The Macroeconomic Effects of Universal Basic Income Programs

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Abstract

I develop a heterogeneous agents overlapping generations model to assess the welfare effects of substituting the US income security system with a UBI policy. I study two counterfactual exercises: an expenditure-neutral reform and a large, policy-oriented UBI reform with a transfer equivalent to $1,000 monthly, both financed by changes in the consumption tax. The first exercise has a moderate fiscal impact, induces increases in the aggregate output and employment, and reduces earnings and wealth inequality. The second exercise requires a large increase in the consumption tax rate, decreases employment and output, and increases earnings inequality, which moves sideways for wealth. In both cases, disposable income and consumption are more equally distributed, with less accrual at the top. The two economies generate positive welfare gains, with those for the generous UBI economy being larger.

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1 Introduction

A universal basic income (UBI) is an unconditional transfer given to all citizens of a given region or country. Over the last several years, pilot programs and experiments have been ongoing in both developed and developing economies.[1] The idea is far from new in economics as similar concepts have been proposed by Meade (1935), Friedman (1962) - with the negative income tax - and Atkinson (1996), among others, and has long been discussed by thinkers across all traditions of the political spectrum (Van Parijs and Vanderborght, 2017). In a nationwide context, the span of proposed policies is fairly broad: from large, one-time grants at the beginning of the working age on top of the already existing programs to an entire substitution of the welfare system, including Social Security and health benefits (Murray, 2006; Thigpen, 2016; Lowrey, 2018).

This paper assesses the effects of substituting the current income security share of the US welfare system for a UBI. I numerically solve a dynamic general equilibrium model that is able to provide micro-founded life-cycle and budgetary implications of such a broad reform of the welfare state as well as a normative assessment, building upon rich dynamics and heterogeneity and taking into account the overall impact on inequality. I develop a large-scale overlapping generations model with retirement and heterogeneity across households that incorporates both intensive and extensive margins of labor supply, human capital accumulation through labor market experience, and childcare costs. Households are also heterogeneous with respect to their permanent ability, child-bearing status, the initial level of assets, and estimated idiosyncratic productivity shocks, which include a high-productivity state to account for the share accrued by the top of the wealth distribution.

The model has a welfare system composed of income and social security systems (henceforth IS and SS) that mimic the US structure, accounting for means-testing require-

[1] Some examples are Brazil, Canada, Finland, Kenya, Switzerland, Uganda, and the United States. The Finnish program ran through 2017-18 (Ministry of Social Affairs and Health, 2019). In the US, some examples are the Y Combinator randomized control trial, the Stockton Economic Empowerment Demonstration in California, and the Democratic candidate Andrew Yang's "freedom dividend" proposal. A longstanding program of unconditional transfers is the Alaska Permanent Fund dividend.

ments and their taxation counterparts. The IS system includes the Earned Income Tax Credit (EITC), the Supplemental Nutrition Assistance Program (SNAP), Temporary Assistance for Needy Families (TANF), and Supplemental Security Income (SSI), the latter only available through retirement. The SS system is budget-balanced and pays retirement benefits to all households in the economy. I calibrate the model to the US economy, and with this macroeconomic toolkit, I conduct counterfactual analyses of implementing reforms in the welfare system toward a UBI and evaluate the welfare implications of means-tested versus unconditional transfers.

In order to bring this model to the data, I estimate a wage process taking into account the target population of cash transfer recipients using the 2008 panels of the Survey of Income and Program Participation (SIPP) similarly to Heathcote et al. (2010) and calibrate parameters to match data moments. The quantitative economy can replicate the overall size of the IS system as well as its taxation counterpart in an untargeted fashion. The model also approximates well the level of inequality of both the earnings and the wealth distributions, including their bottom and top tails. This is achieved through to the steepness of the earnings profile of high-productivity households via human capital accumulation, the means-testing transfer schedule with assets and income limits, and a calibrated superstar idiosyncratic state.

The first counterfactual I implement is an expenditure-neutral reform that keeps constant the total amount of budget outlays in transfers and lets the tax rate on consumption endogenously adjust to balance the government's budget. This is motivated by the common policy proposal of financing UBI via a VAT tax, which is observationally equivalent to a consumption tax in the model.[2] The aggregate response encompasses an increase of 15 percent in physical capital, with an accompanying decrease in the equilibrium interest rate. The result is driven by agents who, early in their life cycle, are at the bottom of the wealth distribution in the benchmark scenario and now save more due to the absence of means-testing and the smaller average level of transfers in the counterfactual economy. Pushed by an increase in aggregate capital, output increases by 13 percent. The absence

[2] Andrew Yang's freedom dividend policy proposal can be found at this link. Another policy proposal suggesting the coupling of UBI and a VAT tax is discussed in Gale (2020).

of requirements for the transfers and the smaller size of the UBI affect the aggregate labor market, raising participation by more than 10 percentage points, further contributing to the growth in savings and labor supply. This reform has a moderate impact on the tax effort to raise revenues for the UBI as the endogenous tax rate on consumption increases 1.3 percentage points. The new economy has lower pre-tax earnings and wealth inequality with better distributed disposable income.

In my second counterfactual exercise, I implement a UBI reform similar to the one proposed by Andrew Yang, the Democratic presidential candidate in the US 2020 election. I let the level of aggregate transfers be the equivalent of US$12,000 annually to each household in the model economy. In this scenario - and not surprisingly - the tax rate on consumption needs to increase by 19.3 percentage points to balance the government's budget. The aggregate response of the economy is a contraction of capital and output, stemming simultaneously from a drop in hours, a decline in labor force participation, and a decrease in the precautionary savings motive generated by the high level of the consumption floor. Regarding the impact on inequality, the second UBI reform increases the Gini coefficient for pre-tax earnings and moves sideways for wealth. This is primarily due to the selection mechanism induced by the labor supply structure, arising from the high-productivity agents who remain in the labor force and who are the only ones who can buffer consumption through higher savings. However, the inequality in disposable income at the very bottom of the distribution decreases, driven by a reduction in the means accrued by the top quintile. In both counterfactual UBI economies, the reduction of disposable income inequality is followed by more consumption redistribution toward the bottom of the income distribution, which is again reshuffled from the top.

The consumption equivalent variation of a newborn under the veil of ignorance required for the current system to attain the same level of welfare of the expenditure-neutral UBI alternative is 2.8 percent. The generous UBI transfer also generates solid welfare gains with a CEV of 3.9 percent. In order to inspect the mechanisms behind the changes in their counterfactuals and unpack the source of welfare gains in the steady-state analysis, I conduct several different analyses highlighting the differential roles of asset-testing, the setup cost in the labor supply, different sources of tax revenues to close the government budget constraint, and the fiscal rules for government spending and debt. A key finding in the expenditure-neutral exercise is that a relevant share of the welfare improvement in this counterfactual is due to the net result of the losses observed when eliminating asset-testing and the gains from eliminating earnings and income thresholds in an economy with large set-up costs of labor supply. Furthermore, the expenditure-neutral UBI reform is able to consistently generate welfare gains independent of the tax rate that is used to close the government's budget and exhibits less pronounced gains in an economy with a large UBI and fixed levels of government spending and debt.

Finally, the transitional dynamics affect the welfare responses of the steady state primarily due to the sharper movements in aggregate labor at the beginning of the transition in comparison to the slow adjustment in aggregate capital. It reduces the welfare gains for the expenditure-neutral counterfactual and increases those for the policy-oriented UBI, as capital increases in the long-run after the former and decreases after the latter. The decomposition of welfare along the age dimension during the enacted period of the transition shows that the welfare gains in the first counterfactual scenario are more pronounced at later ages, since working households that have children receive lower transfers. The second reform has much more pronounced gains at earlier and later ages, with losses at the ages immediately before and after retirement. These results are further confirmed by the breakdown across abilities and child-bearing statuses, where the lower-ability households or those with children accrue the smallest gains or the largest losses, depending on the size of the UBI.

Road Map. This paper is organized as follows. In the remainder of this section, I present a review of the related literature. In Section 2, I construct the setting of my quantitative model. In Section 3, I describe the calibration used to map the model to the data. Section 4 presents the results for the benchmark economy and the properties of the initial steady state. Section 5 lays out the quantitative exercises explored and the results for two counterfactual UBI reforms. In Section 6, I conduct several exercises to inspect the mechanisms behind the impact of the reforms. In Section 7, I discuss the results for the transitional dynamics and their welfare implications. The last section states my conclusions.

Related Literature I begin by briefly discussing the empirical evidence on the labor market effect of unconditional transfers. Marinescu (2018) documents the empirical findings of related experiments such as the negative income tax, casino dividend recipients, and lottery winners. She observes that in such programs, there is either no effect on labor market supply or a slight but not statistically significant reduction in work and earnings. For the case of the Alaska Permanent Fund dividend, one of the few clear examples of windfall transfers in a broad geographic region, Jones and Marinescu (2022) use a synthetic control method and find that the dividend cash transfer had no effect on the employment to population ratio and suggests a close to zero income effect for the extensive margin.

A small response of the labor supply is also confirmed by a cash transfer program held in Iran that compensated for the removal of energy subsidies; the program had a take-up rate of about 95 percent (Salehi-Isfahani and Mostafazi-Dehzooei, 2018). Conversely, a study by Giupponi (2019) on welfare transfers based on a spouse's death uses Italian administrative data to estimate the income effect of losing the benefit. She estimates a marginal propensity to earn from unearned income of approximately -1.0, indicating a larger response than previously observed in the literature. Recent evidence by Egger et al. (2022) estimates the behavioral and general equilibrium impacts of large cash transfers in rural villages in Kenya. The authors do not observe meaningful changes in the labor supply of treated households, with an increase in spending and a local fiscal multiplier of 2.5. For long-term effects, Price and Song (2018) found that the Seattle-Denver Income Maintenance Experiment decreased earnings later in the life of participants, and Cesarini et al. (2017), studying the wealth effect of lottery prizes in Sweden, found that winners had slightly reduced earnings, and the result being persistent and regardless of age, education, and sex.

The return of the UBI concept to the policy debate and, more recently, to the economics literature is due to both its simple design and the recent trends of an increase in economic inequality, a decline in labor force participation, and automation (Nakajima, 2017; Michaels, 2017; Acemoglu and Restrepo, 2020). Furthermore, over the last 20 years, there has been a steady growth of both federal spending and participation in means-tested income security programs, which, differently from the UBI, have testing thresholds that generate high effective marginal tax rates (CBO, 2013, 2015). As with any reform proposal, UBI-type programs involve trade-offs that raise skepticism about the effectiveness and feasibility of their implementation (Ravallion, 2019; Kearney and Mogstad, 2019). Topping the list of concerns are the potential large revenue needed for their financing and disincentives to work in the absence of requirements.[3]

Some of these issues have been tackled in the literature. In a quantitative setting that is akin to my own analysis. Fabre et al.'s (2014) paper is an early work wherein the authors compare the welfare effects of unemployment insurance (UI) against a UBI, finding that the former is socially robust to the latter's introduction. Lopez-Daneri's paper (2016) is a key and pioneer reference as it studies a revenue-neutral reform of the US income tax and welfare system in the form of a negative income tax. The author calibrates a life-cycle model to the US economy with welfare payments in a non-linear function of income and a lump-sum payment of retirement benefits. Taking into account the transitional dynamics of an open economy, the author finds that the optimal NIT imposes a 22 percent marginal tax rate and a transfer of 11 percent of the GDP of the benchmark economy with a welfare gain of 2.1 percent.

Ortigueira and Siassi (2022) develop a structural dynamic model with a rich system of means-tested transfers where households make decisions about family formation and program participation. The authors find in their model that single mothers have large incentives to work, with low-productive ones receiving, on average, a participation subsidy amounting to 15 percent of their labor earnings. Also, asset-testing and eligibility for programs such as SNAP or TANF introduce substantial distortions in the savings decisions of low-productivity workers, a point discussed in detail in Wellschmied (2021). In the context of Medicaid, Pashchenko and Porapakkarm (2017) show that asset-testing can

[3] Another concern lies in the economic intuition of equating the marginal utilities behind economic redistribution, which makes the UBI not intrinsically designed to achieve equity since it pays the same benefits to the rich and the poor.

reduce labor supply distortions in an environment with unobserved productivity. Finally, Nikiforos et al. (2017) study the effects of a UBI reform in a macro-econometric model and find an increase in aggregate demand when assuming no labor supply responses to cash transfers.

The recent quantitative macroeconomics literature analyzing the effects of UBI has been prolific, generating a comprehensive set of contemporaneous papers with a wide range of contributions. Daruich and Fernandez (2024) provide a quantitative general equilibrium approach to a UBI reform with a novel and different focus on skill investments during early childhood and education decisions. The model incorporates explicit intergenerational linkages with altruistic care of parents toward their children and their decision outcomes. Another contemporaneous paper is Conesa et al. (2023), who analyze the role of different types of funding and levels of generosity of a UBI in a model with two types of consumption goods, allowing the study of progressive consumption taxes. In a third contemporaneous paper, Guner et al. (2023) further study the issue of welfare-state reform, comparing the welfare effects of a UBI and an NIT, also at their optimal levels. Guner et al. (2023) use a setting with intra-household heterogeneity with single and married male and female agents. Ferreira et al. (2021) address the comparison of a UBI using conditional cash transfers (CCTs) in developing economies with the case of the Bolsa-Família program in Brazil. Mukbaniani (2021) studies the effects of a UBI in a setting with infinitely lived households. Finally, Rauh and Santos (2022) and Jaimovich et al. (2022) analyze the effects of UBI in a setting with labor market frictions, search, and unemployment, Ferriere et al. (2023) jointly optimize the tax-transfer system and show that a UBI plan can approximate the welfare gains obtained in the optimal outcome, and Guimarães and Lourenço (2024) analyze a UBI reform accounting for incomplete take-up, illegitimate transfers, and administrative costs.

My paper contributes to this strand of the literature and differentiates itself from the previously mentioned papers by explicitly framing a policy scenario of a reform toward a UBI as a departure from the status quo by substituting the IS system. In doing so, I follow Ortigueira and Siassi (2022) and Wellschmied (2021) and model the IS system and the many brackets and kinks for the different means-testing requirements, with an emphasis on the asset and investment income testing, a feature unique to this paper's environment. Such constraints are directly modeled into the households' problem and are calibrated to match the relevant equivalents in the data.[4] Another novel part consists of the interaction of the system with the operative extensive and intensive margins of the labor supply modeled as in Chang et al. (2019), which yields a mechanism that allows for an explicit trade-off between both margins under the different policies. Moreover, on top of that, I account for human capital accumulation based on labor market experience and the effect of children and combine all such ingredients in a general equilibrium framework, taking into account the effects of government spending and debt, as well as the welfare changes during the enacted period of the transitional dynamics.

The welfare gains achieved by the UBI in my analysis are consistent with the positive effects and magnitudes for newborns in Daruich and Fernandez (2024) when using consumption taxes. Also with consumption taxation, positive welfare effects are found in Conesa et al. (2023), mainly in the larger levels of UBIs. A welfare gain in a large UBI, even when using labor income taxes, is also found in Rauh and Santos (2022) when eliminating all means-tested transfers and UI. Guner et al. (2023) find that a UBI reform would generate ex-ante welfare losses for all newborns, but welfare gains for married households, which are more directly comparable to my analysis. In my results, the model can sustain welfare gains for newborns across different sizes of UBI, with different fiscal instruments and regimes. This highlights the importance of the mechanisms generated in the model by simultaneously taking into account the distortions caused by the many kinks of the means-tested transfers and non-convexity in the structure of the labor supply. Without the latter, an expenditure-neutral UBI reform is welfare-decreasing.

The general equilibrium component can be understood as complementary to the approach in dynamic structural models of the labor supply, such as Chan (2013), and to the approach in public economics in Saez (2002), Brewer et al. (2010), and Rothstein (2010), and to other methods reviewed by Chan and Moffitt (2018). A set of recent papers also

[4]See Appendices A.1 and B.4 for details.

study the UBI phenomenon from different perspectives. Hanna and Olken (2018) use data from Indonesia and Peru to analyze the trade-offs of proxy targeting versus a universal basic income. Banerjee et al. (2019) draw on the evidence from cash transfer programs in developing countries to anticipate the potential effects of a UBI as an incremental policy focused on mitigating poverty. Ghatak and Maniquet (2019) develop and study a theoretical framework to assess the normative justifications of a UBI system. Finally, Hoynes and Rothstein (2019) study the role of UBIs in advanced economies with a descriptive framework encompassing different policy designs. Thus, the main contribution of this paper from the perspective of this literature is to add a macroeconomic framework that can serve as a quantitative laboratory to assess the impact of a nationwide reform of the welfare system.

2 The Model

This section describes the dynamic general equilibrium model I use to analyze the macroeconomic effects of a reform of the income security system in the US toward a universal basic income. The environment is a life-cycle, overlapping generations economy with incomplete markets and individual heterogeneity, endogenous labor supply, human capital accumulation, and a tax and transfer system similar to that of the US.

Households are heterogeneous with respect to their age, $j \in \{1, \ldots, J\}$; permanent ability, $\theta \in \Theta$; idiosyncratic productivity shock, $z \in \mathcal{Z}$; human capital stock, $h \in \mathcal{H}$; and asset holdings, $a \in \mathcal{A}$. I also model an extra degree of heterogeneity in the family structure by allowing households to differ in terms of child-bearing, as it is one of the key determinants of allocations within the US tax code, thus keeping track of whether or not households are child-bearers, $k \in \mathcal{K} = \{0, 1\}$. The state-space of the economy is then the set $S = \mathcal{A} \times \mathcal{H} \times \mathcal{Z} \times \mathcal{K} \times \Theta \times \{1, \ldots, J\}$. In the following subsections, I discuss in detail every entry of the individual state space element $s = (a, h, z, k, \theta, j) \in S$.[5]

[5] The environment is set with the underlying purpose of assessing a reform of the transfer system that will be analyzed both in steady states and along the transition; hence, throughout the text, I selectively omit indices to avoid loading the notation. More specifically, I denote all individual variables as defined over the individual state space s; hence, they are age-dependent and thus implicitly indexed by j. However, they

Demographics Each model period stands for one year. Time t is discrete with an infinite horizon and the economy is populated by a continuum of mass one of households that live at most J years. There is uncertainty regarding the time of death in every age $j = 1, \ldots, J$ so that the household faces probability ψ_j of surviving to age j. Therefore, every period, a fraction of the household population dies and leaves accidental bequests q, which are fully taxed by the government. Aggregated accidental bequests are denoted by Q_t. The age profile of the population $\{\mu_j\}_{j=1}^{J}$ is modeled by assuming that the fraction of households with age j in the population is given by the law of motion $\mu_j = \frac{\psi_j}{(1+g_n)}\mu_{j-1}$ that satisfies $\sum_{j=1}^{J} \mu_j = 1$, and where g_n is the population growth rate.

I assume that the household does not decide the number of children to have or when to have them in a similar fashion to Attanasio et al. (2008). At every period t, a fraction p_k of the households are defined as having children during their life-cycle and then flagged by $k = 1$. When they do have children, they all simultaneously have the same number of children, which solely depends exogenously on their age. Households have a number of kids $n_{k,j}$ at age j who are born at working ages $\underline{j}^i$, with $i \in I$, where I is finite. I also assume that children live in the household until they are 18 years old.[6] Given this structure, and by knowing age j and the different ages at which children are born $\underline{j}^i$, we can count the number of children in the household $n_{k,j}$, as follows:

$$n_{k,j} = \sum_{i \in I} \mathbb{1}\left[\underline{j}^i \leq j \leq \underline{j}^i + 17\right]. \tag{1}$$

Households with children pay a childcare cost η whenever they are working and have young children in the household, defined as children between zero and two years old. Aggregate childcare costs are defined as CC_t.[7]

should also be understood as implicitly indexed by time t. As the aggregate variables are more naturally understood to be time-dependent, I explicitly index them by t.

[6]Here I follow the same formulation initially proposed in Attanasio et al. (2008) and used in Fehr and Kindermann (2018).

[7]The childcare cost is defined in units of the single final good produced in the economy.

Preferences Households have a time-separable period utility function and maximize their discounted expected lifetime utility from nondurable goods consumption c and labor supply l. It is defined as follows

$$\mathbb{E}\left[\sum_{j=1}^{J}\beta^{j-1}\left(\prod_{i=1}^{j}\psi_i\right)u(c,l)\right], \tag{2}$$

where β is the discount factor and $\mathbb{E}$ is the expectation operator.

Technology There is a single good produced in this economy, with technology given by a Cobb-Douglas production function that exhibits constant returns to scale, $Y = F(K_t, L_t) = \Lambda_t K_t^{\alpha} L_t^{1-\alpha}$, where $\alpha \in (0,1)$ is the capital income share of output, Λ_t is a technology multiplier, and Y_t, K_t and L_t denote, respectively, aggregate output, physical capital, and labor. The final good can be consumed or invested in physical capital. The price of the consumption good is normalized to one, and aggregate investment in physical capital, I_t, is defined by the standard law of motion, $K_{t+1} = (1-\delta_k)K_t + I_t$, where δ_k is the depreciation rate of physical capital. This technology is used by a representative firm that behaves competitively, maximizing profits at every period t by choosing labor and capital given factor prices. The associated first-order conditions are:

$$r_t = \alpha\Lambda_t\left(\frac{K_t}{L_t}\right)^{\alpha-1} - \delta_k, \quad w_t = (1-\alpha)\Lambda_t\left(\frac{K_t}{L_t}\right)^{\alpha} \tag{3}$$

Endowments and Labor Income All agents are born endowed with one unit of time and are forced to retire at age J_R. At the beginning of their life-cycle, they draw a permanent ability shock, $\theta \sim N(0, \sigma_\theta^2)$, which is discretized to assume two values with equal probability, $\Theta \equiv \{-\sigma_\theta^2, \sigma_\theta^2\}$. In the case of a high-ability draw, agents are endowed with a small level of initial assets, $\bar{a}_{j=1}$. These account for the usual initial level of assets most commonly associated with parental transfers. If households receive the low-ability shock, they start their lives with zero assets. The aggregate stock of assets is denoted by A_t and the stock of assets at the initial age, $A_{t,j=1}$. Since there are no direct intergenerational linkages in the model's demographic structure, I assume the government redistributes these assets from the collected stock of aggregated bequests.

While agents are working, household earnings depend on the competitive wage w_t, the permanent ability shock, θ, human capital level, h_j, and an idiosyncratic and persistent shock, z_j. I assume that households can only choose their hours within the set $[0, 1]$ and are subject to a non-convexity associated with the set-up costs for work, such as commuting time, as in Chang et al. (2019). I then define $\ell(l)$ to be the effective hours of work and use the following functional form to account for this effect:

$$\ell(l) = \max\left\{0, l - \bar{l}\right\}, \; l \in [0, 1], \tag{4}$$

where l is the individual labor supply and $0 < \bar{l} < 1$.

The function in (4) imposes a wedge on the mapping between chosen hours and labor earnings, and it gives rise to adjustments along the extensive and intensive margins as in Prescott et al. (2009). It can also be understood as accounting for the non-linearity of such mapping as studied in Erosa et al. (2016). This formulation is particularly suited to the nature of this paper's question, which calls for predictions about the behavior of the aggregate labor supply and allows a clear distinction between participation and movements along the intensive margin, such as the choice of part-time work.[8]

Households' pre-tax labor income is then defined by:

$$y(l, h_j, z_j) = \quad w \cdot \exp(\theta) \cdot \exp(z_j) \cdot h_j \cdot \ell(l) \tag{5}$$

I follow the approach used in Attanasio et al. (2008) and Guner et al. (2020, 2023) and assume that the human capital component evolves according to a law of motion that takes into account the increasing return on wage due to labor market experience:

[8] As emphasized in Chang et al. (2019), in this setting, adjustments along the intensive margin generate larger increases in efficiency units than those along the extensive margin. Because of this, I report later in the text, among other relevant moments, the changes in the mean aggregate efficiency units of labor and average hours conditional on employment.

$$h_{j+1} = H(h_j, l, j; \nu, \delta_h) = \exp\left[\ln h_j + (\nu_1 - \nu_2 \cdot j) \cdot \mathbb{1}_{[l_j > \bar{l}]} - \delta_h \left(1 - \mathbb{1}_{[l_j > \bar{l}]}\right)\right] \tag{6}$$

where ν_1 captures the positive effect of working, ν_2 is the diminishing marginal return of the incremental year in the labor force, and δ_h stands for the depreciation rate of the human capital stock when out of the labor force.[9] I define the aggregate level of human capital by HC_t. The idiosyncratic component z_j follows an AR(1) process defined by:

$$z_{j+1} = \rho z_j + \varepsilon_j,\ \varepsilon_j \sim N(0, \sigma_\varepsilon^2) \tag{7}$$

which is discretized in a Markov chain with transition matrix $\pi_{z,z'} = \Pr(z_{j+1} = z' | z_j = z)$ and stationary distribution $\Pi(z)$.

From age J_R onward, the labor supply is forcefully zero, and agents live off of potential transfers, retirement benefits, and accumulated wealth. I also assume that there is no altruistic bequest motive, and there is the certainty of death at $J+1$. Hence, agents alive at age J consume all resources, implying $a_{J+1} = 0$.

Government The government runs a welfare system designed to mimic the one in the US economy, has pure public spending G_t, has payments of its debt stock B_t, and collects taxes from households to finance its budget. I assume that in the benchmark economy, spending and public debt are defined by exogenous and constant shares of Y_t given by b_G and b_B, respectively. The revenue to finance welfare and spending is levied by an exogenous tax rate on capital income, τ_r; a non-linear, exogenous, and progressive tax schedule on labor income, $T_l(y)$; and an endogenous tax rate on consumption $\tau_{c,t}$ that adjusts to balance the government budget. Finally, an endogenous payroll tax rate $\tau_{SS,t}$ separately balances the budget of the Social Security system.

[9] Here, I also follow the formulation used in Fehr and Kindermann (2018). Note that, with the set-up costs for work defined in ℓ, the experience gained from participating in the labor force is now defined as being at least attached with a lumpy number of hours, thus avoiding the possibility of gaining returns to human capital by working an arbitrarily small number of hours, which would be the case if the law of motion was defined over l.

The labor income tax function is given by $T_l(y) = \max\{y_j \cdot (1 - \tau_0 \tilde{y}^{-\tau_1}), 0\}$, where τ_0 is the scale parameter that defines the level of the average tax rate, τ_1 is the parameter that governs the degree of progressivity implied by the curvature of the function, and $\tilde{y}$ is gross earnings relative to average labor earnings of working-age households, AE_t. This function, initially used in Benabou (2002), is standard in the literature measuring the impact of top-income taxation on government revenue in general equilibrium economies with heterogeneous agents (Guner et al., 2016; Heathcote et al., 2017; Holter et al., 2019).[10] I denote by TL_t the aggregate level of labor income tax collected. The SS system is operated on a pay-as-you-go schedule. It is separately balanced by a payroll tax rate $\tau_{SS,t}$ and pays retirement benefits independent of individuals' history defined by $b(AE_t) = b_{SS} AE_t$, where b_{SS} is the replacement rate.

The income security system (IS) is composed of the Earned Income Tax Credit (EITC), other means-tested transfers such as the Supplemental Nutrition Assistance Program (SNAP) or the Temporary Assistance for Needy Families (TANF), and Supplemental Security Income (SSI), available only when agents retire. I model the brackets and testing details of the EITC as defined by the Internal Revenue Service (IRS) by closely following the formulations in Ortigueira and Siassi (2022). The modeling of SNAP, TANF, and SSI closely follows the setting in Wellschmied (2021), drawing, respectively, from the details provided by the US Department of Agriculture (USDA), the Urban Institute, and the US Social Security Administration (SSA).

The eligibility and benefit calculation for these transfers follow a complex set of rules that require assessment of households' gross labor earnings, $y(l, h_j, z_j)$; investment income, $d = ra$; adjusted gross income, $y_a \equiv y(l, h_j, z_j) + d$; their stock of assets a for asset limits; household size defined by the number of kids $n_{k,j}$; and their age and work status. The benefit amount received by households for each of the programs is defined as $T_{EITC}(y, l, d, j)$, $T_{SNAP}(y, l, a, j)$, $T_{TANF}(y, l, a, j)$, and $T_{SSI}(b, a, j)$. I explain all the de-

[10] The version of the function I use has two important features: (i) the progressive income tax schedule is applied only to labor earnings and hence defined over $\tilde{y}$ as in Holter et al. (2019) and (ii) it only considers the non-negative part of the tax schedule as in Rauh and Santos (2022). The reasoning for the latter is that the region of the function that yields negative values approximates the role of the EITC as a wage subsidy in the data. As the EITC is separately modeled among the transfers, the adjustment is needed to avoid households receiving an excess amount of total tax credits.

tails for the eligibility and calculation of the benefits and lay out the formulas for each program in Appendix A.1 The total aggregate expenditure of the government on means-tested transfers is denoted by TR_t.

Lastly, as mentioned previously, I also assume that the government is responsible for collecting and taxing all accidental bequests q_j, denoted by Q_t when at the aggregate level. This assumption precludes the model environment from having two sources of lump-sum insurance and thus highlights the UBI transfer's relative effect. Hence, at any time t, the budget of the tax system is balanced if, and only if,

$$G_t + (1 + r_t)B_t + TR_t + A_{t,j=1} = \tau_{c,t}C_t + TL_t + \tau_r r_t A_t + Q_t + (1 + g_n)B_{t+1}.^{11} \tag{8}$$

2.1 Recursive Household Problem

Let $v(s)$ denote the value function of a j-year-old agent. As defined previously, $s = (a, h, z, k, \theta, j) \in S$ is the individual state space. Also, let $v^R(s)$ for $j = J_R, \ldots, J$ denote the value function of an individual age j who is retired and receives Social Security benefits. I normalize the value function of the terminal age J to zero, $v^R(s_{-j}, J + 1) = 0$, where henceforth s_{-j} stands for the individual state space without the age dimension.

The problem of an agent at age $j = 1, \ldots, J_R - 1$ who lies inside the fraction p_k of the population that bears children during their life-cycle is represented in the recursive form in the Bellman equation (9). For the agents in the complement fraction $(1 - p_k)$, the definition of the problem is identical but with $k = 0,\ \forall j$ and without childcare costs, η.

[11] Here we have that, in the aggregate, the transition path is characterized by several time-dependent endogenous objects, including the government's debt. This formulation follows the one in Kindermann and Krueger (2022) and, by assumption, the government does not run fiscal deficits to ensure satisfaction of its budget constraint.

$$
\begin{aligned}
&v(a,h,z;k=1,\theta,j) = \max_{c,a',l} u(c,l) + \beta\psi_{j+1}\mathbb{E}_z\left[v(a',h',z';k=1,\theta,j+1)\right] \\
&\text{s.t.} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (9)\\
&(1+\tau_c)c + a' + \eta\mathbb{1}_{\left[l>\bar{l},\,(j-\underline{j}^i)\leq 2\right]} = a(1+r(1-\tau_r)) + (1-\tau_{SS})y(l,h,z) \\
&\qquad\qquad - T_l[y(l,h,z)] + T_{EITC}(y,l,d,j) + T_{SNAP}(y,l,a,j) + T_{TANF}(y,l,a,j)
\end{aligned}
$$

$$
\begin{aligned}
&y(l,h,z) = w\exp(z+\theta)h\ell(l), \quad h' = H(h,l,j;\nu,\delta_h) \\
&n_{k,j+1} = \sum_{i\in I}\mathbb{1}\left[\underline{j}^i \leq j+1 \leq \underline{j}^i + 17\right] \\
&c > 0, \qquad a' \geq 0, \qquad 0 \leq l \leq 1
\end{aligned}
$$

For individuals at ages $j = J_R, \ldots, J$ the problem is:

$$
\begin{aligned}
&v^R(a,j) = \max_{c,a'} u(c,0) + \beta\psi_{j+1}v^R(a',j+1) \\
&\text{s.t.} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (10)\\
&(1+\tau_c)c + a' = a(1+r(1-\tau_r)) + b(AE) + T_{SSI}(b,a,j) \\
&\qquad c > 0, \quad a' \geq 0
\end{aligned}
$$

The solution of the dynamic programs (9) and (10) provides us with the decision rules for the asset holdings $a : S \to \mathbb{R}_+$, consumption $c : S \to \mathbb{R}_{++}$, labor supply $l : S \to [0,1]$, and human capital allocation $h : S \to \mathbb{R}_+$. The recursive competitive equilibrium for this economy is defined in Appendix A.2, and the computational details for the model solution are described in Appendix E.

3 Calibration

Demographics In the model, agents are born at $j = 1$, which stands for age 20 in real life; start their retirement at age $J_R = 45$, standing for 65 in real life; and die with probability one at age $J = 80$, equivalent to 100 years old. The age-dependent survival probabilities $\{\psi_j\}_{j=1}^{J}$ are the ones estimated by Fehr and Kindermann (2018) for the US population in 2010. Population growth is set to be $g_n = 1.1$ percent, the average long-run value for the US (Lopez-Daneri, 2016). I set the fraction of households that will have children during their life span to $p_k = 0.3$, which is the share of households living with children of their own under age 18 in the 2011 American Community Survey (ACS) as calculated by the Census Bureau (Vespa et al., 2013). They will have three children born at ages $\underline{j}^i = \{27, 30, 33\}$, with $I = \{1, 2, 3\}$ in equation (1), which defines the number of children at age j, $n_{k,j}$ (Fehr and Kindermann, 2018). The number of children is set to a maximum of three due to the design of the EITC as defined by the IRS.[12]

Preferences The period utility is

$$u(c, l) = \log(c) - \varphi \frac{l^{1+\frac{1}{\gamma}}}{1 + \frac{1}{\gamma}} \tag{11}$$

where φ controls the intensity of labor vs. consumption and γ governs the Frisch elasticity. I set $\gamma = 0.6$ as in Kindermann and Krueger (2022). Values between 0.5 and 1.5 are standard in the literature as discussed in Keane and Rogerson (2012), and the value chosen is at the center of the range of the ones analyzed in Chang et al. (2019), the main reference for the modeling structure of the labor supply. I jointly and endogenously calibrate φ and $\bar{l}$ so that the aggregate average hours dedicated to work conditional on employment are a third of the household's unit endowment of time, $H = 33$ percent, and the employment rate (ER) is 76.7 percent.[13] Both of these targets are taken from Chang et al.

[12] All details of the calibrated EITC benefit schedule are discussed in Appendix B.4.

[13] As in Chang et al. (2019), given the startup time costs present in the labor supply mapping to earnings, I condition the aggregate hours on employment, where participation is defined as the households' labor supply being above $\bar{l}$.

(2019), the former is standard in the literature, and the latter is calculated using the Panel Survey of Income Dynamics (PSID) for heads of households and spouses during the period 1980-2004. Finally, I endogenously calibrate the time discount factor β to match a capital-output ratio of $K/Y = 2.9$, as in Kindermann and Krueger (2022).

Technology I set the capital share of the economy to be $\alpha = 35$ percent as in Lopez-Daneri (2016), which is the average calculated for the US between 1960 and 2007. Following Kindermann and Krueger (2022), I calibrate the depreciation rate of capital δ_k so that the benchmark steady-state real interest rate is $r^* = 4$ percent and set the technology multiplier, Λ, to normalize the steady-state wage to $w^* = 1$. This implies that the labor-to-output ratio always equals the labor share, i.e., $(1 - \alpha)$ or 65 percent.

Labor Income As mentioned above, I calibrate the parameter $\bar{l}$ governing the wedge between hours and earnings jointly with φ to match average hours and employment rates. The variance for the permanent ability shock is calibrated to be $\sigma_\theta^2 = 0.009$ to target the Gini index of the earnings distribution. The bend points $\{\nu_1, \nu_2\}$ for the returns to experience in the human capital law of motion are taken from the coefficients estimated in the Mincerian regression given by equation (A.5) shown in Appendix B.2. The third coefficient of the cubic polynomial is of a negligible order of magnitude and has a less straightforward economic interpretation, and thus is discarded. The human capital depreciation is taken from Guvenen et al. (2014) and set to $\delta_h = 1.5$ percent. The persistence ρ and the error variance σ_ε^2 are the ones obtained from the estimation of the income process from the SIPP 2008. I use the point estimates obtained with the identity matrix as the GMM weighting matrix. The methodology is described in Appendix B.2, and the point estimates and standard errors are shown in Table A.5.

If households have kids with of age $j^i \in \{0, 1, 2\}$ in the household, they pay childcare cost η whenever they have a positive labor supply. This value is calibrated to target childcare costs of 17.1 percent of the average household's earnings. The is the model-equivalent ratio of \$9,600 in 2010 dollars. The cost is taken from the 2018 report "The US and the High Cost of Child Care" released by Child Care Aware of America and stands for the average level of the share of earnings paid by married couples.[14] If households have high ability, they receive an initial endowment of assets, $\bar{a}_{j=1}$ which is calibrated to be 1.33 percent of average assets, A. I obtain this value by using the estimates in Kuhn and Rios-Rull (2016) of the share of assets accrued by college-educated households (26.3 percent) and multiplying it by the the mean value of the stock of assets held by households of age under 25 relative to the mean value of the stock of assets of all households (5.05 percent).

Government I follow Conesa et al. (2023) and set the fraction of pure government public spending to be $b_G = 20.0$ percent and follow Trabandt and Uhlig (2011) to set the debt-to-GDP ratio to be $b_B = 63.0$ percent. I also follow their estimates to calibrate the capital income tax rate and set it at $\tau_r = 36$ percent. I set the parameters governing the progressive income tax function as in Holter et al. (2019), who use OECD tax data to find the values for married couples in the US. That yields a scale parameter $\tau_0 = 0.9420$ and curvature $\tau_1 = 0.1577$. The payroll contribution rate of the Social Security system, τ_{SS}, is calibrated endogenously to target a replacement rate $b_{SS} = 36$ percent. This is the median rate calculated by the CBO based on either the highest 35 years of earnings or the last 5 years of substantial earnings. This number is calculated for both sexes and includes all quintiles of the earnings distribution (CBO, 2019b). Finally, the whole IS system run by the government and embedded in the model amounts to several parameters. As there are many values and references to document, I explain them all in detail in Appendix B.4.

Summary of the Calibration Table 1 shows the endogenously calibrated parameters, the targeted moments associated with each of them, and the source of such moments for their data counterparts. In Table A.6 in Appendix B.3, one can find the values for the exogenously calibrated parameters and their sources. Finally, in Appendix B.4, I discuss in detail all the parameters and values used in the model economy's income security system. All the relevant data and ratios that map data for the parameters to the model can be found in Tables A.7 through A.13.

[14] The report can be found in this link.

Table 1: Endogenously calibrated parameters.

	Parameter	Value	Target	Data	Model	Source
Preferences						
Discount factor	β	0.996	K/Y	2.9	2.9	Kindermann and Krueger (2022)
Disutility of labor	φ	58.36	H	33.0%	33.1%	Standard
Commuting costs	$\bar{l}$	0.209	ER	76.7%	78.0%	Chang et al. (2019)
Endowments						
Initial asset level	$\bar{a}_{j=1}$	-	1.33% $\cdot A$	-	0.017	Kuhn and Rios-Rull (2016)
Labor Income						
Childcare cost	η	0.054	17.1% $\cdot AE$	$9,600	$9,600	Child Care Aware of America
Var. of permanent shocks	σ_θ^2	0.010	Earn. Gini	0.67	0.66	Kuhn and Rios-Rull (2016)
Superstar shock	z_8	32.15	Wealth 99% - 100%	35.5%	30.8%	Kuhn and Rios-Rull (2016)
Prob of becoming superstar	$\pi_{x,8}$	$7.96 * 10^{-4}$	Wealth 95% - 99%	27.4%	23.7%	Kuhn and Rios-Rull (2016)
Prob of staying superstar	$\pi_{8,8}$	0.974	Wealth Gini	0.85	0.83	Kuhn and Rios-Rull (2016)
Technology						
Technology multiplier	Λ	0.911	$w^* = 1.00$	1.000	1.000	Standard
K depreciation rate	δ_k	0.081	$r^* = 0.04$	0.040	0.040	Standard
Government						
SS Payroll tax	τ_{SS}	10.61%	b_{SS}	36.0%	36.0%	Congressional Budget Office

Notes: The table summarizes the details for the endogenously calibrated model parameters. The columns show their numerical values, the associated targeted moments in the model economy, the values attained in the model economy for these moments, and their data sources. See text for details.

4 The Benchmark Economy

4.1 Aggregates

I begin the assessment of the benchmark economy by reporting untargeted equilibrium quantities of some of the main aggregate variables of the model and comparing them to their counterparts in the data. Table 2 summarizes the moments of the benchmark model with the baseline welfare system composed of the means-tested transfers. The size of the IS system, captured the total amount of transfers as a share of GDP, TR/Y, lies within the range identified in the data by the CBO (CBO, 2019a) and the average outlays between 2009 and 2019 for the Income Security programs as tabulated by the White House's Office of Management and Budget (OMB, 2023). It is also close to the value of 2.3 percent reported in Guner et al. (2023).

As I target the replacement rate of the SS system, b_{SS}, the payroll tax used to close the system's budget endogenously achieves the rate of 10.61 percent, which is thus nontargeted and close to the 12.4 percent rate set by the IRS. A similar pattern applies to the endogenous tax on consumption, τ_c, with the difference that the US does not have such a tax at the federal level. Nonetheless, the value obtained of 4.3 percent is close to the one estimated by Trabandt and Uhlig (2011). This rate provides an approximation of the tax revenue needed to sustain the benchmark income security system and thus the aggregate level of transfers, TR, which is a critical figure in the counterfactual comparisons.

Table 2: Untargeted aggregate statistics in the benchmark economy.

Variable	**Benchmark**	**Data**	**Source**
TR/Y	2.4%	1.3% - 2.8%	CBO, OMB
τ_c	4.3%	5.0%	Trabandt and Uhlig (2011)
τ_{SS}	10.6%	12.4%	IRS

Notes: The table shows untargeted moments in the model economy, their counterparts in the data, and their sources. The CBO data stand for the breakdown of mandatory spending in 2018 (CBO, 2019a). The OMB data stand for the average mandatory outlays for the income security system as a share of GDP between 2010-2019, calculated using Table 8.6 of the Historical Tables (OMB, 2023). The IRS defines the SS withholding rate and can be found here.

4.2 Earnings and Wealth Distributions

Table 3 shows the model-generated distributions of earnings and wealth, respectively, in comparison with the 2013 Survey of Consumer Finances (SCF) estimates by Kuhn and Rios-Rull (2016). The model is able to approximate well the overall level of inequality of both the earnings and the wealth distributions, especially at the bottom, with moderate success at the quintiles' partition. For the earnings distribution, this is not surprising since the wage process was estimated directly from the SIPP 2008, which tends to over-sample the bottom of the income distribution due to its focus on program participants. Furthermore, the focus of the calibration was to attempt to generate more inequality at the top by matching the SCF moments.[15]

At the very bottom of the wealth distribution, since the model does not allow borrowing, the distribution stops at zero assets. It is not able then to capture the negative value

[15] In Appendix B, I describe in detail the sample used and provide summary and distributional statistics.

standing for debt, as observed in the data for the first quintile. However, the model is able to capture a low level of savings for the first three quintiles. This outcome is mainly possible due to a combination of a few model ingredients that are added to the calibration to match the top: the steep profile in earnings generated by the human capital accumulation component, the labor supply friction that disincentivizes low-productivity households to, at the margin, participate in the labor force, and the different levels of asset, investment income, and adjusted income testing that the IS system imposes on agents in the economy.

The intuition behind this outcome comes from the fact that households are born with zero or low-level assets and then climb up the savings ladder as they receive idiosyncratic shocks. The shocks are persistent, and households that receive low-level shocks prefer to choose a smaller level of assets to front-load consumption when incentives to work are small. This consumption-savings trade-off is further enhanced by the presence of the asset means-tested transfers and the labor force participation cost.[16]

The model is able to capture some of the targeted large accrual observed in the data at the top of the earnings and wealth distributions but does not attain the numbers with precision, especially at the breakdown of the upper tail and at the very top 1 percent. It is able to moderately approximate the top 10 percent of the distributions, but it does so while exacerbating earnings inequality and underestimating wealth inequality.

[16]Such low wealth accumulation due to asset means-testing has a mechanism similar to the one pointed out in Hubbard et al. (1995) and re-emphasized in Wellschmied (2021). Using recent SIPP data, Luduvice and Johnson (2022) document that means-tested transfer recipients have lower wealth than non-recipients along the entire income distribution and review the empirical literature on the topic from earlier evidence, such as the seminal analysis by Hurst and Ziliak (2006), to more recent work.

Table 3: Earnings and wealth distributions in the model economy (in percent).

	Bottom			*Quintile*					*Top*			
	0-1	1-5	5-10	1st	2nd	3rd	4th	5th	90-100	95-100	99-100	Gini
						Earnings						
Model	0.0	0.0	0.0	0.0	5.9	10.1	16.6	67.4	53.5	43.6	28.6	0.66
Data	-0.1	0.0	0.0	-0.1	3.0	10.4	20.2	66.5	49.6	37.2	18.8	0.67
						Wealth						
Model	0.0	0.0	0.0	0.0	0.2	2.0	12.8	85.0	68.7	54.4	30.7	0.83
Data	-0.3	-0.3	-0.1	-0.7	0.6	3.2	9.8	87.0	75.0	62.9	35.5	0.85

Notes: The table shows the different quantiles for the model's earnings and wealth distributions and compares them to their data counterparts. The data shown in the table are as reported in Kuhn and Rios-Rull (2016), computed from the 2013 SCF.

5 UBI Counterfactuals

The idea behind the counterfactual toward a UBI reform of the income security system is simple: substitute all transfers $T_{EITC}(y, l, d, j)$, $T_{SNAP}(y, l, a, j)$, $T_{TANF}(y, la, j)$, and $T_{SSI}(b, a, j)$, with an unconditional payment TR_{UBI}. In this section, I do so with two levels of TR_{UBI}, one expenditure-neutral and one inspired by a policy proposal. In both cases, I hold constant the shares of government spending and debt, $G = b_G Y$, $B = b_B Y$, and let the government budget constraint be balanced by τ_c with equation (8) holding analogously but with TR_{UBI} instead of TR. For the first main counterfactual exercise, I carry out an expenditure-neutral exercise in which I distribute to households the aggregate level of total transfers TR computed for the benchmark equilibrium on a per household basis. As shown in Table 2, $TR/Y = 2.4$, which amounts to US$1,440 per year, or US$120 monthly.

The second main counterfactual conducted is a non-neutral increase in the total amount of transfers, TR, to a level equivalent to US$12,000 in the steady state. This exercise is inspired by the policy proposal advocated by Andrew Yang, a candidate in the Democratic Party primaries for the 2020 US presidential election. The thought experiment, using a similar approach to the candidate's proposal, is to give every agent in the economy a UBI that would amount to US$1,000 monthly, mostly financed by a VAT tax, which, in the model, is observationally equivalent to the endogenous consumption tax that is used to clear the government's budget constraint.[17]

5.1 Steady-State Results

Table 4 displays the effects of the counterfactual exercises in relevant model aggregates and statistics in comparison with the benchmark scenario. I also report the ex-ante steady-state welfare for households with age $j = 1$, i.e., the discounted expected value of being born into each economy, as measured by the consumption equivalent variation (CEV). This measure defines the increment in consumption, under the veil of ignorance, that we would need to give newborn households in each state of the world so that they would be indifferent between their level of consumption in the alternative economies.[18]

For the first exercise, one can observe an overall increase in all the main aggregate variables, with a significant increase in the capital stock and labor input and, thus, output and consumption. The K/Y increases in this case due to a larger increase in K relative to Y, indicating a rise in precautionary savings due to the shrinkage of the income security system at the bottom and an absence of asset-testing constraints. For similar reasons, labor supply shows an increase in both the intensive margin, through a small rise in hours worked, and the extensive margin, with a significant increase in the employment rate. This happens because households at the bottom of the productivity distribution now receive, on average, a smaller level of transfers and face fewer constraints on earnings and income with the absence of the means tests.

The increase in labor supply and savings translates into a substantially smaller pre-tax inequality in earnings and wealth, as captured by the decrease in the Gini indices. The transfer share of output TR/Y declines, since we keep TR at the benchmark level,

[17] The value of US$12,000 annually is equivalent to US$10,405 in 2010 dollars. In order to convert this amount to model units, I use as a reference the average value of annual household income calculated from the SIPP 2008 data in Appendix B, which amounts to US$64,894. This yields $TR_{UBI} = 0.16 \cdot INC$, where INC is the average household income in the model economy.

[18] I present the algebra and details on how to obtain the CEV for the newborn households in Appendix D.

and thus requires a moderate increase in the consumption tax of 1.4 percentage points to sustain its size in the new equilibrium. The increase in τ_c imposes extra pressure on consumption and slightly decreases the consumption-to-output ratio, C/Y. The capital-to-labor ratio K/L decreases, yielding moderate price changes, with an increase in w and a decrease in r. The reform induces a positive welfare gain. One of the reasons for such a welfare gain stems from the substantial decrease in inequality, which, despite the moderate size of the UBI, translates into higher disposable income and consumption for most households at the bottom of the income distribution. This point is more clearly observed in the breakdown in Table 5.

For the second counterfactual, the overall result is that the economy contracts significantly and recovers the benchmark scenario's overall pre-tax earnings and wealth inequality. It also exhibits less labor input with fewer hours worked and a lower employment rate, showing the large effect of the robust UBI on both the intensive and the extensive margins of labor supply. The capital-to-output ratio increases because Y decreases relatively more than K. As expected, the budget cost to raise the level of transfers to the desired level is high, and hence, the taxation on consumption has to climb up to 23.6 percent to balance the government's budget. This high level of taxes together with the wealth effect and insurance provided by the large size of the UBI compound to depress labor supply, savings, and aggregate consumption, yielding a smaller output in a more unequally distributed economy when measured on a pre-tax basis. The large UBI reform induces robust welfare gains, larger than those in the expenditure-neutral economy. Despite the increase in wealth inequality and taxes and the shrinkage of output, the increase in leisure, disposable income, and insurance provided by the transfer is more than enough to compensate fot potential welfare losses.

The total stock of human capital in the economy, HC, exhibits a substantial increase in terms of GDP when compared with the former counterfactual and the benchmark economy. This result stems from a selection effect operating behind the extensive margin: low-productivity agents sort themselves into zero labor supply due to the generous consumption floor created by the UBI. In contrast, high-productivity agents remain attached to the labor force throughout their life-cycle, with virtually no human capital depreciation. The rearrangement toward inequality shown by the Gini indices is then a byproduct of such a process and happens directly through the accrual of less earnings at the bottom and, thus, fewer savings resulting from the drop in the labor supply of low-productivity households. Since the environment is in general equilibrium, there is an accompanying wage rate adjustment. This effect is further seen in the average life-cycle profile for hours worked and human capital accumulation shown in Figure A.1 in Appendix C. For the large UBI, the profile of these allocations lies below the averages of the other two economies.

Table 4: Comparison of model statistics for the two UBI counterfactuals.

Variable	**Means-Tested**	**UBI**	**UBI AY**
Y	100	113.6	92.2
K	100	115.1	94.6
L	100	112.7	90.9
C	100	112.5	91.0
H	33.1%	33.2%	31.9%
ER	78.0%	90.0%	72.6%
K/Y	290.1%	294.0%	297.5%
L/Y	65.0%	64.5%	64.1%
C/Y	53.2%	52.7%	52.5%
HC/Y	468.9%	460.3%	490.0%
TR/Y	2.4%	2.1%	13.3%
w	1.000	1.007	1.014
r	0.040	0.038	0.037
τ_c	4.3%	5.8%	23.6%
Earn. Gini	0.66	0.60	0.70
Wealth Gini	0.83	0.78	0.82
CEV	-	2.8%	3.9%

Notes: The table shows model-generated aggregate statistics. The column "Means-Tested" shows the results of the benchmark model, the column "UBI" shows the results for the expenditure-neutral counterfactual, and the column "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal.

5.2 Impact on Inequality

Table 5 shows the distributional outcomes of disposable income and consumption for the benchmark means-tested economy and the two counterfactual scenarios. We can observe that both UBI counterfactuals are overall more redistributive after tax and transfers than the benchmark model. More specifically, the top quintile of the disposable income distribution is significantly trimmed when compared to the means-tested economy, with an increase of accrual at each quintile for the expenditure-neutral UBI and a slightly larger increase for all the middle quintiles for the large UBI economy, with a flat result at the bottom 20 percent.

The consumption accrual shown in Table 5 is ordered along the quantiles of the income distribution. We can see that the accrual of consumption is higher in both UBI economies along the bottom three quintiles, with a decrease in the top two quintiles. The quintile breakdown is similar across counterfactuals, but the expenditure-neutral UBI exhibits a larger accrual of consumption at the bottom 20 percent, which remains true in the breakdown of the very bottom of that distribution. This stems from the fact that, despite the larger transfer value, the higher consumption tax in the larger UBI economy exerts a moderately regressive effect at the bottom of the income distribution.

Table 5: Comparison of quantiles between benchmark and UBI counterfactuals.

	Disposable Income			Consumption		
	MT	**UBI**	**UBI AY**	**MT**	**UBI**	**UBI AY**
Bottom						
0% - 1%	0.0%	0.0%	0.2%	0.1%	0.2%	0.2%
1% - 5%	0.6%	0.4%	0.7%	1.1%	1.9%	0.9%
5% - 10%	0.9%	1.2%	0.9%	1.4%	2.1%	1.6%
Quintile						
0% - 20%	4.5%	5.5%	4.4%	7.2%	9.0%	8.3%
20% - 40%	9.6%	10.1%	10.7%	12.0%	12.5%	12.7%
40% - 60%	11.8%	12.7%	13.2%	15.4%	16.8%	16.6%
60% - 80%	18.1%	18.4%	18.6%	21.5%	20.0%	20.4%
80% - 100%	56.0%	53.3%	53.1%	43.8%	41.8%	41.9%
Gini	0.50	0.47	0.47	0.37	0.33	0.34

Notes: The table shows model-generated distributional statistics by quintile for disposable income and consumption, the latter ordered across the income distribution. The column "MT" shows the results of the benchmark model, the column "UBI" shows the results for the expenditure-neutral counterfactual, and the column "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal.

6 Inspecting the Mechanisms

In this section I conduct two sets of counterfactual exercises to inspect the impact of some of the main elements used in the modeling of the benchmark economy. The first set of exercises analyzes the impact of asset-testing and the set-up cost on labor supply, while the second set alters the financing regime by closing the government budget constraint with different taxes and by fixing the share of government spending and debt.

6.1 Asset-Testing and Labor Supply

I conduct additional exercises that focus on dissecting the effects of two of the main frictions of the economy: asset-testing and the set-up cost on the labor supply. In such exercises, I focus on the expenditure-neutral reform to keep the financing needs less pressing at the aggregate level and highlight the impact of the changes in the transfer system. To better gauge the direct effect of the frictions, I recalibrate the model without each of these model features, one at a time, and then conduct the expenditure-neutral counterfactual in the newly defined economy. I also add a counterfactual where I release the asset-testing constraints in the benchmark economy without any other changes aside from the adjustment in the consumption tax to balance the government's budget. Table 6 repeats the original benchmark economy, adds the expenditure-neutral and not asset-tested counterfactuals, and then reports the newly calibrated economy without each of the assumptions denoted by adding "(R)" to the column label.[19]

The first set of counterfactuals with $\bar{a} = +\infty$ highlight the importance of the asset-testing constraints for households' savings and participation decisions and, ultimately, capital accumulation in the economy.[20] The absence of asset-testing increases the transfer share of output as well as the consumption tax rate needed to sustain it. This exercise highlights the quantitative effect of easing the access to transfers to wealthier households: their elimination decreases all major aggregates by approximately 12 percent, with a steep drop in participation, which increases pre-tax earnings inequality and largely decreases welfare. The effect of increased savings relative to output due to the elimination of kinks is maintained, with K/Y increasing as in the original counterfactuals.

When we enact the expenditure-neutral UBI reform in the recalibrated economy without asset-testing, we observe a large increase in all aggregates, now adjusting without the mitigating effect of dropping the asset-testing constraints in the opposite direction. A similar movement is shown in the increase in the employment rate, which now increases proportionally more than in the original counterfactual. This exercise thus highlights the strong response caused by the elimination of the earnings and income-testing thresholds in an economy with large set-up costs of labor supply. With a substantially less generous benefit scheme for those at the bottom of the income distribution, households have a

[19]In Table A.14 in Appendix B.5, one can find the endogenously calibrated parameters for both alternative economies.

[20]I use the $\bar{a}$ notation as a simplified shorthand for all the asset-related constraints in the IS system. It thus includes the investment income testing threshold $\bar{d}_{TC}$ of the EITC as well as the other asset-testing constraints for the SNAP, TANF, and SSI programs, all described in Appendix A.1. Given the nature of the exercise and how they are calculated in the data, I do not relax the thresholds on adjusted income, y_a.

strong incentive to participate in the expenditure-neutral economy and accumulate assets, sharply decreasing pre-tax earnings and wealth inequality and increasing all allocations in the economy. The result is a large increase in welfare for newborns despite the higher consumption tax rate. From the comparison of the welfare response of the third and fifth columns of Table 6, we have a clear picture of the direction of the forces at play, with the net result being the solid, but smaller increase in the CEV for newborns from the reform in the benchmark economy.

The counterfactual with $\bar{l} = 0$ shows a similar qualitative response to the main counterfactual in many of the statistics calculated. Most of the measures move in the same direction, but with a much less pronounced quantitative response for the levels of the aggregates and an equivalent response for the output shares. The presence of the non-convexity in the labor supply amplifies the effect of releasing the means-testing constraints when moving to the UBI economy, as noted in the exercises with $\bar{a} = +\infty$. Without the operative intensive and extensive margins, the share of transfer outlays also decreases, as there is now a higher incentive to participate, which allocates households into a less generous partition of the means-tested transfer system. Moreover, it increases hours worked, since now households adjust their labor supply in the intensive margin. With the participation margin muted, the comparison with the original UBI reform allows for the isolation of the change in the savings allocation response due to asset-testing, which is also amplified by the convolution of asset-testing and commuting costs in the original counterfactual. With respect to welfare, the impact of the UBI reform in the absence of the labor convex costs would change, yielding a loss, reflecting the strong disutility of more hours worked in a transfer system that is less progressive in terms of wealth inequality.

Table 6: Comparison of model statistics for different assumptions.

	Benchmark		$\bar{a} = +\infty$			$\bar{l} = 0$	
Variable	**MT**	**UBI**	**MT**	**MT (R)**	**UBI (R)**	**MT (R)**	**UBI (R)**
Y	100	113.6	87.7	100.0	126.3	100.0	102.3
K	100	115.1	88.8	100.0	126.6	100.0	104.6
L	100	112.7	87.1	100.0	126.1	100.0	101.2
C	100	112.5	87.9	100.0	124.7	100.0	101.3
H	33.1%	33.2%	33.7%	33.0%	32.5%	33.0%	34.6%
ER	78.0%	90.0%	67.3%	73.9%	94.9%	-	-
K/Y	290.1%	294.0%	293.6%	289.8%	290.6%	289.6%	295.9%
L/Y	65.0%	64.5%	64.6%	65.0%	64.9%	65.0%	64.3%
C/Y	53.2%	52.7%	53.4%	53.7%	53.0%	53.0%	52.5%
HC/Y	468.9%	460.3%	477.7%	393.5%	383.6%	119.0%	116.3%
TR/Y	2.4%	2.1%	3.8%	3.5%	2.8%	1.9%	1.9%
w	1.000	1.007	1.007	1.000	1.001	1.000	1.012
r	0.040	0.038	0.039	0.040	0.040	0.040	0.037
τ_c	4.3%	5.8%	5.6%	5.3%	6.9%	-0.0%	0.0%
Earn. Gini	0.66	0.60	0.70	0.68	0.59	0.68	0.66
Wealth Gini	0.83	0.78	0.83	0.81	0.78	0.81	0.76
CEV	-	2.8%	-7.3%	-	9.9%	-	-1.0%

Notes: The table shows model-generated aggregate statistics for different counterfactuals. For each case considered, the columns "MT" and "UBI" show the results of the benchmark model, the column "MT (R)" shows the results of the benchmark model when recalibrated to a different assumption, and the column "UBI (R)" shows the results for the expenditure-neutral counterfactual in its respective recalibrated economy. The columns with "$\bar{a} = +\infty$" show results for these exercises but without any asset or investment income testing. The columns with "$\bar{l} = 0$" shows the two exercises but without set-up costs in the mapping between hours worked and earnings.

6.2 Other Financing Regimes

One of the most critical aspects of a UBI is the funding required to raise the revenues for the fiscal reform. So far, I have only studied counterfactuals with an endogenous adjustment of the consumption tax, as it is the main form of taxation for UBI policy proposals. In Table 7, I enact the UBI reform while clearing it either with the parameter that governs the average labor income tax, τ_0, or the investment income tax, τ_r. Moreover, since output changes in different directions for the additional reforms as shown in Table 4, I also show a variation in which instead of committing to the output shares of G and B, the government finances the fixed value of these outlays at the benchmark level, henceforth

$\bar{G}$ and $\bar{B}$, but closes its constraint with τ_c as in the initial set of results. Finally, to show how the variation in the size of TR_{UBI} affects the government instruments, I also show the counterfactual with $2 \cdot TR$, hence doubling the size of the initial level of transfers to highlight the marginal impact of increasing the size of the program.

For a set of exercises that enact the original expenditure-neutral counterfactual while changing the tax instrument used, one can see that the difference implied by closing the model with a different tax is tenuous, with movements in aggregates and inequality remaining closer to the counterfactual quantities. Both taxes naturally rise with the reform, with a reduction in τ_0 and an increase in τ_r. Welfare does not change significantly either, though it increases more with the alternative taxes than with τ_c. For the same set of exercises but doubling the size of the expenditure-neutral UBI, the overall impact moves along the direction of the policy-oriented UBI and is similar across tax instruments: all shares of output and prices move in the same direction. Among the differences, the increase in the labor tax further decreases wealth inequality, while the increase in τ_r naturally makes wealth more unequally distributed.

The exercise with the most distinct impact is the one in which we keep the same level of pure public spending and debt as in the benchmark economy, denoted by $\bar{G}, \bar{B}$ in Table 7. As output rises in the expenditure-neutral exercise, the relative spending in these quantities in the new steady-state decreases. This requires less taxation to finance the UBI reform and yields a large increase in the consumption share of output for the same employment rate, which amounts to more than double the welfare gains initially achieved. As we increase the size the UBI transfer, however, the welfare gains start to decrease. To better highlight that, I include in the last column of Table 7, the policy-oriented UBI, where we see that the decrease in aggregates and the need for a relatively higher τ_c in the new equilibrium virtually wash out the large welfare gains first observed in the expenditure-neutral exercise.

Table 7: Comparison of model statistics for different financing regimes.

			τ_0		τ_r		$\bar{G}, \bar{B}$		
Variable	**MT**	**UBI**	**UBI**	2·**UBI**	**UBI**	2·**UBI**	**UBI**	2·**UBI**	**UBI AY**
Y	100	113.6	112.3	106.7	112.6	105.8	114.0	109.9	91.8
K	100	115.1	112.9	106.2	111.9	99.6	116.2	111.9	93.9
L	100	112.7	111.9	106.9	113.0	109.4	112.9	108.8	90.7
C	100	112.5	111.5	106.8	112.7	108.8	117.9	112.5	87.7
H	33.1%	33.2%	33.1%	32.6%	33.2%	32.6%	33.2%	32.7%	31.9%
ER	78.0%	90.0%	89.7%	87.8%	90.1%	88.6%	90.2%	88.1%	72.4%
K/Y	290.1%	294.0%	291.7%	288.8%	288.2%	272.9%	295.7%	295.5%	296.4%
L/Y	65.0%	64.5%	64.8%	65.2%	65.2%	67.2%	64.3%	64.4%	64.2%
C/Y	53.2%	52.7%	52.9%	53.3%	53.3%	54.7%	55.0%	54.5%	50.9%
HC/Y	468.9%	460.3%	464.6%	480.9%	464.7%	486.5%	458.7%	468.3%	491.9%
TR/Y	2.4%	2.1%	2.1%	4.4%	2.1%	4.5%	2.1%	4.3%	1.3%
w	1.000	1.007	1.003	0.998	0.997	0.968	1.010	1.010	1.012
r	0.040	0.038	0.039	0.405	0.041	0.048	0.038	0.038	0.037
τ_x	4.3%	5.8%	0.92	0.88	40.8%	51.9%	1.0%	5.6%	27.9%
Earn. Gini	0.66	0.60	0.60	0.62	0.60	0.62	0.60	0.62	0.70
Wealth Gini	0.83	0.78	0.78	0.78	0.78	0.80	0.78	0.79	0.82
CEV	-	2.8%	3.0%	4.7%	3.0%	4.6%	7.8%	7.7%	0.4%

Notes: The table shows model-generated aggregate statistics. The column "MT" shows the results of the benchmark model, and the column "UBI" shows the results for the expenditure-neutral counterfactual with the government budget constraint closed with τ_c. After that the columns have similar names but are closed with the tax highlighted in the name above the columns. τ_0 shows the results for the UBI counterfactual with the government budget constraint closed with the labor tax parameter, τ_r is the analogous result for investment income. The columns "2·UBI" show experiments with two times the expenditure-neutral level of UBI and the column at the end "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal. Finally "$\bar{G}, \bar{B}$" shows the UBI counterfactual closing with τ_c but holding the constant the values of B, G at their benchmark level. The row with τ_x shows the tax rate or level of the parameter for the respective tax instrument used to close the government's budget constraint.

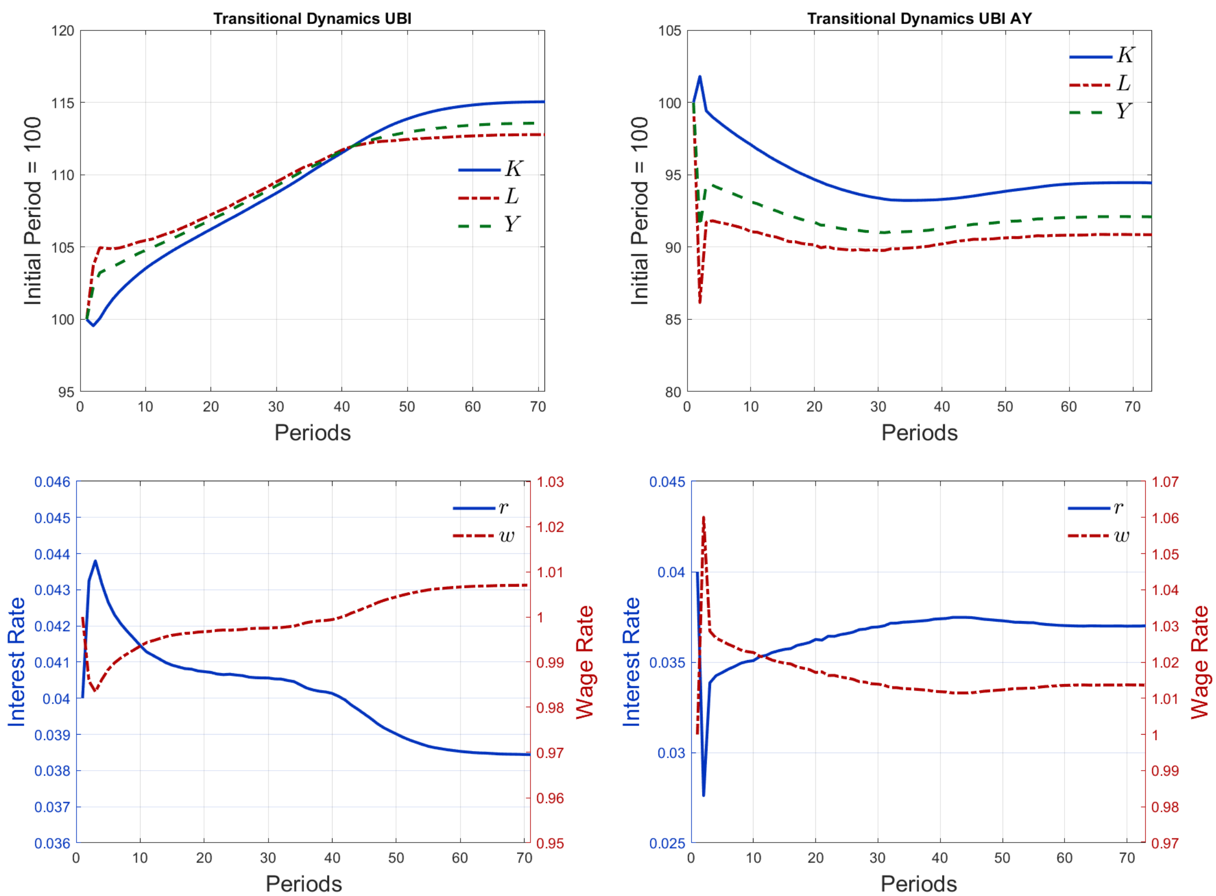
7 Transitional Dynamics and Welfare

The exercise conducted for the transitional dynamics consists of starting at the initial steady state at period $t = 0$, and, enacting the counterfactual reform at period $t = 1$. The policy is permanent and unexpected by the agents. The generations $j = 1, \ldots, J$ that were alive in period $t = 0$ will reoptimize to adapt to the new scenario, and prices in the capital and labor markets adjust along the transition path, clearing all markets in the economy.[21]

7.1 Aggregates

Figure 1 depicts the transitional dynamics of the main aggregate variables and of prices after each of the UBI counterfactual reforms is enacted. The left-hand side shows the expenditure-neutral UBI, while the right-hand side shows the generous UBI.

Figure 1: Transitional dynamics of aggregate variables.



Notes: The figure shows the transitional dynamics for aggregate capital, labor input, and output and the wage and interest rates for the three economies studied. In the top panels, the solid line shows the time path for aggregate capital, the dash-dotted line for labor input, and the dashed line for aggregate output. In the bottom panels, the solid line shows the time path for the interest rate, and the dash-dotted line shows the time path for the wage rate. The initial period represents the original steady-state quantities, which are normalized to 100. The duration of the transition shown is 70 years.

When the first reform is enacted, agents immediately and largely adjust their labor

[21] The adjustment to the new steady state is close to being achieved in 50 periods. I use a maximum of 72 periods for computational purposes. The graph depicts the first 70 periods, which are those for which market clearing is achieved at the desired tolerance level.

supply decisions due to the loss of the generous means-tested transfers to a low level of UBI. This reaction can be observed by the spike in aggregate labor, L, which is 5 percent higher than in the initial steady state. Moreover, there is also the trade-off between consumption and savings, which can be seen in the decrease in aggregate capital, K. The initial period's drop in capital is smaller relative to the jump in labor, only starting to increase to higher levels of the new steady state a few years after the reform. In the final periods, one can observe that the equilibrium trades off the initial movement in the labor supply for the increase in savings, then starts reaching the level of the aggregates in the new steady state, all higher than their initial levels. The price adjustment follows the behavior expected from the decreasing marginal returns of the neoclassical production function.

There is a symmetric initial response of the aggregate variables and prices between counterfactuals. The large UBI reform yields the opposite signs of change in the aggregates. With the new and unexpected large transfer, agents drop out of the labor force and work significantly less, thus reducing L by almost 15 percent. The extra income, combined with the exclusion of asset testing, causes a small increase in K, which later converges to the smaller level in the new steady state due to the decrease in precautionary savings and hours worked allowed by the UBI's consumption floor. Eventually, both factors and output reach their lower steady-state levels. At the same time, price adjustments show the converse behavior of the previous counterfactual at the beginning of the transition, but eventually settle at a smaller interest rate and a larger wage rate.

7.2 Decomposing the Welfare Effects

In Table 8, I show the results for the welfare evaluation taking into account the transitional dynamics and the decomposition along the dimensions of initial heterogeneity. To understand the effect of the transition on welfare, I compare the CEV at the enacted period of the transition, hence at time $t = 1$, between the benchmark and each of the main counterfactuals studied.[22]

[22] See details of the welfare measure calculation in Appendix D.

The CEV at the beginning of the transition for the expenditure-neutral UBI is of 2 percent, thus smaller than in the steady state. The opposite is true for the US$1,000 UBI, with an increase of 4.3 percent in welfare. This highlights the fact that the first reform generates a less generous level of UBI for households that were receiving means-tested transfers, with gains that will be later amplified as the aggregates grow and prices increase, with the converse intuition applying to the large UBI with fewer resources available as aggregates drop. Moreover, the spike in labor during the enacted period of the reform is always relatively larger than the spike in capital, diminishing welfare gains when it rises in the first reform and augmenting when it drops in the second.

Table 8: Comparison of consumption equivalent variation.

	UBI	**UBI AY**
CEV Steady state	2.8%	3.9%
CEV Transition	2.0%	4.3%
Initial Heterogeneity		
Low ability	1.1%	2.3%
High ability	1.7%	1.6%
No children	4.2%	4.7%
With children	-1.3%	-0.8%

Notes: The column "UBI" shows the results for the expenditure-neutral counterfactual, and the column "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal. The row "CEV Transition" shows the CEVs calculated at the enacted period of the transition, $t = 1$. The rows under "Initial Heterogeneity" decompose the different CEVs at the steady states along the initial heterogeneity dimension.

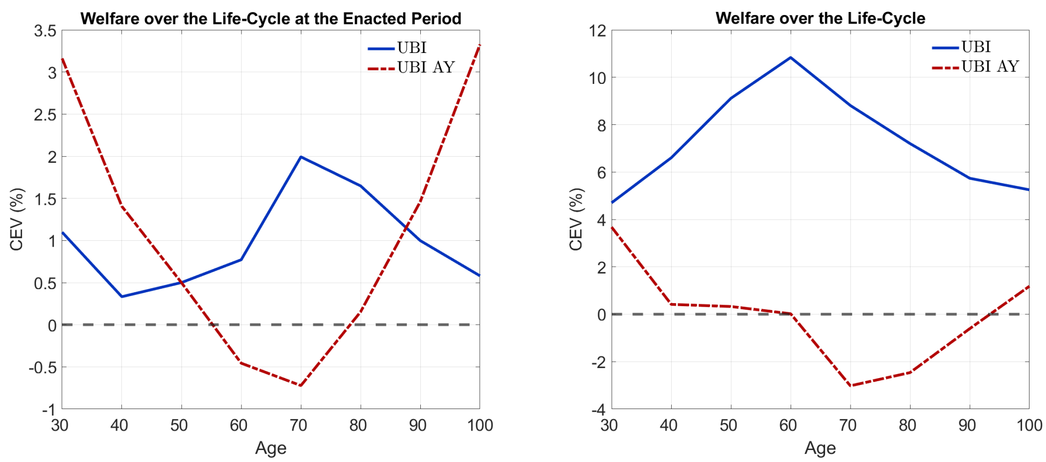
In order to understand better who are the winners and losers of both reforms, it is helpful to decompose the welfare changes into different cuts of the state space. An essential dimension of the decomposition is the permanent ability level of the households. The value θ is the only source of labor income heterogeneity in households' initial conditions. In Table 8, one can observe the breakdown for the two points at which I discretize this shock. Given how the wage risk was estimated, this point can be roughly interpreted as comparing college and non-college levels of initial ability. The results for the steady states show that there is an inverse pattern between the two counterfactuals. In the small UBI economy, low-ability households carry a heavier burden and experience lower gains than high-ability households. In the second counterfactual, the breakdown works in a converse manner: since high-ability agents will most likely be the ones bearing the hike in taxation needed to sustain the reform, they benefit less from the new policy.

In the initial heterogeneity breakdown, households in this economy are also distinct with respect to child-bearing in their life-cycles. As can be seen in Table 8, in both reforms, households that have children are worse off, experiencing significant welfare losses. This result is intuitive, as the original means-tested system is skewed toward more generosity for larger families and households are differentiated on that dimension. The UBI economy, in the way it was designed, gives a flat transfer, no matter large or small, to a household unit as a whole, thus decreasing the relative amount of benefits families receive.

To get a better sense of the role of the age dimension, I plot in Figure 2 the cross-sectional average of the CEV across decades of households' lives. I do so for their values both at the enacted period of the reform and at the steady state. We can observe in the plot on the left-hand side that the expenditure-neutral system exhibits positive levels of CEV throughout the life cycle, with lower levels at the beginning. As households have children at earlier ages, it is natural that a transfer with an average level lower than before leaves agents worse off in that period of their lives. However, as soon as households start moving along the increasing path of their earnings profile, the savings they accumulate under the new UBI regime decreases the dominance of any transfer losses. In effect, households in the benchmark economy during those periods are trapped into working less effective hours and saving less to remain inside the constraints that guarantee reception of the benefits. In the long run, the lower welfare at earlier ages is washed out, generating a hump-shaped pattern of large and positive gains throughout the life-cycle.

For the second counterfactual, in the short run, we observe positive welfare gains for almost all ages before retirement, surpassing the gains of the first counterfactual. However, they steeply decrease and become negative in the preceding and first years of retirement, when the larger consumption tax and the need for a higher labor supply start imposing their costs. Households at later ages exhibit positive welfare, at levels similar to those in the pre-retirement years. In the long run, as capital is depleted, the gains for all cohorts except the younger ones are largely subdued. This is caused by the increase in labor supply relative to its initial change shown in Figure 1, the smaller size of capital and output, and the higher consumption tax that depletes retirees' savings.

Figure 2: Consumption equivalent variation over the life-cycle.



Notes: The figure shows the CEV over the life-cycle for the two counterfactual economies studied. The CEVs shown are for 10-year averages and start at the average for cohorts between 20 and 30 years old, yielding eight averages until the last decade ending at 100 years old. The left panel shows the averaged cohort CEVs under the veil of ignorance in the first period of the transition, and the right panel shows the same quantities at their steady states.

8 Conclusion

In this paper, I addressed the question of the impact of a nationwide reform of the US welfare system based on a universal basic income proposal. I have developed an overlapping generations model with idiosyncratic income risk that incorporates both intensive and extensive margins of the labor supply, human capital accumulation through labor market experience, and child-bearing costs. The model has a welfare system with an income security system that matches the US design and accounts for means-testing requirements of income and wealth and their taxation counterparts. My analysis focused on the changes in aggregates, inequality, government budget, and welfare.

I calibrated the model to the US and conducted two counterfactual exercises implementing UBI reforms. The first exercise analyzed was an expenditure-neutral reform of the income security system, while, in the second counterfactual exercise, I set the level of transfers to be US$12,000 annually to each agent in the economy. The overall finding of the paper is that a UBI reform can generate solid welfare gains. The size of the UBI transfer is a key factor in such exercises since it entails substantially different aggregate and distributional consequences, though with a general finding that the larger the size of the UBI, the higher the welfare gains when compared to the benchmark economy. The mechanism of the model mostly stems from the frictions in savings and participation in the labor force, which allow the counterfactuals to be welfare-improving. In the absence of the labor supply friction in the benchmark economy, a small UBI generates welfare losses. The overall result is independent of the type of tax used to implement the reform but hinges on the size of the spending to which the government commits in order to fund its expenses and debt.

I have abstracted from several dimensions of heterogeneity and mechanisms in my model, such as intra-household heterogeneity, intergenerational linkages, human capital investment, search frictions or involuntary unemployment, among others. Most of these issues have been tackled by contemporaneous papers that study a UBI reform in alternative settings. Other topics of interest are related to the effects of UBI on entrepreneurship or health outcomes. I leave those for future research.

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Online Appendix

"The Macroeconomic Effects of Universal Basic Income Programs"

André Victor Doherty Luduvice

A Details of the Model

A.1 Definitions of Means-Tested Transfers

In this section I describe all the details for the eligibility and calculation of the benefits from the means-tested transfers in the model. It is helpful to recall and lay out key definitions used in the characterization of the transfer programs. Total labor income, or earnings, $y(l, h_j, z_j)$ will henceforth stand for *gross income* and $d = ra$ for *investment income*. I also need to define *adjusted gross income* as $y_a \equiv y(l, h_j, z_j) + d$. Here I focus on the pure modeling aspects of such transfers, while in Appendix B.4, I explain in detail how I conduct the calibration and map all quantities and thresholds to the data and their sources.

Earned Income Tax Credit (EITC) The EITC is a refundable credit for which eligibility is determined by two criteria: first, investment income cannot exceed a level $\bar{d}_{TC}$, and second, adjusted gross income cannot be higher than an upper bound $\bar{y}^k_{a,TC}$ which depends on the number of children $n_{k,j}$ present in the household. The minimum and maximum income for maximum credit are defined over earnings and are denoted, respectively, as $\underline{y}^k_{TC}$ and $\bar{y}^k_{TC}$. Since the program is defined as a percentage of positive gross income y, it is, in essence, a wage subsidy. The payment structure is composed of three parts: a phase-in region, a so-called plateau region, and a subsequent phase-out region. The transfer payments modeling follows closely the formulation in Ortigueira and Siassi (2022) and is defined as follows:

$$T_{EITC}[y,d,j] = \begin{cases} \kappa_1^k y, & \text{if } 0 \leq y < \underline{y}_{TC}^k \\ \kappa_1^k \underline{y}_{TC}^k, & \text{if } \underline{y}_{TC}^k \leq y < \bar{y}_{TC}^k \\ \max\{\kappa_1^k \underline{y}_{TC}^k - \kappa_2^k (y - \bar{y}_{TC}^k), 0\}, & y > \bar{y}_{TC}^k \\ 0, & \text{if } d > \bar{d}_{TC} \text{ or } y_a > \bar{y}_{a,TC}^k \text{ or } j \geq J_R \end{cases} \tag{A.1}$$

where κ_1^k and κ_2^k are the phase-in and phase-out rates, respectively. Note that all brackets are indexed by k, which stands for the dependence on the number of children, $n_{k,j}$. The investment income eligibility requirement, on the other hand, is identical for all households.

Supplemental Nutrition Assistance Program (SNAP) SNAP is treated here, as is common in the literature, as an in-kind transfer that has a near-cash value. The formulation for SNAP includes a direct limit for households' assets, $\bar{a}_{SNAP}$, a limit for adjusted gross income, $\bar{y}_{SNAP}^k$, a maximum amount of transfer that the household receives, t_{SNAP}^k, and an income disregard or "allowance," e_{SNAP}^k.

The testing for the level of assets is defined over a special category called "resources," which encompasses the total amount of the types of assets that are effectively tested for eligibility in SNAP. The testing thresholds are defined over households' total income and the allowance is defined over labor earnings. Except for the resources limit, all parameters depend on the number of children in the household. There is a phase-out rate of 30 percent in the payment schedule and, if working, households are allowed to discount 20 percent of their total earned income.

The payment schedule for SNAP transfers follows closely the modeling in Wellschmied (2021) and is defined as follows:

$$T_{SNAP}(y_a, l, a, j) = \begin{cases} \max\{t^k_{SNAP} - 0.3\left(0.8y_a - e^k_{SNAP}\right), 0\}, & \text{if } \ell(l) > 0 \\ \max\{t^k_{SNAP} - 0.3\left(y_a - e^k_{SNAP}\right), 0\}, & \text{if } \ell(l) = 0 \\ 0, & \text{if } a > \bar{a}_{SNAP} \text{ or } y_a > \bar{y}^k_{SNAP} \text{ or } j \geq J_R \end{cases} \tag{A.2}$$

Temporary Assistance for Needy Families (TANF) The formulation for TANF benefits is similar to the one for SNAP and includes a direct limit on assets, a_{TANF}, a limit on the adjusted gross income, $\bar{y}^k_{TANF}$, a maximum amount of transfer that the household receives, t^k_{TANF}, and an income disregard, e^k_{TANF}.

The testing for TANF is defined over the same quantities of the SNAP schedule for each of its parameters. There is a phase-out rate of 50 percent in the payment schedule and, if working, households are allowed to disregard the allowance value, e_{SNAP}.

The payment schedule for TANF transfers is:

$$T_{TANF}(y_a, l, a, j) = \begin{cases} \max\{t^k_{TANF} - 0.5\left(y_a - e^k_{TANF}\right), 0\}, & \text{if } \ell(l) > 0 \\ \max\{t^k_{TANF} - 0.5(y_a), 0\}, & \text{if } \ell(l) = 0 \\ 0, & \text{if } a > \bar{a}_{TANF} \text{ or } y_a > \bar{y}^k_{TANF} \text{ or } j \geq J_R \end{cases} \tag{A.3}$$

Supplemental Security Income (SSI) Households have access to SSI benefits only during their retirement spell as an extra payment to the Social Security pension benefits. For modeling purposes, the SSI rules differ from those of the other programs since only the level of assets is tested for eligibility, with limit $\bar{a}_{SSI}$. There is a phase-out of half of households' retirement income with a disregard, e_{SSI}, and a maximum level of transfers, t_{SSI}, both independent of household size. The testing for assets is defined over households' resources, while the other parameters are defined over labor earnings. The payment schedule for SSI transfers is:

$$T_{SSI}(y_a, l, a, j) = \begin{cases} \max\{t_{SSI} - 0.5\,(b - e_{SSI})\,, 0\}, & \text{if } j \geq J_R \\ 0, & \text{if } a > \bar{a}_{SSI} \text{ or } \text{ or } j < J_R \end{cases} \tag{A.4}$$

A.2 Recursive Competitive Equilibrium

Agents are heterogeneous at each point in time in the state $s \in S$. The agents' distribution among the states s is described by a measure of probability Φ_t defined on subsets of the state space S. Let $(S, \mathcal{B}(S), \Phi_t)$ be a space of probability, where $\mathcal{B}(S)$ is the Borel σ-algebra on S. For each $\omega \subset \mathcal{B}(S)$, $\Phi_t(\omega)$ denotes the fraction of agents who are in probability state ω. There is a transition function $M_t(s, \omega)$ that governs the movement over the state space from time t to time $t+1$ and that depends on the invariant probability distribution of the idiosyncratic shock $\Pi(z)$ and on the decision rules obtained from the household problem.

Definition 1 (Recursive Competitive Equilibrium)**.** *A recursive competitive equilibrium with population growth for this economy is an allocation of value functions* $\{v_t(s), v_t^R(s)\}_{t=0}^{\infty}$*, policy functions* $\{c_t(s), a_t'(s), l_t(s), h_t(s)\}_{t=0}^{\infty}$*, factor prices* $\{w_t, r_t\}_{t=0}^{\infty}$*, production plans for the firm* $\{K_t, L_t\}_{t=0}^{\infty}$*, consumption taxes* $\{\tau_{c,t}\}_{t=0}^{\infty}$*, social security taxes and benefits* $\{\tau_{SS,t}, b(x_t)\}_{t=0}^{\infty}$*, aggregate transfers* $\{TR_t\}_{t=0}^{\infty}$*, government expenditures and debt* $\{G_t, B_t\}_{t=0}^{\infty}$*, accidental bequests* $\{Q_t\}_{t=0}^{\infty}$*, and an age-dependent measure of agents* $\{\Phi_t\}_{t=0}^{\infty}$*, such that,* $\forall t$*:*

1. *Given factor prices, taxes and transfers, and initial conditions, the value functions* $\{v_t(s), v_t^R(s)\}$ *and policy functions* $\{a_t'(s), c_t(s), l_t(s), h_t(s)\}$ *solve the households' optimization problems* (9) *and* (10)*;*

2. $\{r_t, w_t\}$ *are such that they satisfy the firm's first-order conditions in* (3)*;*

3. *The individual and aggregate behaviors are consistent:*

$$G_t = g_y Y_t, \;\; B_t = g_b Y_t$$

$$(1+g_n)K_{t+1} = \int_S a_t'(s)d\Phi_t(s) - (1+g_n)B_{t+1}$$

$$C_t = \int_S c_t(s)d\Phi_t(s)$$

$$L_t = \int_S \exp(\theta + z_j)h_t(s)\ell(l_t(s))d\Phi_t\left(s_{-j}, \{1, \ldots, J_R - 1\}\right)$$

4. *The final good market clears:*

$$C_t + K_{t+1} + G_t + CC_t = AK_t^{\alpha}L_t^{1-\alpha} + (1-\delta_k)K_t$$

5. *Accidental bequests equal the savings left from deceased households:*

$$Q_t = \int_S (1 + r(1-\tau_k))(1-\psi_{j+1})a_t'(s)\, d\Phi_t(s)$$

6. *The government balances its budget:*

$$G_t + \int_S \left[T_{EITC}(s) + T_{SNAP}(s) + T_{TANF}(s) + T_{SSI}(s)\right] d\Phi_t(s) + (1+r_t)B_t =$$
$$Q_t + \int_S \left[\tau_r r_t a_t(s) + \tau_{c,t}c_t(s) + T_l(y(s))\right] d\Phi_t(s) + (1+g_n)B_{t+1} - A_{t,j=1}$$

7. *Social Security's budget balances:*

$$\tau_{SS,t}w_tL_t = \int_S b(x_t)d\Phi_t\left(s_{-j}, \{J_R, \ldots, J\}\right)$$

8. *Given the decision rules, Φ_t satisfies:*

$$\Phi_{t+1}(\omega) = \int_S M_t(s,\omega)d\Phi_t(s),\ \forall\omega \subset \mathcal{B}(S),$$

where $M_t : (S, \mathcal{B}(S)) \to (S, \mathcal{B}(S))$, can be written as folllows: $\forall j \in \{2, \ldots, J\}$,

$$M_t(s,\omega) = \begin{cases} \pi_{z,z'} \cdot \psi_{j+1}\ , & \textit{if}\ \ a'_t(s) \in \mathcal{A},\ h'_t(s) \in \mathcal{H},\ k \in \mathcal{K},\ \theta \in \Theta,\ j+1 \in \{2,\ldots,J\} \\ 0\ ,\ \textit{otherwise.} & \end{cases}$$

and for $j \in \{1\}$,

$$\Phi_{t+1}\left(S_{-J}, 1\right) = (1+g_n)^t \begin{cases} \sum_{k\in\mathcal{K},\theta\in\Theta} p_k \cdot p_\theta\ , & \textit{if}\ \ a_0 \in \mathcal{A},\ h_0 \in \mathcal{H},\ \bar{z} \in \mathcal{Z} \\ 0\ ,\ \textit{otherwise,} & \end{cases}$$

where p_k *and* p_θ *are, respectively, the probabilities of being a household with children and of drawing* θ *out of its discretized distribution. The initial conditions are:* $a_0 = \bar{a}_{j=1}$*, if* θ *is high and* $a_0 = 0$*, if low;* $h_0 = 1$*; and* $\bar{z}$ *is the median level of productivity.*

B Details of the Data and Calibration

B.1 Survey of Income and Program Participation (SIPP)

In this section I outline the empirical estimates obtained from the 2008 panel of the Survey of Income and Program Participation (SIPP). The SIPP is a representative sample of the civilian United States population and provides information on earnings, transfers from different US income security programs, a fine breakdown of households' balance sheets, and detailed demographics that are used in the calibration of the model for the US economy. The SIPP is the natural candidate for obtaining household survey data for this paper's question as it has detailed questions about many of the programs designed to target this stratum of the population.

The 2008 panel consists of 16 waves for which interviews are conducted every 4 months. The sample selection used spans from May of 2008 to December 2013, and is observed monthly. I deflate all values with the CPI for the last month in my sample. In the SIPP, I use the classification of reference person in my selection within observation units. The data for assets are taken from the Assets and Liabilities Topical Modules of the 2008 panel.

I conduct the empirical documentation following a methodology similar to the one used in Kaplan et al. (2014) and Kuhn and Rios-Rull (2016), in which the authors characterize several measures of inequality in different household survey data sets. All quantities are the ones reported in the data at the household level. I restrict the sample to households in which the reference person has age equal to or above 20 years old and drop all households with non-negative earnings. This is done in order to be consistent with the model's demographics and earnings definition.

Table A.1 displays the summary statistics for my sample and Table A.2 characterizes the percentiles' partitions.

Table A.1: Summary Statistics.

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Earnings	4,205.95	5,220.86	0.0	77,845.26
Total Income	5,407.84	5,079.59	-653.2	81,354.84
Net Worth	230,989.43	645,029.80	-729,020.1	108,191,996.60
Cash Transfers	57.80	228.99	0.0	5,039.70
Resources	154,491.39	247,579.07	-723,941.9	10,334,906.28

Notes: The table shows summary statistics for some of the main variables calculated from the SIPP 2008 panel. These values include numbers from all three topical modules that include questionnaires with information about assets. All values are in December 2013 US dollars, flow variables are in monthly values, and stock variables are in annual values.

For Tables A.2 and A.3, I restrict the observations to those that are present in the 10th topical module of the 2008 panel. This yields monthly observations from September to December of 2011. Given that, Table A.3 displays the contemporaneous correlations between the statistics calculated.

Table A.2: Percentiles for the SIPP 2008 Panel.

Percentile	Earnings	Income	Net Worth	Resources	Transfers
1%	0.00	159.76	-65,427.60	0.00	0.00
5%	0.00	821.32	-14,861.93	0.00	0.00
10%	0.00	1,160.81	-1,966.85	16.18	0.00
25%	270.91	2,175.45	6,905.78	3,656.00	0.00
50%	2,802.26	4,087.43	95,785.29	52,339.04	0.00
75%	6,068.25	7,023.72	299,610.37	202,357.13	0.00
90%	10,057.93	10,862.83	610,292.86	434,017.27	80.81
95%	12,973.55	13,810.23	881,724.99	624,747.57	470.68
99%	24,575.70	25,269.95	1,619,938.88	1,104,556.64	1,118.19
Gini	0.58	0.44	0.70	0.69	0.94

Notes: The table shows the percentiles and the Gini index for the statistics calculated from the 10th topical module of the SIPP 2008 panel. All values are in December 2013 US dollars, flow variables are in monthly values, and stock variables are in annual values.

Table A.3: Joint Distribution for the SIPP 2008 Panel.

	Earnings	Income	Net Worth	Resources	Transfers
Earnings	1.00	0.94	0.27	0.47	-0.13
Income	0.94	1.00	0.39	0.56	-0.10
Net Worth	0.27	0.39	1.00	0.63	-0.08
Resources	0.47	0.56	0.63	1.00	-0.10
Transfers	-0.13	-0.10	-0.08	-0.10	1.00

Notes: The table shows the correlations between statistics calculated from the 10th topical module of the SIPP 2008 panel.

B.2 Estimation of the Wage Process

I use the data from the SIPP 2008 panel to estimate the idiosyncratic income risk present in the model. I select households in which the reference person is between 20 and 65 years old and drop observations with non-positive earnings ending with a sample of 1.2 million observations grouped in 38,077 households. I run a linear regression on log wages and obtain the wage residuals w_{ijt}, which will then be used in the process estimation. The regression estimated is

$$\log W_{ijt} = c + \mathbf{D}_t + \mathbf{E}_{ijt} + \nu' \mathbf{A}_{ijt} + w_{ijt} \tag{A.5}$$

where i stands for reference person, W_{ijt} are wages obtained dividing total household monthly earnings by hours worked, c is a regression constant, $\mathbf{D}_t$ are time dummies for the years of observation 2008-2013, $\mathbf{E}_{ijt}$ are dummies that control for two levels of schooling - less than or equal to a high school diploma or some college or a college degree - and $\mathbf{A}_{ijt}$ stands for a cubic polynomial on years of potential labor market experience, which are tied to age.

Following the literature, my specification is the first-stage regression. As shown in Table A.6, the point estimates for $\{\nu_1, \nu_2\}$ are used in the calibration of the human capital law of motion in equation (6). Given its numerically small size, I do not use the point estimate for the third coefficient. Table A.4 shows the regression estimates.

Table A.4: Regression Results for Equation (A.5)

	$\log W_{ijt}$
D_{2009}	0.012
	(0.003)
D_{2010}	-0.018
	(0.003)
D_{2011}	-0.045
	(0.003)
D_{2012}	-0.056
	(0.003)
D_{2013}	-0.074
	(0.003)
E_2	0.485
	(0.001)
ν_1	0.046
	(0.001)
ν_2	-0.001
	(0.00004)
ν_3	0.00001
	(0.00000)
Constant	2.742
	(0.005)
Observations:	1,184,838
Number of households:	38,077

Notes: The table displays the estimated parameters obtained by running regression (A.5). Numbers in parenthesis are the standard errors for the estimates.

As in Heathcote et al. (2010), I assume stationarity and postulate that the log residuals follow a process with persistent and transitory shocks, z and η, respectively:

$$w_{i,j} = \eta_{i,j} + z_{i,j}, \;\; \eta_{i,j} \sim N(0, \sigma_\eta^2), \;\; z_{i0} \sim N(0, \sigma_{z_0}^2) \tag{A.6}$$

$$z_{i,j+1} = \rho z_{i,j} + \varepsilon_{i,j}, \;\; \varepsilon_{i,j} \sim N(0, \sigma_\varepsilon^2) \tag{A.7}$$

The parameters from this process can be identified in levels by the theoretical moments. More precisely, ρ is identified by the slope of the autocovariance of z at lags greater than 0; σ_ε^2 and σ_η^2 are both identified by the difference between the variance and autocovariance of z, and $\sigma_{z_0}^2$ can be obtained residually from $var(z_{i,0})$.

I obtain the empirical moments used in the estimation by computing an age covariance matrix with entries that have been calculated with a minimum of 100 observations for each age pair. This yields a total of 256 moments for four parameters, which renders the model to be largely overidentified. As is standard in the literature, I use a minimum-distance estimator of the GMM family and conduct the estimation using two types of weighting matrices Ω: an identity and a diagonal of the optimal weighting matrix.[23] In the model economy, I use the estimates obtained with the former and treat the transitory shock as a measurement error, thus setting $\hat{\sigma}_\eta^2 = 0$ in the model economy. Table A.5 shows the estimates obtained.

Table A.5: Estimation of the Wage Process.

Ω	$\hat{\rho}$	$\hat{\sigma}_\varepsilon^2$	$\hat{\sigma}_\eta^2$	$\hat{\sigma}_{z_0}^2$
Identity	0.9766	0.0243	0.2917	0.2129
	(0.0020)	(0.0012)	(0.0002)	(0.0218)
Diag Optimal	0.9546	0.0446	0.2302	0.1528
	(0.0007)	(0.0004)	(0.0001)	(0.0217)

Notes: The table shows the point estimates and asymptotic standard errors for the four parameters of the wage process described in (A.6) and (A.7). "Identity" and "Diag Optimal" stand for the two types of weighting matrices used in the estimation. See text for details.

B.3 Exogenously Calibrated Parameters

Table A.6 summarizes the exogenously calibrated parameters:

[23] The suggestion can be found in Guvenen (2009).

Table A.6: Exogenously calibrated parameters.

	Parameter	Value	Target / Source
Demographics			
Model's terminal and retirement ages	JJ, J_R	80, 45	Ages 100 and 65
Population growth	n_p	1.1%	Lopez-Daneri (2016)
Survival probabilities	$\{\psi_j\}_{j=1}^{J}$	-	Fehr and Kindermann (2018)
Ages children are born	$\{n_i\}_{i=1}^{3}$	27, 30, 33	Fehr and Kindermann (2018)
Fraction of pop. with children	p_k	30%	Vespa et al. (2013)
Preferences			
Frisch elasticity	γ	0.6	Fehr and Kindermann (2018)
Technology			
Capital share	α	0.35	Lopez-Daneri (2016)
Labor Income			
Persistence and variance of AR(1)	$\{\rho, \sigma_\varepsilon^2\}$	0.9766, 0.0243	SIPP 2008
Human capital returns	$\{\nu_1, \nu_2\}$	0.04550, -0.0010	SIPP 2008
Depreciation rate of human capital	δ_h	1.5%	Guvenen et al. (2014)
Government			
Public consumption goods, national debt	$\{b_G, b_B\}$	20.0%, 63.0%	Conesa et al. (2023); Trabandt and Uhlig (2011)
Investment income tax rate	τ_r	36.0%	Trabandt and Uhlig (2011)
Scale and curvature of income taxes	$\{\tau_0, \tau_1\}$	0.9420, 0.1577	Holter et al. (2019)

Notes: The table shows model parameters, their numerical values, targeted moments in the model economy, and their data sources.

B.4 Data and Calibration of Means-Tested Programs

The model uses four different types of means-tested transfers, namely the EITC, SNAP, TANF, and the SSI, with parameters that govern each function described in A.1 that require mapping to the data. In this section I explain in detail how I proceed for each parameter of each program.

First, I use 2011 as the reference year for all the quantities that are means-tested by the different programs. This allows for internal consistency of values as it coincides with the reference year for the last topical module with assets' data of the SIPP 2008 panel. In Tables A.7, A.8 and A.9, I collect the dollar values for income, benefits, asset limits, and allowances/disregards that were used for the different programs in the data in 2011. They vary by size of the household, which starts with a unit with two people and no qualifying children and reaches the maximum size of five people to coincide with the model economy maximum of three children in a household.

For the EITC, for example, the maximum annual adjusted gross income (AGI) to be eligible for a household of two people was US$13,660 if filing as single or as a head of household and US$18,740 if married and filing jointly. The maximum benefit for this category at the plateau region is US$464. With respect to assets, the investment income limit was US$3,150 as shown in Table A.8. The data for the EITC come from the IRS Fact Sheet (IRS, 2012).

For SNAP, the maximum gross monthly income eligibility standard for a household of two people was US$1,579 with a maximum benefit of US$367 (USDA, 2010, 2014). The values for maximum resources for SNAP are in Table A.8 and can be found in CBO (2012) and are adjusted for inflation and rounded down according to the nearest US$250 increment in accordance with Pub.L. 110-234 (link). As in the benefit calculation formula (A.2), households can deduct 20 percent of earned income and apply a standard deduction to all earned and unearned income, which is depicted in Table A.9. This minimum standard deduction or "alowance" for SNAP is for the 48 States and DC and increases with household size (USDA, 2014).

For TANF, the maximum level of available monthly income does not vary by household size and is capped at US$797. The benefit varies by size and can be as high as US$645. The asset limit for TANF is calculated as an average across states and amounts to US$2533. A similar procedure is applied to the income disregard, which is US$182, monthly. All values for TANF are calculated based on the "Welfare Rules Databook" compiled and made available in text and spreadsheet format by the Urban Institute (OPRE, 2012).

Finally, the SSI benefit only applies to an individual living on his or her own or a couple with both husband and wife eligible. In that case, the maximum countable earnings for the latter would be US$2107, with a maximum benefit of US$1,011. The maximum resource limit is US$2,000 or US$3,000 for a couple. Furthermore, individuals are allowed to discount up to US$85 of earned and unearned income. All values for the SSI are taken from the Annual Statistical Supplement of the SSA (SSA, 2012).

Table A.7: Income and benefit limits for means-tested transfer programs.

	Income / Benefit Limits			
Program	Two members	Three members	Four members	Five members
EITC	13,660 (18,740)/464	36,052 (41,132)/3,094	40,964 (46,044)/5,112	43,998 (49,078)/5,751
SNAP	1579/367	1984/526	2389/668	2794/793
TANF	797/393	797/483	797/565	797/645
SSI	1433 (2107)/674 (1,011)	-	-	-

Notes: At each cell, values to the left of the slash are for income limits and values to the right are for benefit limits. Values for the EITC can be found in IRS (2012); numbers in parenthesis indicate values if married filing jointly; values for SNAP can be found in USDA (2010) and USDA (2014); values for TANF are calculated based on the "Welfare Rules Databook" and can be found in OPRE (2012); and values for the SSI and an example of the formula to calculate the maximum countable earnings shown can be found in SSA (2012); numbers in parenthesis are for couples with husband and wife eligible. All values are in 2011 US dollars.

Table A.8: Investment income and resources limits for means-tested transfer programs.

Program	EITC	SNAP	TANF	SSI
Asset Limits	3,150	2000 (3000)	2533	2000 (3000)

Notes: The value for maximum investment income for the EITC can be found in IRS (2012); the values for maximum resources for SNAP can be found in CBO (2012) and are adjusted for inflation and rounded down to the nearest US$250 increment in accordance with Pub.L. 110-234 (link); values for TANF are calculated based on the "Welfare Rules Databook" and can be found in OPRE (2012); and values for the SSI and an example of the formula to calculate the maximum countable earnings shown can be found in SSA (2012). All values are in 2011 US dollars.

Table A.9: Income allowances and disregards for means-tested transfer programs.

	Allowances/Disregards for Benefits			
Program	Two people	Three people	Four people	Five people
SNAP	142	142	153	179
TANF	181	-	-	-
SSI	85	-	-	-

Notes: Values for the EITC can be found in IRS (2012); values for SNAP can be found in USDA (2010; 2014); values for TANF are calculated based on the "Welfare Rules Databook" and can be found in OPRE (2012); and values for the SSI and an example of the formula to calculate the maximum countable earnings shown can be found in SSA (2012). All values are in 2011 US dollars.

Turning to the model parameters, I now discuss the ratios that are used to map the quantities in the data present in Tables A.7 through A.9 to model units. Each program requires several parameters, described in Section A.1.

The ratios for the EITC are shown in Table A.10. The maximum adjusted gross income limits, $\bar{y}^k_{a,TC}$, and the investment income limit, $\bar{d}_{TC}$, are defined in terms of average household income in the model, INC. In order to map these to the data, I find average annual income in the data by multiplying by 12 the average monthly income value calculated for the SIPP 2008 sample shown in Table A.1. Then to find the ratio for each of these parameters, I divide the values for the EITC in 2011 shown in Table A.7. In the case of investment income, this yields the number $r_{d,EITC}$, which is shown in Table A.10. More precisely, $\bar{d}_{TC} = r_{d,EITC} \cdot INC$, where r_{EITC} is obtained by dividing the investment income limit of US$3,150 by the average annual household income in the data. Hence, households are tested as to whether $r \cdot a \leq \bar{d}_{TC}$ is true in their individual maximization.

For the minimum and maximum income for maximum benefit, since they are defined in terms of household wages, I define them as a share of average household earnings in the model economy, AE. In order to find the ratios, I use the same method used for the investment income limit, but using household earnings calculated from the SIPP. The associated dollar values can be found in IRS (2012). The phase-in and phase-out rates κ_1 and κ_2 are independent of aggregate model statistics and are thus the ones defined by the IRS for 2011. They are taken from the Tax Policy Center tables (Tax Policy Center, 2023).

Table A.10: Ratios that map data to the model and their associated EITC parameters.

# Children	κ_1	κ_2	$\bar{d}_{TC}$	$\bar{y}^k_{a,TC}$	$\underline{y}^k_{TC}$	$\bar{y}^k_{TC}$
$n_{k,j} = 0$	0.0765	0.0765	0.0485	0.2105	0.1203	0.1504
$n_{k,j} = 1$	0.3400	0.1598	-	0.5555	0.1803	0.3307
$n_{k,j} = 2$	0.4000	0.2106	-	0.6312	0.2532	0.3307
$n_{k,j}x = 3$	0.4510	0.2106	-	0.6780	0.2532	0.3307

Notes: The values shown in the table are model units for conversion ratios. See text for details.

The parameters for the other programs are defined in a similar fashion. For SNAP, since units are counted over earned and unearned income, benefit maxima and income lits, $\{\bar{y}^k_{SNAP}, t^k_{SNAP}\}$, respectively, are defined relative to average income, INC. Allowances, e^k_{SNAP}, are defined over average earnings, AE. A similar approach to the EITC parameters is taken for SNAP parameters using the values shown in Tables A.7 through A.9 combined with the statistics calculated directly from the SIPP sample in Table A.1. For the asset limit, the ratios are relative to the average assets in the model economy, A. Since this value stems for the single risk-free asset that may capture all assets in an economy, including housing or vehicles, I only apply the ratios to a share of the total assets defined to be equivalent to the "resources" category that is effectively tested by the programs.

To do so, I compute the ratio of average resources to average net worth in the data shown in Table A.1. This ratio is then applied to A to recover the share of average resources for the model economy to which the asset ratios in Table A.11 will be multiplied to obtain the model economy's asset limit. The ratio to be applied to the result of that calculation for SNAP, $r_{a,SNAP}$, is computed by averaging the ratios of asset limit value (US$2,000 or and US$3,000) to average resources in the data. More precisely, I calculate the share of average resources relative to the share of average net worth, $r_{resources}$, and multiply it by the ratio, $r_{a,SNAP}$. Hence, the asset constraint for SNAP (or SSI, since they use the same values) in the model is $\bar{a}_{SNAP} = r_{a,SNAP} \cdot r_{resources} \cdot A$.

Table A.11: Ratios that map data to the model and their associated SNAP parameters.

# HH members	$\bar{a}_{SNAP}$	$\bar{y}^k_{SNAP}$	t^k_{SNAP}	e^k_{SNAP}
Two	0.0162	0.2920	0.0679	0.0338
Three	-	0.3668	0.0973	0.0338
Four	-	0.4418	0.1235	0.0364
Five	-	0.5166	0.1466	0.0425

Notes: The values shown in the table are ratios for the conversion of data values into model units. See text for details.

Table A.12 collects the ratios for TANF, which use the same methodology described for SNAP, with $\{\bar{y}^k_{TANF}, t^k_{TANF}\}$ defined by multiplying the ratios by INC, e^k_{TANF} by AE, and $\bar{a}_{TANF}$ by multiplying the ratios by A.

Table A.12: Ratios that map data to the model and their associated TANF parameters.

# HH members	$\bar{a}_{TANF}$	$\bar{y}^k_{TANF}$	t^k_{TANF}	e^k_{TANF}
Two	0.0164	0.1473	0.0726	0.0431
Three	-	-	0.0893	-
Four	-	-	0.1045	-
Five	-	-	0.1193	-

Notes: The values shown in the table are ratios for the conversion of data values into model units. See text for details.

Finally, Table A.13, shows the ratios used for the SSI, which are obtained with a similar methodology as the one for the other programs. The values for $\{t_{SSI}, e_{SSI}\}$ are obtained by multiplying the ratios by AE and the value for $\bar{a}_{SSI}$ by A. For the income and benefits ratios as well as for the asset-testing ratio, similar to the approach used for SNAP, I use the average of the two values shown in Tables A.7 and A.8.

Table A.13: Ratios that map data to the model and their associated SSI parameters.

Parameter	$\bar{a}_{SSI}$	t_{SSI}	e_{SSI}
Value	0.0162	0.2003	0.0202

Notes: The values shown in the table are ratios for the conversion of data values into model units. See text for details.

B.5 Inspecting the Mechanisms - Extra Material

Table A.14: Endogenously calibrated parameters for alternative economies.

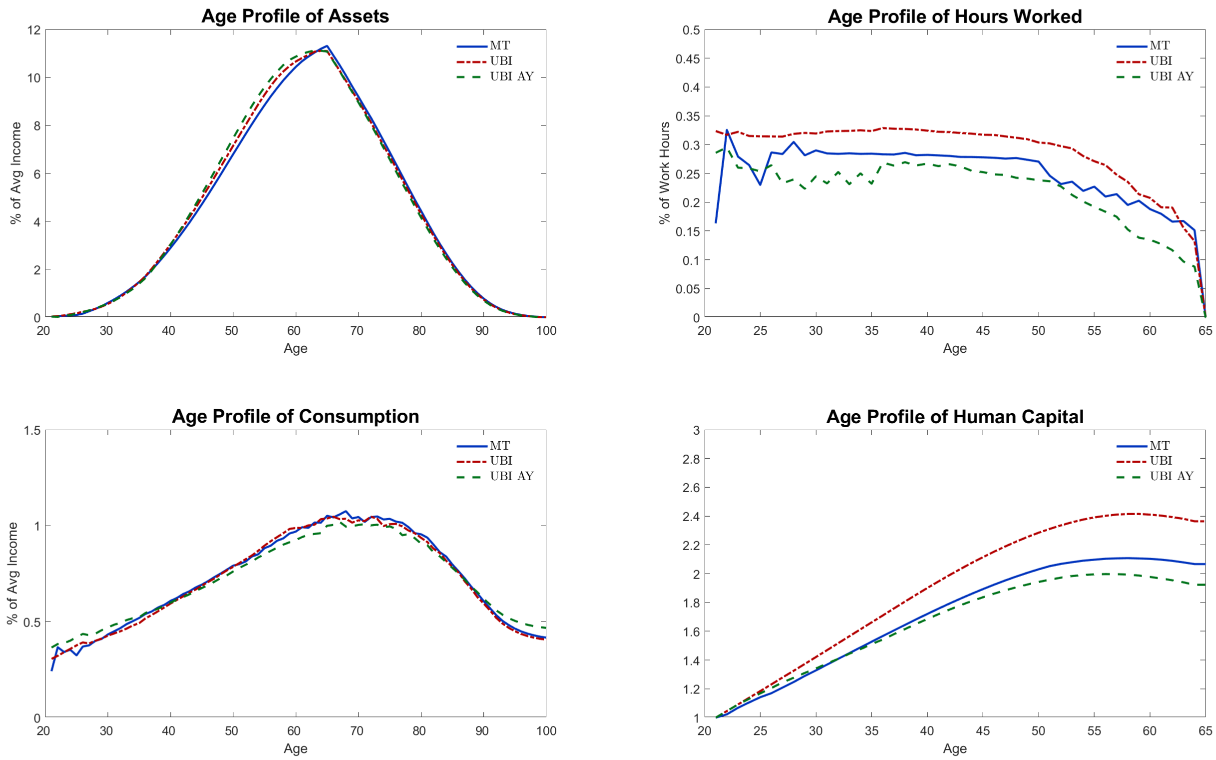
	Parameter	Value		Target	Data	Model		Source
		$\bar{a} = +\infty$	$\bar{l} = 0$			$\bar{a} = +\infty$	$\bar{l} = 0$	
Preferences								
Discount factor	β	0.995	1.003	K/Y	2.9	2.9	2.9	Kindermann and Krueger (2022)
Disutility of labor	φ	49.92	16.79	H	33.0%	33.0%	33.0%	Standard
Commuting costs	$\bar{l}$	0.185	-	ER	76.7%	74.0%	-	Chang et al. (2019)
Endowments								
Initial asset level	$\bar{a}_{j=1}$	-	-	1.33% $\cdot A$	-	0.019	0.080	Kuhn and Rios-Rull (2016)
Labor Income								
Childcare cost	η	0.059	0.246	17.1% $\cdot AE$	\$9,600	\$9,600	\$9,600	Child Care Aware of America
Var. of permanent shocks	σ_θ^2	0.005	0.700	Earn. Gini	0.67	0.68	0.67	Kuhn and Rios-Rull (2016)
Superstar shock	z_8	32.75	33.15	Wealth 99% - 100%	35.5%	31.5%	29.4%	Kuhn and Rios-Rull (2016)
Prob of becoming superstar	$\pi_{x,8}$	$8.31 * 10^{-4}$	$1.33 * 10^{-4}$	Wealth 95% - 99%	27.4%	23.2%	25.8%	Kuhn and Rios-Rull (2016)
Prob of staying superstar	$\pi_{8,8}$	0.976	0.973	Wealth Gini	0.85	0.81	0.80	Kuhn and Rios-Rull (2016)
Technology								
Technology multiplier	Λ	0.912	0.912	$w^* = 1.00$	1.000	1.000	1.000	Standard
K depreciation rate	δ_k	0.080	0.080	$r^* = 0.04$	0.040	0.040	0.040	Standard
Government								
SS Payroll tax	τ_{SS}	10.61%	10.61%	b_{SS}	36.0%	36.0%	36.0%	Congressional Budget Office

Notes: The table summarizes the details for the endogenously calibrated model parameters for the two alternative economies discussed in Section 6. The columns show their numerical values, the associated targeted moments in the model economy, the values attained in the model economy for these moments, and their data sources. See text for details.

C Life-Cycle Profiles

Figure A.1 shows the average life-cycle profiles for the benchmark economy and for the two counterfactual economies at their steady-state equilibria:

Figure A.1: Average Life-Cycle Profiles.



Notes: The figure shows the average life-cycle profiles for assets, labor suply, consumption, and human capital for the three economies studied. The solid blue line shows the profiles for the means-tested economy, the dotted-dashed red line shows the ones for the expenditure-neutral UBI, and the dashed green line shows the ones for Andrew Yang's proposal. The age range is from 20 to 100 years old and assets and consumption are shown as a percentage of households' average income, the labor supply as a percentage of hours worked, and human capital in its own level units.

D Welfare Calculation

In this section I describe in detail how to derive the consumption equivalent variation (CEV) that quantifies the welfare costs of the UBI reforms studied in the text. The context for the welfare analysis is a comparison between a benchmark economy that has an income security system with means-tested transfers and counterfactual economies that implement a reform of that system with a UBI program. I follow Conesa et al. (2008) and define the ex-ante lifetime utility for a newborn agent as follows:

$$W(\{\tau\},\zeta,TR) = \int_S v^*(a=a_0,h=1,z=\bar{z},k,\theta,j=1 \mid \{\tau\},\zeta,TR)\, d\Phi^* \tag{A.8}$$

where $\{\tau\}$ are all the taxation parameters, ζ is the collection of means-testing parameters, $\zeta = \{\bar{y}^k_{TC}, \bar{d}_{TC}, \ldots\}$, TR is the aggregate level of total transfers, and $\{v^*, \Phi^*\}$ are the equilibrium value functions and distributions.

For the computation of the CEV, I follow steps analogous to the ones in Appendix B of Krueger et al. (2016). The procedure to compare different equilibria consists basically of computing lifetime utility and how it changes if, at any point in time t, and for every state of the world, it is scaled by a factor of $1+g$. Denote the lifetime utility of an age $j=1$ with individual state space s_{-j} by $v(s_{-j}, j=1)$ and the lifetime utility of the scaled-up consumption sequence by s_{-j} by $v(s_{-j}, j=1; g)$.[24]

First, compute the lifetime utility using the functional form for the utility function shown in equation (11) in the description of the calibration (Section 3):

$$v(s_{-j}, j=1) = \mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1}\left(\prod_{i=1}^{j}\psi_i\right) u(c_j, l_j)\right] \tag{A.9}$$

$$= \mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1}\left(\prod_{i=1}^{j}\psi_i\right)\left\{\log(c_j) - \varphi \frac{l_j^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}\right\}\right] \tag{A.10}$$

Now applying the scaling factor, we have that:

[24] Here I borrow the typical notation in game theory that, given a vector $\vec{x}$ with arbitrary entries $i \in I$, we denote the same vector but exclude specific entry i_0 by $\vec{x}_{-i_0}$.

$$
\begin{aligned}
v(s_{-j}, j=1; g) &= \mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1}\left(\prod_{i=1}^{j}\psi_i\right)\left\{\log[(1+g)c_j] - \varphi\frac{l_j^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}\right\}\right] \\
&= \mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1}\left(\prod_{i=1}^{j}\psi_i\right)\left\{\log(1+g) + \log(c_j) - \varphi\frac{l_j^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}\right\}\right] \\
&= \sum_{j=1}^{J} \beta^{j-1}\left(\prod_{i=1}^{j}\psi_i\right)\log(1+g) \qquad \text{(A.11)} \\
&+ \underbrace{\mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1}\left(\prod_{i=1}^{j}\psi_i\right)\left\{\log(c_j) - \varphi\frac{l_j^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}\right\}\right]}_{=v(s_{-j}, j=1)} \\
&= \sum_{j=1}^{J} \beta^{j-1}\left(\prod_{i=1}^{j}\psi_i\right)\log(1+g) + v(s_{-j}, j=1) \qquad \text{(A.12)}
\end{aligned}
$$

If we ask the question by what percentage g do we need to increase consumption in the initial stationary equilibrium for the households to be indifferent between living in the old equilibrium or the new one, we are simply finding the g that solves the following equality:

$$
v^{MT}(s_{-j}, j=1; g) = v^{UBI}(s_{-j}, j=1) \qquad \text{(A.13)}
$$

where v^{MT} denotes that the equilibrium value function is relative to the initial means-tested steady state and v^{UBI} denotes the one associated with the new steady state under one of the UBI counterfactuals. Using equations (A.11) and (A.13), we can characterize the factor g:

$$v^{UBI}(s_{-j}, j=1) = \sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i \right) \log(1+g) + v^{MT}(s_{-j}, j=1) \tag{A.14}$$

$$\implies g(s_{-j}, j=1) = \exp\left\{ \frac{v^{UBI}(s_{-j}, j=1) - v^{MT}(s_{-j}, j=1)}{\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i \right)} \right\} - 1 \tag{A.15}$$

which is defined for a newborn household with characteristics s_{-j}.

If we want to evaluate the consequences of the reform under the veil of ignorance, i.e., before any identity is revealed, we can integrate over the state space and redefine g as:

$$g^{SS} = \exp\left\{ \frac{\int_S v^{UBI}(s_{-j}, j=1) d\Phi(s) - \int_S v^{MT}(s_{-j}, j=1) d\Phi(s)}{\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i \right)} \right\} - 1 \tag{A.16}$$

in which we recover in the numerator the difference of two ex-ante lifetime utilities for a newborn household (as depicted in (A.8)) in the distinct equilibria. As mentioned in Conesa et al. (2008), this can be calculated as the average expected lifetime utility across the different initial conditions.

Finally, in order to make the same evaluation but taking into account the transitional dynamics, we perform the same thought experiment but consider the comparison between a previous steady state and the first period of the reform. Denoting v_{∞}^{MT} as the value function associated with the stationary equilibrium under means-testing and $v_{t=1}^{UBI}$ as the value function under the new UBI regime but during the period in which the reform is enacted, we can define the associated g:

$$g^{Trans} = \exp\left\{ \frac{\int_S v_{t=1}^{UBI}(s_{-j}, j=1) d\Phi_{t=1}(s) - \int_S v_{\infty}^{MT}(s_{-j}, j=1) d\Phi_{\infty}(s)}{\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i \right)} \right\} - 1 \quad \text{(A.17)}$$

E Computation of the Model

E.1 Recursive Competitive Equilibrium

I solve for the households' problem by backward induction. The algorithm is similar to the one in Kindermann and Krueger (2022). Households surviving to the last period J have an immediate solution as $v_t^R(s_{-j}, J+1) = 0$. Aggregate quantities and prices are found by taking the following steps:

1. Guess initial values for K_t, L_t, $\tau_{c,t}$, and $\tau_{SS,t}$;
2. Given such initial values, use the firm's first-order conditions to obtain r_t and w_t;
3. Given prices and policy parameters, set the value function after the last age to 0 and solve the value function for the last period of life for each point of the grid. This yields policy functions and value functions over retirement $v_t^R(s)$;
4. Also given prices and policy parameters, solve for the household's decision rules by backward induction and value function iteration, repeating it until the first period of life;
5. Use forward induction to compute the associated distribution of households using the policy functions, starting from the known distribution at the beginning of the life-cycle;
6. Use the equilibrium conditions to update the values of the guessed variables and to compute all other aggregate variables;

7. Use dampening to obtain the new values for K_t and L_t, and check the whether the associated markets and the goods market clear;

8. Iterate until convergence.

E.2 Details of the Computation

I discretize all continuous dimensions of the state space: assets, human capital, productivity shocks, and permanent ability levels. I do so in 100, 20, 8 and 2 points, respectively. The children component is a binary index $k \in \{0, 1\}$, and the age list $j \in \{1, \dots J\}$ has 80 points for a fully fledged life-cycle. The transition is assumed to converge in 72 periods, adding the associated number of points to the individual arrays.

Due to several kinks in the budget constraint generated by the means-tested transfers, the value function iteration to find the choice of the next period's optimal assets is done by brute force grid search. Following Wellschmied (2021), I discretize the next period's assets grid in 250 points. Due to the non-convexity generated by the labor set-up costs, I also discretize the labor choice in 50 points and use a brute force grid search in the intra-period decision on the household's labor supply. I include an extra loop for precision on the evaluation of the extensive margin choice, which affects the next period's value via the law of motion of human capital. As there are values for the asset and human capital allocation that lie outside of the state space defined by the state grids, I use linear interpolation for each of these variables in order to find indices for the next period's value function and stationary distribution. All aggregate statistics and distributional and inequality measures are calculated using the discrete theoretical stationary distribution as in Krueger and Kindermann (2022).

The code for the computation of the quantitative model is written in *Fortran90* and compiled using both the GNU® and the Intel® Fortran Compilers. The household problem is solved by taking advantage of single-node parallelization with OpenMP. The code uses as main references Fehr and Kindermann (2018) and Krueger and Kindermann (2022). Following Kindermann and Krueger (2022), I use non-linearly spaced grids for assets and human capital. For the grids for the current and the next period's assets, I allocate substantially more nodes at the lower end, which are crucial for solving my problem due to the presence of multiple constraints for asset-testing. The assets' grid is defined as the array $\{\hat{a}^1, \ldots, \hat{a}^i, \ldots \hat{a}^{N_a}\}$, where $N_a = 100$ for the state level of assets and $N_a = 250$ for a'. I discipline the choice of the grid using the formula:

$$\hat{a} = \bar{a}\frac{(1+g_a)^{i-1}-1}{(1+g_a)^{N_a-1}-1} \tag{A.18}$$

where $\bar{a}$ is the upper bound of the discrete space and $g_a > 0$ is the growth of the distance between points. In my computation, I use $\bar{a} = 1200$ so that it does not constraint the household's optimization in any of the quantitative exercises conducted. Lastly, I choose $g_a = 0.14$, for the state assets' grid and $g_a = 0.05$ for a', which guarantees that there are at least 16 and 26 points, respectively, in the lower tail of the asset grid before the lowest asset means-testing threshold, $\bar{a}_{SNAP,SSI}$.[25]

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[25] A similar approach to dealing with the computational challenge for asset means-testing can be found in Wellschmied's (2021) description of the computational details in the paper's technical appendix.

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