above \$10,750. Thus, a household with very low earnings does not qualify for the ACTC. Given CTC_{actual} and CTC_{credit}, the ACTC is calculated as

$$ACTC(I) = \begin{cases} \min\{\max[(earnings - 0.178), 0] * 0.15, CTC_{potential}(I) - CTC_{actual}(I)\} \\ \qquad\qquad \text{if } CTC_{actual}(I) \leq CTC_{credit}\ (I) \\ 0, \text{ otherwise} \end{cases}.$$

Childcare Credits All households with positive income can qualify for the Child and Dependent Care Tax Credit (CDCTC), or, as we refer in the paper, for *childcare credits*. We model these credits as closely as possible to the tax code. Potential childcare credits are calculated in two steps, using the total childcare expenditures of the household, a cap, and rates that depend on household income. First, for each household, a childcare expenditure that can be claimed against credits is calculated. This expenditure is simply the minimum of the earnings of each parent in the household, a cap and actual childcare expenditures. The cap is set \$3,000 and \$6,000 for households with one child and with more than one child in 2004. Second, each household can claim a certain fraction of this qualified expenditure as a tax credit. This fraction starts at 35%, and declines by household income by 1% for each \$2,000 above \$15,000 until it reaches 20%, and then remains constant at this level.

We model the childcare credits (CDCTC), child credits (CTC) as well as the Earned Income Tax Credit (EITC) as they appear in 2004 tax code. Since we represent all variables as a fraction of mean household income, in the absence of any change in the tax code, the reference year is not critical. While there were temporary changes in the tax code during the Great Depression, the only major permanent change has been the 2017 Tax Cuts and Jobs Act.

For a married couple with k children, the qualified expenditure is calculated as follows

$$\text{Expense } = min\{d_{CDCTC} \times \min\{k, 2\}, earnings_1, earnings_2, d\},$$

where $earnings_1$ and $earnings_2$ are the earnings of the household head and his/her spouse and d is the child care expenditure (net of any childcare subsidy that a household might qualify). Note that a married couple household can have qualified expenses only if both the husband and the wife have non-zero earnings. The child care expenditures for the calculation of the childcare credits are capped at d_{CDCTC} per child per year, with a maximum of $2 \times d_{DCCTC}$.

For a single female household, the equivalent formula is given by

$$\text{Expense } = min\{d_{CDCTC} \times \min\{k, 2\}, earnings, d\}.$$

In 2004, d_{CDCTC} was \$3,000, i.e. maximum qualified expenditure for households with more than 1 child was capped at \$6,000. In multiples of mean household income in the U.S. (\$60,464 in that year), d_{CDCTC} was equal to 0.0496, i.e. about 5% of mean household income in the US. A household, however, only receives a fraction $\theta_{CDCTC}(I)$ of qualified expenses. The rate, θ_{CDCTC}, is a declining function of household income. It is set at 35% for households whose income is below \$15,000 ($\widehat{I}_{CDCTC}$), and after this point the rate declines by 1% for each extra \$2,000 that the household earns down to a minimum of 20%. Hence, the potential $CDCTC$ that a household can receive is then given by

$$CDCTC_{potential}(I) = \text{Expense} \times \theta_{CDCTC}(I), \tag{12}$$

with

$$\theta_{CDCTC}(I) = \begin{cases} 0.35, \text{ if } I \leq \widehat{I}_{CDCTC} \\ 0.35 - \min\{[\text{integer}(\frac{I-\widehat{I}_{CDCTC}}{0.033}) + 1] \times 0.01, 0.15\}, \text{ otherwise} \end{cases},$$

where $\widehat{I}_{CDCTC}$ is equal to 0.248 is in multiples of mean household income in the U.S. in 2004. Figure A4 (right panel) illustrates the sum of $CDCTC_{potential}(I)$ and $CTC_{potential}(I)$.[17]

[17] The simulations for $CDCTC_{potential}(I)$ in Figure A4 are done under the assumption th at at each income level, the husband and the wife earns 60% and 40% of the household income, respectively, and the households spend 10% of their income on childcare.

Childcare Subsidies We assume that the childcare subsidies in the model economy reflect the childcare subsidies provided by the Children Child Care and Development Fund (CCDF) in the US. In 2010, about 1.7 million children (ages 0-13) were served by CCDF. This is about 5.5% of all children (ages 0-13) in the US. In 2010, the average household income of households that received childcare subsidy was about \$19,000. About 74% of families who receive childcare subsidies from CCDF made co-payments , and co-payments were about 6% of family income. If we take \$19,000 as average income of subsidy receivers, this amounts to a co-payment of 1,140 dollars per year. In 2010, the average monthly payment for childcare providers (including the co-payment by the families) was about \$400 per month or \$4,800 a year. Hence about 24% of total payments $(1,140/4,800)$ came from households, while the remaining 76% are subsidies. In our calibration we simply set $\theta = 0.75$ and set $\widehat{I}$ such that the poorest 5.5% of families with children receive a subsidy from the government. This procedure sets $\widehat{I}$ at about 15.8% of mean household income in the benchmark economy. In the main policy experiments that we consider, we make the childcare subsides universal by setting $\widehat{I}$ to an arbitrarily large number.

Means-Tested Transfers We use the 2004 wave of the Survey of Income and Program Participation (SIPP) to approximate a welfare schedule as a function of labor earnings for different household types. The sample of household heads aged 25-54 spans 876,277 observations across 24,392 households. Per household there are between 1 and 48 monthly observations with an average of nearly 36 monthly observations per household. The SIPP is a panel surveying households every three months retrospectively for each of the past three months. We compute the average amount of monthly welfare payments and monthly labor earnings, both corrected for inflation, for each household. The welfare payments include the following main means-tested programs: Supplemental Social Security Income (SSI), Temporary Assistance for Needy Families (TANF formerly AFDC), Supplemental Nutrition Assistance Program (SNAP formerly food stamps), Supplemental Nutrition Program for Women, Infants, and Children (WIC), and Housing Assistance.[18] We then estimate an "effective transfer function" (conditional on marital status and the number of children). We assume that these functions take the following form

$$W(I) = \begin{cases} \omega_0 \text{ if } I = 0 \\ \max\{0, \omega_1 - \omega_2 I\} \text{ if } I > 0 \end{cases},$$

where ω_0 is the transfers for a household with zero income and ω_2 is the benefits reduction rate. In order to determine ω_0, we simply calculate the average amount of welfare payments for households with zero non-transfer income. Then we estimate an OLS regression of welfare

[18] The SIPP only provides the information of whether a household receives Housing Assistance, but does not contain information on actual payments. We use the methodology of Scholz, Moffitt and Cowan (2009) to impute Housing Assistance reception. For all other transfer programs, the SIPP provides information on the actual amount received.

payments on household non-transfer income to determine α_0 and α_1. In Table A11 shows the estimated values of ω_0, α_1 and α_2 by marital status and the number of children. Figures A3 (left panel) shows the welfare payments as a function of household income for married and single female households, respectively.

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Table A1: Initial Productivity Levels, by Type and Gender

	$\varpi_m(1,z)$	$\varpi_f(1,x)$	$\varpi_f(1,x)/\varpi_m(1,z)$
Skilled	0.95	0.83	0.88
Unskilled	0.73	0.58	0.80

Note: Entries are the productivity levels of males and females, ages 25, using 1980-2006 data from the CPS March Supplement. These levels are constructed as weekly wages for each type –see text for details.

Table A2: Distribution of Married Working Households by Type

	Females	
Males	Unskilled	Skilled
Unskilled	51.37	12.81
Skilled	8.93	26.90

Note: Entries show the fraction of marriages out of the total married pool, by wife and husband educational categories. The data used is from the 2008 ACS, ages 30-39. Entries add up to 100 –see text for details.

Table A3: Fraction of Agents by Type, Gender and Marital Status

	Males			Females		
	All	Married	Singles	All	Married	Singles
Unskilled	65.38	48.19	17.19	62.23	44.03	18.21
Skilled	34.62	26.51	8.11	37.77	29.10	8.66

Note: Entries show the fraction of individuals in each educational category, by marital status, constructed under the assumption of a stationary population structure –see text for details.

Table A4: Labor Force Participation of Married Females, 25-54

	Females	
Males	Unskilled	Skilled
Unskilled	69.1	85.2
Skilled	64.8	73.3

Note: Each entry shows the labor force participation of married females ages 25 to 54, calculated from the 2008 ACS. The outer row shows the weighted average for a fixed male or female type.

Table A5: Childbearing Status, Single Females

	Childless	Early	Late
Unskilled	29.27	57.42	13.31
Skilled	54.63	28.17	17.20

Note: Entries show the distribution of childbearing among single females, using data from the CPS-June supplement. See text for details.

Table A6: Childbearing Status, Married Couples

Childless			Early		
	Females			Females	
Male	Unskilled	Skilled	male	Unskilled	Skilled
Unskilled	9.22	13.17	Unskilled	63.46	40.58
Skilled	9.89	11.51	Skilled	45.88	26.95

Note: Entries show the distribution of childbearing among married couples. For childlessness, data used is from the U.S. Census. For early childbearing, the data used is from the CPS-June supplement. Values for late childbearing can be obtained residually for each cell. See text for details.

Table A7: Fertility Differences

Singles		Married		
			Females	
		Male	Unskilled	Skilled
Unskilled	2.21	Unskilled	2.34	2.05
Skilled	1.82	Skilled	2.33	1.98

Note: Entries show, conditional on having children, the total number of children different types of households have by age 40-44. The authors' calculations from the 2008 CPS-June supplement. See text for details.

Table A8: Tax Functions

Estimates	Married		Single	
	(no child)	(2 child.)	(no child)	(2 child.)
λ	0.9024	0.9078	0.8815	0.9227
τ	0.0569	0.0596	0.0356	0.0351

Note: Entries show the parameter estimates for the postulated tax function. These result from regressing effective average tax rates against household income, using 2000 micro data from the U.S. Internal Revenue Service. For singles with two children, the data used pertains to the 'Head of Household' category – see text for details.

Table A9: Social Security Benefits, Singles

	Male	Female
Unskilled	1	0.888
Skilled	1.166	0.995

Note: Entries show Social Security benefits, normalized by the mean Social Security income of the lowest type male, using data from the 2008 ACS. See text for details.

Table A10: Social Security Benefits, Married Couples

	Females	
Males	Unskilled	Skilled
Unskilled	1.764	1.911
Skilled	1.981	2.093

Note: Entries show the Social Security income, normalized by the Social Security income of the single lowest type male, using data from the 2008 ACS. See text for details.

Table A11: Welfare System

Estimates	Married		Single Female		Single Male
	(no child)	(2 child.)	(no child)	(2 child.)	(no child)
ω_0	0.063	0.090	0.090	0.116	0.075
ω_1	0.023	0.043	0.044	0.101	0.032
ω_2	-0.017	-0.033	-0.042	-0.091	-0.028

Note: Entries correspond to the parameters summarizing our description of a host of transfer and social insurance programs ('welfare system'). Data comes from the 2004 wave of the SIPP. See text for details.

Table A12: Parameter Values - Idiosyncratic Shocks

Statistic	Permanent Shocks	Persistent Shocks
Variance Single Skilled Males	0.281	0.0042
Variance Single Unskilled Males	0.244	0.0066
Variance Single Skilled Females	0.226	0.0020
Variance Single Unskilled Females	0.226	0.0015
Variance Married Skilled Males	0.230	0.0036
Variance Married Unskilled Males	0.230	0.0061
Variance Married Skilled Females	0.220	0.0008
Variance Married Unskilled Females	0.228	0.0021
Covariance (male, female)	0.047	0.0010

Note: Entries are the variances of permanent and persistent innovations, by marital status, gender and skill. For married individuals, we covariances reported are independent of skill as assumed. See text for details.

Table A13: Parameter Values

Parameter	Value	Comments
Population Growth (n)	0.01	U.S. Data
Discount Factor (β)	0.982	Calibrated - matches K/Y
Labor Supply Elasticity (γ)	0.2	Literature estimates.
Disutility from work, (B_f, B_m)	82.15, 28.67	Calibrated
Preference Shock $\theta = 1 \pm \triangle$	1 ± 0.88	See text – Matches variance log hoursat age 40
Skill depreciation, females (δ_x)	0.025, 0.056	Calibrated
Growth of skills (α_x^e)	-	See text - CPS data
Distribution of utility costs $\zeta(.\vert z)$ (Gamma Distribution)	-	See text - matches LFP by education conditional on husband's type
Loading Factor $\vartheta_x(t_{\min})$	-	See text – matches LFP by age of youngset child
Capital Share (α)	0.343	Calibrated
Skilled Labor Share (ν)	0.513	Calibrated
Substitution Elasticity (ρ)	1/3	Literature estimates
Depreciation Rate (δ_k)	0.055	Calibrated
Childcare costs for single females, $d^S(x,t)$	-	See text - matches expenditure by age, and skills.
Childcare costs for married females $d^M(x,t)$	-	See text - matches expenditure by age, and skills.
Tax functions $T^M(I,k)$ and $T^S(I,k)$	-	See Appendix - IRS Data
Transfer functions $TR^M(I,k)$,	-	See text and Appendix
$TR_f^S(I,k)$ and $TR_m^S(I,k)$	-	
Payroll Tax Rate (τ_p)	0.086	See Appendix
Social Security Incomes,	-	See Appendix - U.S. Census
$p_m^S(z)$, $p_f^S(x)$ and $p^M(x,z)$	-	
Capital Income Tax Rate (τ_k)	0.097	See Appendix - matches corporate tax collections

Note: Entries show parameter values together with a brief explanation on how they are selected. Values for the population growth rate, the discount factor and depreciation rates are at the annual level. See text and Appendix for details.

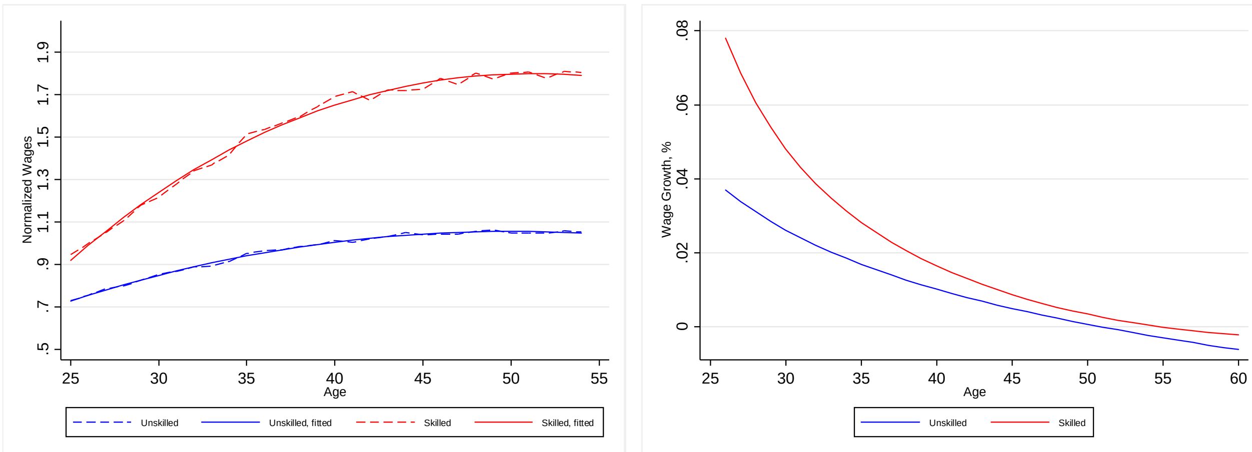

Figure A1 - Age-Labor Productivity Profiles, Males (left);
Female Human Capital Growth (right)

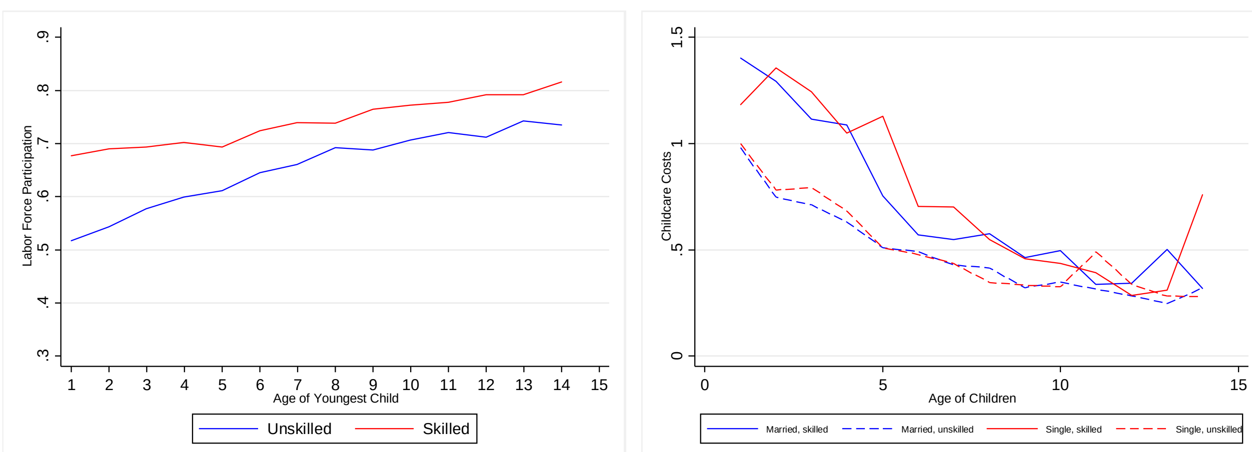

Figure A2 - LFP of Mar. Females, by age of the youngest child (left);
Childcare Costs per Child (right)

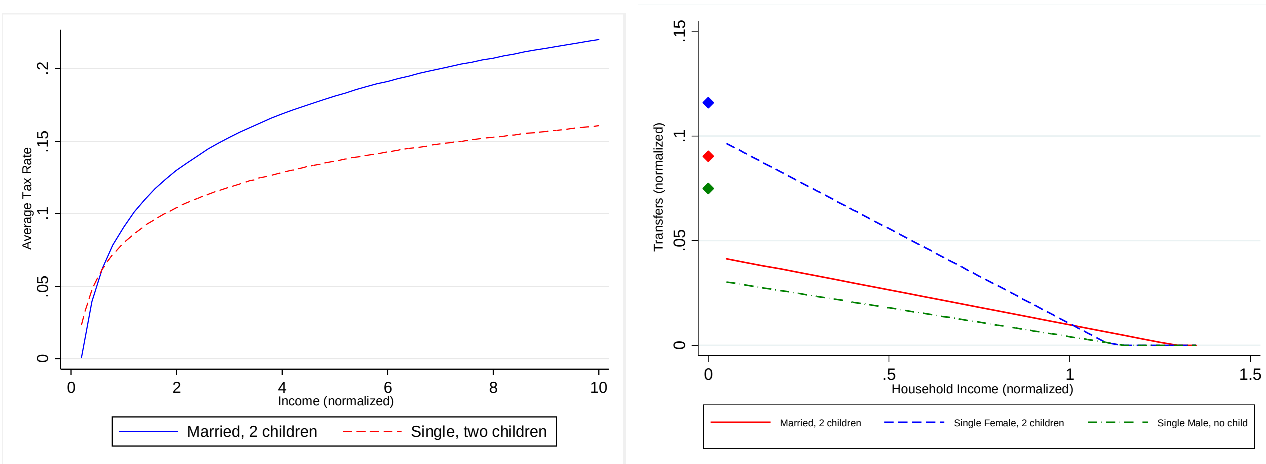

Figure A3 - Average Taxes (left); Welfare Payments (right)

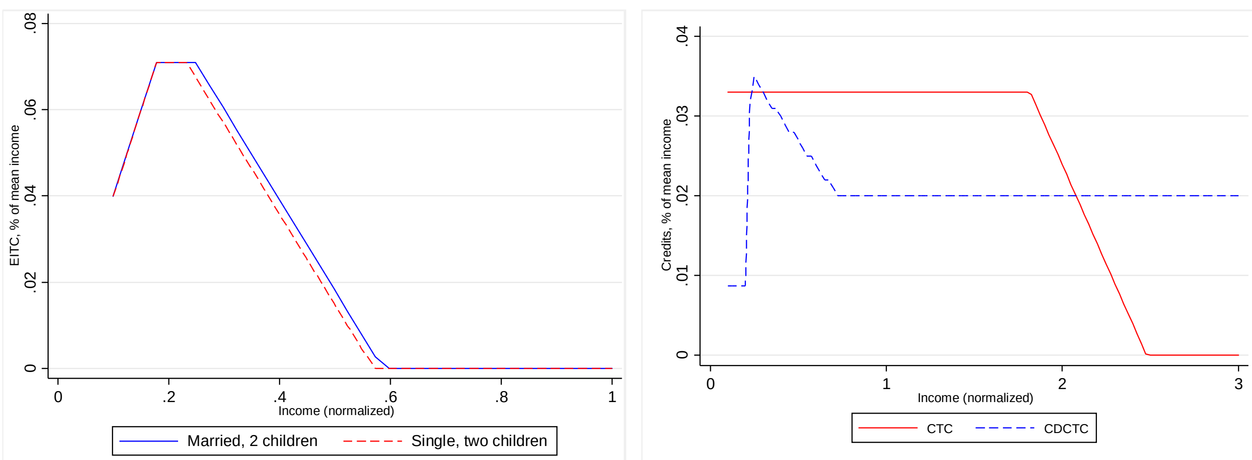

Figure A4 - The Earned Income Tax Credit (left); Potential CTC and CDCTC (right)