Investment-Specific Technological Change and Universal Basic Income in the U.S.

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Abstract

Since 1980, income and wealth inequality increased gradually in the U.S.. Several solutions have been proposed, namely the introduction of a Universal Basic Income (UBI) system. In order to assess whether a UBI financed by a progressive labor tax is a viable solution to reduce inequality, we develop an overlapping generations model, with multiple sources of technological change and four different occupations. Calibrating the model to the U.S. we find that the welfare-maximizing level of UBI is actually quite low, 0.5% of GDP. Even though a higher UBI would decrease income and wealth inequality, it would negatively affect economic efficiency and make all types of agents worse off. The main mechanism is the distortionary effect of higher labor income taxation on capital accumulation which prevents the economy from incorporating the gains from investment-specific technological progress.

Keywords: Macroeconomics, Income Inequality, Technological Change, Universal Basic Income

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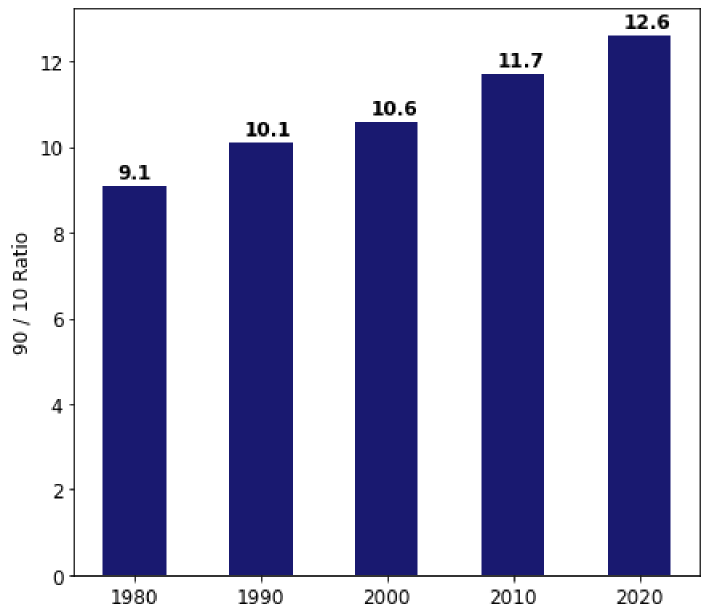
1. Introduction

Income inequality in the U.S. has increased gradually since 1980. As Figure **??** shows, the ratio between the 90th and the 10th income percentile increased by 39% in the past 40 years. In fact, the pre-tax income for the bottom quintile in the U.S. in 2017 was only 35.67% higher compared to the value in 1979, in real terms. On the other hand, the income for the top 1% of the distribution grew 243% [1] during the same time period, generating the aforementioned income dispersion. Income inequality is not only rising, it is also higher than most other advanced economies: the U.S. had a gross income Gini index of 0.41 in 2016, which is considerably larger than the world average of 0.35, and above most advanced economies[2].

Figure 1: 90 / 10 Ratio in the U.S. (1980 - 2020)



Note: Figure 1 plots the ratio between the gross income of the 90th and the 10th percentile household in the U.S. from 1980 until 2020. Incomes are not adjusted for household sizes. Data from the U.S. Census Bureau.

Wealth inequality has also spiked considerably: in 1980, the wealthiest 0.1% Americans owned 2.3% of the country's total wealth, whereas in 2018 this value was 9.6%, more than a four-fold increase. Contrast this with the bottom 90% of the distribution whose wealth share decreased 33% in the same time period, from 31.8% to only 21.2% in 2016 [3].

[1] Data from the Congressional Budget Office.
[2] Data from OECD.
[3] See Footnote 1

There are several explanations for these facts. Brinca et al. (2021a) find that occupation-based technological change can account for 90% of the increase in the U.S. earnings Gini between 1980 and 2015. The decrease in the price of equipment investment goods promotes capital accumulation, raising the demand for workers that perform tasks which are more complementary with capital, leading to a higher wage premium for highly skilled, non-routine workers over their less-skilled counterparts, and widening income inequality. Guerreiro et al. (2017) and work by Acemoglu and Restrepo [4] also highlight the connection between increased automation and higher income inequality. Lastly, Ferreira (2019) claims that the effects from skill-biased technological change account for 42% of the overall increase in income inequality.

There have been numerous suggestions proposed to address this problem. Commonly adopted policies include increasing labor tax progressivity in order to finance welfare programs, or raising the minimum wage. Some authors have also come up with less typical proposals. For instance, in the popular book Capital in the Twenty-First Century, Thomas Piketty recommends the adoption of a wealth tax, with several brackets, as a way of promoting redistribution, a suggestion that may have inspired a recent Democratic proposal for legislation that would tax unrealized capital gains. Saez and Zucman (2021) suggest instead a new tax on corporations' stock shares for all publicly listed companies and large private companies headquartered in G20 countries.

In addition to the previous proposals, one idea that has come up is a Universal Basic Income (UBI) system. Essentially, the government transfers a fixed monetary amount each month or year to each household, indepedently of their level of income or any other characteristics. There are different ways to apply and finance such system. For example, Andrew Yang proposed a monthly payment of $1.000 to all U.S. citizens over the age of 18[5], financed by scaling down or eliminating existing welfare programs and by introducing a Value-Added Tax as well as a financial transactions tax. An alternative could be to finance it through a linear income tax on income above a certain threshold, or even without the threshold in order to reduce the administrative costs of managing the program. In this work, we focus on using a progressive labor tax to finance lumpsum household transfers which are our conception of UBI.

[4] Acemoglu & Restrepo (2019), Acemoglu & Restrepo (2020), and Acemoglu & Restrepo (2021).

[5] See Andrew Yang's website, for more details.

Beyond the well-established idea that taxing individuals with higher income in order to finance transfers and subsidies to lower income ones helps reduce income inequality, a UBI system can have other potential benefits. Firstly, there is ample evidence, for instance by Lochner et al. (2011), showing that credit constraints prevent many students from obtaining higher educational achievements, implying that a UBI could improve human capital accumulation, leading to higher future productivity and wages. Secondly, Parijs et al. (2017) suggest that UBI can help shift labor supply from precarious jobs to ones that provide opportunities for further professional and personal growth and that may be more in line with individual preferences. Similarly, Hoynes et al. (2019) propose the possibility that a UBI will foster entrepreneurship and innovation, by prodiving a stable and permanent income. However, for simplicity, we focus on the effect of UBI on welfare and other macroeconomic variables such as labor supply and capital accumulation.

On the other hand, Kearney et al. (2019) argue that UBI is not the best tool for redistributive purposes. Because resources are limited and the government must define a way to finance the UBI transfers, the more money that is given universally, the less there is to give to the ones that need it the most. These authors claim that, in the U.S., existing welfare programs such as the Earned Income Tax Credit (EITC) and the Supplemental Security Income Program are better for redistributive goals. Since they specifically target lower income individuals, the literature suggests that scaling up these programs would be a better idea than adopting a UBI system. Finally, they claim that a UBI alone would not help social mobility, since targetted programs have higher social returns when they are targetted to disadvaganted families. For example, a large body of evidence documents that the current EITC system has better efficiency and equity characteristics than a UBI, by providing tax credits for enrolling in higher education or a payroll subsidy conditional on the working status of the individual.

As such, in this work we assess what is the optimal monetary amount of UBI for the U.S. economy in 2015, and analyze other economic consequences of UBI, namely whether a higher level of transfers can indeed reduce income and wealth inequality, especially across workers with different characteristics.

In order to answer the previously mentioned questions, we use the framework developed by Brinca et al. (2021b): an overlapping generations model featuring uninsurable idiosyncratic earnings risk, multiple sources of technological change, a detailed tax system, and occupational choice. This framework is commonly used in the literature and is able to generate plausible income and wealth distributions, which are determinant for the quantitative trade-offs that are involved when analysing universal basic income (see Brinca (2020a)). Households choose an occupation at the start of their work lives based on an individual-specific cost of acquiring the necessary skills and on the distribution of future earnings. Occupations differ in terms of the nature of the tasks that are being performed, following the ideas of Autor et al. (2003): non-routine cognitive (NRC), non-routine manual (NRM), routine cognitive (RC), and routine manual (RM).

Calibrating the model to match the data of the U.S. economy in 2015, we find that the level of UBI that maximizes social welfare is quite low, only 0.5% of per capita GDP. Interestingly, without considering the transitory dynamics and focusing only on the differences between the steady state of both levels of UBI, all four types of workers prefer this level of UBI above higher values that could, in theory, reduce income inequality and produce better outcomes for workers at the bottom of the income distribution. The key mechanism behind these conclusions is related to the distortionary effects of a higher level of labor taxes that would be required in order to finance a higher level of UBI, while keeping the government's budget constraint balanced. Lower post-tax labor income leads households to reduce labor supply in order to enjoy more leisure time, therefore reducing their savings to be able to smooth consumption across time. Since households save partially in the form of capital, the stock of capital in the economy is lower in the new steady state leading to a lower GDP per capita and a lower capital-to-labor ratio. Because the occupations are complementary with capital, the average wage in the economy goes down.

Even though a higher level of UBI is able to reduce income and wealth inequality by around 3.5%, social welfare as a whole, and for each worker, is lower than with a UBI level of 0.5% of GDP, due to the negative impact that higher labor taxation has on economic efficiency. This analysis highlights the role of investment-specific technological change: the higher productivity in the equipment capital sector, which generates higher wages for all occupations, can only be realized via the households' capital accumulation process, contrasting with other sources of technological change, such as total factor productivity and labor augmenting technological improvement, which do not rely as heavily on capital accumulation. It also demonstrates the trade-off between equity and efficiency: despite lowering income and wealth inequality, the reduction in economic efficiency is large to the point that agents end up enjoying more welfare in a less equal, but more efficient, society.

This work is organized in the following way: Section 2 presents the OLG with heterogeneous agents theoretical framework, based on Brinca et al. (2021), Section 3 explains the calibration procedure for the U.S. economy in 2015, Section 4 answers the initial questions, presenting the key results and economic mechanisms involved and, finally, Section 5 concludes. The appendix contains further details on the model's predictions.

2. Model

This section describes the model used to assess the impact of a Universal Basic System on social welfare and other variables. The model is based on the work by Brinca et al. (2021b) which, in turn, base their modeling strategy of the production side of the economy on Krusell et al. (2000) and Karabarbounis and Neiman (2014), whereas the asset structure has a similar framework to Krusell et al. (2010).

The model is an incomplete markets economy with overlapping generations of heterogeneous agents and partially uninsurable idiosyncratic risk that generates both an income and a wealth distribution. Before entering the labor market, households choose their occupation type based on an idiosyncratic cost of acquiring the necessary skills to perform it. This decision is assumed to be irreversible and mutually exclusive, and determines from which labor market the household will draw its wage over his lifetime. After entering the labor market, households receive an individual-specific flow of earnings in the form of wages, and decide how much to consume and save, together with the number of hours worked.

There are three final goods sectors in the economy: consumption goods, structure capital goods and an equipment capital goods sector. Additionally, the production functions include four different labor varieties: non-routine cognitive, non-routine manual, routine cognitive, and routine manual, which represent the choices available to the households mentioned in the previous paragraph.

Finally, households can decide to hold three asset types, structures capital, equipment capital and government bonds. Consequently, saving decisions of workers will impact equipment capital accumulation, determining how easily investment-specific technological change is incorporated into the production functions – a key mechanism in the model.

2.1. Demographics

We assume the economy is populated by a set of J - 1 overlapping generations, as in Brinca et al. (2016). We define a period in the model to correspond to one year. Thus, j, the household's age, varies between 0 (for age 20 households) and 80 (for age 100 households). Before entering the labor market, agents must make an irreversible and mutually exclusive occupation choice, deciding which labor market will determine their wages over the course of their lives. Households draw idiosyncratic utility from acquiring the necessary skills to join a given occupation type, κ_{i0}, where $o \in O = \{NRC, NRM, RC, RM\}$ and i indexes the household. The idiosyncratic utility can be viewed as the personal cost (or benefit, if positive) of the process of acquiring skills to perform the tasks associated with a given occupation type, such as the effort (or joy) from studying in the case of cognitive occupations, for example. κ_{i0} follows a type 1 extreme value distribution, H_0, with location parameter $\mu_{\kappa,0}$ and scale parameter $\sigma_{\kappa,0}$ in the tradition of discrete choice modeling of McFadden (1973). Households choose the occupation where total utility, $\tilde{V}_{io}$, is highest:

$$\tilde{V}_{io} = \kappa_{io} + V_o \tag{1}$$

where V_o is expected utility from choosing occupation type o, κ_{io} is the idiosyncratic utility draw for occupation o. Assuming $\sigma_{\kappa,0} = 1, \forall o \in O$, this formulation allows us to write the probability of choosing an occupation o before κ_{io} is known:

$$p_o = \frac{e^{\mu_o + V_o}}{\sum_{l \in O} e^{\mu_l + V_l}} \tag{2}$$

Equation **??** is also a closed form expression for the employment shares in our model. Other than occupation, households differ in the value of their persistent idiosyncratic productivity shock, u_{ij}, permanent ability, a_i, and asset holdings, h_{ij}. Working age agents have to choose how much to work, n_{ij}, how much to consume, c_{ij}, and how much to save, h_{ij+1}, to maximize utility.

After retiring at age 65, households face an age-dependent probability of dying, $\pi(j)$, dying with certainty at age 100. $\omega(j)$ = 1-$\pi(j)$ defines the probability of surviving given the agent's age, and so, at any given period, using the law of large numbers, the fraction of retired agents of age $j \geq 45$ is equal to $\Omega(j) = \prod_{t=45}^{t=j} \omega(t)$. Some households leave unintended bequests which are redistributed between the households that are currently alive via lumpsum transfers, denoted by Γ. We include a bequest motive in this framework to make sure that the age distribution of wealth is empirically plausible, as in Brinca et al. (2021a), and Brinca et al. (2019). Retired households make consumption and saving decisions and receive a retirement benefit, $\Psi(a_i)$. For simplicity, we assume that the public retirement benefit is constant until the agent's death and is equal to a fraction, ψ_{ss}, of the average earnings of an agent with permanent ability a_i at age $j = 44$ working 1/3 of his time. ψ_{ss} is such that the Social Security system breaks even in the equilibrium.

2.2. Labor Income

Labor productivity is a function of three elements which, together, determine the amount of efficiency units each household is endowed with in each period: Age, j, permanent ability, a_i, and the idiosyncratic productivity shock, u_{ij}, which we assume follows an AR(1) process:

$$u_{ij} = \rho_u u_{ij-1} + \epsilon_{ij}, \epsilon_{ij} \sim \mathcal{N}(0, \sigma_\epsilon^2) \tag{3}$$

Thus, household i's wage at age j is given by:

$$w_i(j, s_i, a_i u_{it}) = w_o e^{\gamma_0 + \gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 + a_i + u_{ij}}, \tag{4}$$

where γ_1, γ_2 and γ_3 are estimated directly from the data to capture the age profile of wages, and γ_0 is set such that the age polynomial is equal to zero at age 20 in the model. Households' labor income also depends on the wage per efficiency unit of labor $w_o, o \in O = \{NRC, NRM, RC, RM\}$, where o is the labor variety supplied by the household. Permanent ability is assigned at labor market entry and has variance $\sigma_{a,o}$ which depends on the occupation, in order to match the within group wage dispersion.

2.3. Preferences

Household utility is given by $\mathcal{U}(c_{ij}, n_{ij})$. It increases with higher consumption and decreases with more work hours, $n_{it} \in (0, 1]$, and is defined as:

$$\mathcal{U}(c_{ij}, n_{ij}) = \frac{c_{ij}^{1-\lambda}}{1-\lambda} - \chi \frac{n_{ij}^{1+\eta}}{1+\eta}, \tag{5}$$

where λ is the constant relative risk aversion coefficient and η is the inverse of the Frisch elasticity of labor supply. The utility function of retired households is also affected by the bequest they leave to living generations:

$$D(h_{ij+1}) = \Phi log(h_{ij+1}) \tag{6}$$

2.4. Technology

In this economy, there are three competitive final goods sectors: consumption, structure investment goods, and equipment investment goods. These are produced by transforming a single intermediate input using a linear production technology. All payments are made in the consumption good, which is the numeraire.

The consumption good is obtained by transforming a quantity $\mathcal{Z}_{c,t}$ of intermediate input into output, which is then sold at price $p_{c,t}$ to both households and the government. The transformation technology is:

$$C_t + G_t = Z_{c,t}, \tag{7}$$

where $\mathcal{Z}_{c,t}$ is the quantity of the input, purchased at $p_{z,t}$ from a representative intermediate goods firm. Given that the consumption good is competitively produced, its price equals the marginal cost of production:

$$p_{c,t} = 1 = p_{z,t} \tag{8}$$

Likewise, structure investment good firms produce output with a similar techonology:

$$X_{s,t} = Z_{s,t} \tag{9}$$

and therefore we have that $p_{s,t}$ = 1. The production of $X_{e,t}$, the equipment investment good, uses the transformation technology:

$$X_{e,t} = \frac{Z_{e,t}}{\xi_t}, \tag{10}$$

where $Z_{e,t}$ is the quantity of input z used in the production of the final equipment good. 1/ξ_t is the level of technology used in the production of $X_{e,t}$ relative to the final consumption good. As ξ_t declines, the relative productivity in assembling the equipment good increases. We assume that ξ_t evolves exogenously in this economy. We obtain the price of the equipment good from the zero profit condition:

$$p_{e,t} = \xi_t p_{z,t} = \xi_t, \tag{11}$$

where $\xi_t = p_{e,t}$ / $p_{c,t}$ is interpreted as the relative price of the equipment good.

A representative intermediate goods firm produces $Z_{c,t} + Z_{s,t} + Z_{e,t}$ using a constant returns to scale technology in capital and labor inputs, $y_t = F(K_{s,t}, K_{e,t}, N_{NRC,t}, N_{NRM,t}, N_{RC,t}, N_{RM,t})$, where $K_{s,t}$ is structure capital and $K_{e,t}$ is capital equipment. The firm rents non-equipment capital at rate $r_{s,t}$, equipment at r^e_t and each labor variety at $w_o, t, o \in O$. Aggregate demand measured in terms of the consumption good, $Y_t = C_t + G_t + X_{s,t} + \xi_t X_{e,t}$, factor prices and the price of the intermediate good $p_{z,t}$ are taken as given. The firm chooses capital and labor inputs each period in order to maximize profits:

$$\Pi_{z,t} = p_{z,t} y_t - r_{s,t} K_{s,t} - r_{e,t} K_{e,t} - \sum_{o \in O} w_{o,t} N_{o,t}, \tag{12}$$

subject to:

$$y_t = Z_{c,t} + Z_{s,t} + Z_{e,t} = C_t + G_t + X_{s,t} + \xi_t X_{e,t} = Y_t \tag{13}$$

This setup implies that $Z_{c,t} = C_t + G_t, Z_{s,t} = X_{s,t}, Z_{e,t} = \xi_t X_{e,t}$, and $F(.) = Y_t = C_t + G_t + X_{s,t} + \xi_t X_{e,t}$. We assume that the production function of intermediate goods is Cobb-Douglas over non-equipment capital and CES over the remaining inputs:

$$F(.) = A_t G(.) = A_t K_{s,t}^{\alpha} \left[\sum_{i=1}^{3} \varphi_i Z_{i,t}^{\frac{\sigma-1}{\sigma}} + \left(1 - \sum_{i=1}^{3} \varphi_i\right) N_{RM,t}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma(1-\alpha)}{\sigma-1}},$$

$$Z_{1,t} = \left[\phi_1 K_{e,t}^{\frac{\rho_1-1}{\rho_1}} + (1-\phi_1) N_{NRC,t}^{\frac{\rho_1-1}{\rho_1}} \right]^{\frac{\rho_1}{\rho_1-1}}, Z_{2,t} = \left[\phi_2 K_{e,t}^{\frac{\rho_2-1}{\rho_2}} + (1-\phi_2) N_{NRM,t}^{\frac{\rho_2-1}{\rho_2}} \right]^{\frac{\rho_2}{\rho_2-1}}, \tag{14}$$

$$Z_{3,t} = \left[\phi_3 K_{e,t}^{\frac{\rho_3-1}{\rho_3}} + (1-\phi_3) N_{RC,t}^{\frac{\rho_3-1}{\rho_3}} \right]^{\frac{\rho_3}{\rho_3-1}}$$

where A_t is total factor productivity, ϕ_i and φ_i are distribution parameters where $i = 1, 2, 3$, indicating the occupation types NRC, NRM, and RC. ρ_i is the elasticity of substitution between capital and nested labor variety i, and σ is the elasticity of substitution between each composite $Z_{i,t}$ and routine manual labor. Complementarity between the two inputs in $Z_{i,t}$ requires that $\rho_i < \sigma$, as explained in Krusell et al. (2000).

Each variety of labor input is measured in efficiency units, $N_{0,t} \equiv h_{0,t}\varrho_{0,t}$, where $h_{o,t}$ is the quantity of hours worked in the aggregate and $\varrho_{0,t}$ is an efficiency index representing the latent quality per hour worked of labor type o in period t. $\varrho_{o,t}$ can be interpreted as an occupation-specific technology level, due to research and development, or as human capital accumulation.

Firm maximization implies that marginal products equal factor prices.

$$w_{NRC,t} = \Xi_t \varphi_1 \left[\phi_1 \left(\frac{K_{e,t}}{N_{NRC,t}}^{\frac{\rho_1-1}{\rho_1}} \right) + (1-\phi_1) \right]^{\frac{\sigma-\rho_1}{(\rho_1-1)\sigma}} [1-\phi_1]\, \varrho_{NRC,t}, \tag{15}$$

$$w_{NRM,t} = \Xi_t \varphi_2 \left[\phi_2 \left(\frac{K_{e,t}}{N_{NRC,t}}^{\frac{\rho_2-1}{\rho_2}} \right) + (1-\phi_2) \left(\frac{N_{NRM,t}}{N_{NRC,t}} \right)^{\frac{\rho_2-1}{\rho_2}} \right]^{\frac{\sigma-\rho_2}{(\rho_2-1)\sigma}} [1-\phi_2] \left(\frac{N_{NRM,t}}{N_{NRC,t}} \right)^{-\frac{1}{\rho_2}} \varrho_{NRM,t} \tag{16}$$

$$w_{RC,t} = \Xi_t \varphi_3 \left[\phi_3 \left(\frac{K_{s,t}}{N_{NRC,t}} \right)^{\frac{\rho_3-1}{\rho_3}} + (1-\phi_3) \left(\frac{N_{RC,t}}{N_{NRC,t}} \right)^{\frac{\rho_3-1}{\rho_3}} \right]^{\frac{\sigma-\rho_3}{(\rho_3-1)\sigma}} [1-\phi_3] \left(\frac{N_{RC,t}}{N_{NRC,t}} \right)^{-\frac{1}{\rho_3}} \varrho_{RC,t} \tag{17}$$

$$w_{RM,t} = \Xi_t(1-\varphi_1-\varphi_2-\varphi_3)\left(\frac{N_{RM,t}}{N_{NRC,t}}\right)^{-\frac{1}{\sigma}} \varrho_{RM,t} \tag{18}$$

$$r_{s,t} = A_t\alpha\left[\frac{K_{e,t}}{N_{NRC,t}}\right]^{\alpha-1}\Lambda_t^{\frac{\sigma(1-\alpha)}{\sigma-1}} \tag{19}$$

$$\begin{aligned} r_{e,t} = \Xi_t\Bigg[&\varphi_1\left(\phi_1\left[\frac{K_{e,t}}{N_{NRC,t}}\right]^{\frac{\rho_1-1}{\rho_1}}+[1-\phi_1]\right)^{\frac{\sigma-\rho_1}{(\rho_1-1)\sigma}}\phi_1\left(\frac{K_{e,t}}{N_{NRC,t}}\right)^{-\frac{1}{\rho_1}}+ \\ &+\varphi_2\left(\phi_2\left[\frac{K_{e,t}}{N_{NRC,t}}\right]^{\frac{\rho_2-1}{\rho_2}}+[1-\phi_2]\left[\frac{N_{NRM,t}}{N_{NRC,t}}\right]^{\frac{\rho_2-1}{\rho_2}}\right)^{\frac{\sigma-\rho_2}{(\rho_2-1)\sigma}}\phi_2\left(\frac{K_{e,t}}{N_{NRC,t}}\right)^{-\frac{1}{\rho_2}}+ \\ &+\varphi_3\left(\phi_3\left[\frac{K_{e,t}}{N_{NRC,t}}\right]^{\frac{\rho_3-1}{\rho_3}}+[1-\phi_3]\left[\frac{N_{RC,t}}{N_{NRC,t}}\right]^{\frac{\rho_3-1}{\rho_3}}\right)^{\frac{\sigma-\rho_3}{(\rho_3-1)\sigma}}\phi_3\left(\frac{K_{e,t}}{N_{NRC,t}}\right)^{-\frac{1}{\rho_3}}\Bigg], \end{aligned} \tag{20}$$

where[6].

$$\Xi_t = A_t\left[\frac{K_{s,t}}{N_{NRC,t}}\right]^{\alpha}[1-\alpha]\Lambda_t^{\frac{1-\sigma\alpha}{\sigma-1}}$$

The capital laws of motion are:

$$K_{s,t+1} = (1-\delta_s)K_{s,t} + X_{s,t}, \tag{21}$$

$$K_{e,t+1} = (1-\delta_e)K_{e,t} + X_{e,t}, \tag{22}$$

where δ_s and δ_e are the depreciation rates.

2.5. Government

The social security system is managed by the goverment and runs a balanced budget. Revenues are collected from taxes on employees and on the representative firm at rates τ_{ss} and $\tilde{\tau}_{ss}$,

[6]Variable Λ_t is defined as:

$$\Lambda_t = \varphi_1\left(\phi_1\left[\frac{K_{e,t}}{N_{NRC,t}}\right]^{\frac{\rho_1-1}{\rho_1}}+[1-\phi_1]\right)^{\frac{\rho_1(\sigma-1)}{(\rho_1-1)\sigma}} + \varphi_2\left(\phi_2\left[\frac{K_{e,t}}{N_{NRC,t}}\right]^{\frac{\rho_2-1}{\rho_2}}+[1-\phi_2]\right)^{\frac{\rho_2(\sigma-1)}{(\rho_2-1)\sigma}} + \varphi_3\left(\phi_3\left[\frac{K_{e,t}}{N_{NRC,t}}\right]^{\frac{\rho_3-1}{\rho_3}}+[1-\phi_3]\right)^{\frac{\rho_3(\sigma-1)}{(\rho_3-1)\sigma}} + (1-\varphi_1-\varphi_2-\varphi_3)\left(\frac{N_{RM,t}}{N_{NRC,t}}\right)^{\frac{\sigma-1}{\sigma}}$$

respectively, and are used to pay retirement benefits, Ψ.

The government taxes consumption, τ_c, and capital income, τ_k, at flat rates. The labor income tax follows a non-linear functional form as in Heathcote et al. (2019) and Benabou (2002).

$$y_a = 1 - \theta_0 y^{-\theta_1}, \tag{23}$$

where θ_0 and θ_1 define the level and progressivity of the tax schedule, respectively. y is the pre-tax labor income and y_a is the after-tax labor income.

Tax revenues from consumption, labor and capital income taxes are used to finance public consumption of goods, G_t, public debt interest expenses, $r_t B_t$, and lump sum transfers, g_t, which are a residual which clears the government budget constraint (later on in the analysis, we define the value of this variable since it is our conception of UBI, and it will be the value of θ_0 that will clear the budget constraint). Denoting social security revenues by R_t^{ss} and the other tax revenues as T_t, the government budget constraint is defined as:

$$T_t = G_t + r_t B_t + g_t; \tag{24}$$

$$\Psi_t \left(\sum_{j \geq 45} \Omega_j \right) = R_t^{ss} \tag{25}$$

2.6. Asset Structure

Households hold three asset types: Structures capital, $k_{s,ij}$, equipment capital, $k_{e,ij}$, and government bonds, b_{ij}. There is no investment-specific technological change in the steady state, i.e., $\xi_{t+1} = \xi_t = \xi$, so we drop the time index on return rates for this exposition. The return on the government bond must satisfy:

$$\frac{1}{\xi}[\xi + (r_e - \xi\delta_e](1 - \tau_k)] = 1 + r(1 - \tau_k), \tag{26}$$

which follows from non-arbitrage: investing in equipment capital must yield the same return as investing the same amount in bonds. Similarly, the return rate on structure capital must satisfy:

$$\frac{1}{\xi}[\xi + (r_e - \xi\delta_e](1 - \tau_k)] = 1 + r(r_s - \delta_s)(1 - \tau_k), \tag{27}$$

Total assets for the consumer are defined as:

$$h_{ij} \equiv \xi k_{e,ij} + b_{ij} + k_{s,ij} \tag{28}$$

2.7. Household Problem

On any given period a household is defined by age , j, asset position, h_{ij}, permanent ability, a_i, and a persistent idiosyncratic productivity shock u_{ij}. A working-age household chooses consumption, c_{ij}, work hours, n_{ij}, and future asset holdings, h_{ij+1}, to solve his optimization problem. The household budget constraint is given by:

$$\begin{gathered} c_{ij}(1+\tau_c) + \xi k_{e,ij+1} + b_{ij+1} + k_{s,ij+1} = [\xi + (r_e - \xi\delta_e)(1-\tau_k)]k_{e,ij}+ \\ +[1 + r(1-\tau_k)]b_{ij} + [1 + (r_s - \delta_s)(1-\tau_k)]k_{s,ij} + q\Gamma + Y^N + g, \end{gathered} \tag{29}$$

where Y^N is the household's labor income after social security and labor income taxes, and $q = 1/(1+r(1-\tau_k))$. Using **??** and **??**, in equilibrium we can rewrite the budget constraint as:

$$c_{ij}(1+\tau_c) + h_{ij+1} = (h_{ij+1} + \Gamma)[1 + r(1-\tau_k)] + Y^N + g \tag{30}$$

The household problem can then be formulated recursively as:

$$V(j, h_{ij}, o_i, a_i, u_{ijt}) = \max_{c_{ij}, n_{ij}, h_{ij+1}} \left[U(c_{ij}, n_{ij}) + \beta \mathbb{E}_{u_{j+1}}[V(j+1, h_{it+1}, o_i, a_i, u_{ij+1})]\right]$$

$$s.t.:$$

$$c_{ij}(1+\tau_c) + h_{ij+1} = (h_{ij} + \Gamma)[1 + r(1-\tau_k)] + Y^N + g$$

$$Y^N = \frac{n_{ij} w(j, o_i, a_i, u_{ij}}{1+\tilde{\tau_{ss}}} \left(1 - \tau_{ss} - \tau_l \left[\frac{n_{ij} w(j, o_i, a_i, u_{ij}}{1+\tilde{\tau_{ss}}}\right]\right)$$

$$n_{ij} \in (0,1]; h_{ij} \geq 0; h_{i0} = 0, \forall i; c_{ij} > 0$$

The problem of a retired household differs in three features: the age dependent probability of dying $\pi(j)$, the bequest motive $D(h_{ij+1})$, and labor income, which is replaced by constant retirement benefits depending on permanent ability, $\Phi(a_i)$. Therefore, the retired household's problem is defined as:

$$V(j, h_{ij}, a_i) = \max_{c_{ij}, h_{ij+1}} [U(c_{ij}, h_{ij+1} + \beta(1 - \pi(j))V(j+1, h_{ij+1}, a_i) + \pi(j)D(h_{ij+1})]$$

$s.t.:$

$$c_{ij}(1 + \tau_c) + h_{ij+1} = (h_{ij} + \Gamma)[1 + r(1 - \tau_k)] + \Phi(a_i) + g$$

$$h_{ij+1} \geq 0; c_{ij} > 0$$

2.8. Stationary Recursive Competitive Equilibrium

$\Phi(j, h_{ij}, s_i, a_i, u_{ij})$ is the measure of agents with corresponding characteristics $(j, h_{ij}, s_i, a_i, u_{ij})$. Dropping the time index from aggregate variables, because this is the characterization of the steady state, we can define the stationary recursive competitive equilibrium by:

1. Taking factor prices and initial conditions as given, the value function $V(j, h_{ij}, s_i, a_i, u_{ij})$ and the policy functions, $s_{i0}(\kappa_{i0}), c_{ij}(h_{ij}, s_i, a_i, u_{ij}), h_{ij+1}(h_{ij}, s_i, a_i, u_{ij})$, and $n_{ij}(h_{ij}, s_i, a_i, u_{ij})$, solve the household's optimization problem.

2. Markets clear:

$$\xi K_e + B + K_s = \int h + \Gamma d\Phi,$$

$$N_{RM} = \varrho_{RM} \int n_{RM} d\Phi, \;\; N_{RC} = \varrho_{RC} \int n_{RC} d\Phi,$$

$$N_{NRM} = \varrho_{NRM} \int n_{NRM} d\Phi, \;\; N_{NRC} = \varrho_{NRC} \int n_{NRC} d\Phi,$$

$$C + G + \delta_s K_s + \xi \delta_e K_e = F(K_s, K_e, N_{NRC}, N_{NRM}, N_{NRC}, N_{RM}).$$

3. Equations **??**-**??** hold.

4. The government budget balances:

$$G + rB + g = \int \tau_k r(h + \Gamma) + \tau_c c + n\tau_l \left[\frac{nw(j, o, a, u)}{1 + \tilde{\tau_{ss}}}\right] d\Phi \quad (31)$$

5. The social security system balances:

$$\int_{j\geq 45} \Psi d\Phi = \frac{\tilde{\tau_{ss}} + \tau_{ss}}{1+\tilde{\tau_{ss}}} \left(\int_{j<45} nwd\Phi \right) \tag{32}$$

6. The assets of the deceased at the beginning of the period are uniformly distributed among the living:

$$\Gamma \int w(j) d\Phi = \int (1 - w(j)) hd\Phi \tag{33}$$

3. Calibration

This section describes the calibration of the baseline model to match the U.S. economy in 2015. Some parameters were set directly, without solving the model, to match their empirical counterparts. Since the remaining parameters are not observable, they were estimated using a Simulated Method of Moments (SMM) approach. Results are shown in Table **??**.

3.1. External Calibration

Demographics The inverse of the Frisch elasticity of labor supply, η, which corresponds to the standard value in the literature. The risk aversion parameter, λ, is set to 1, corresponding to a logarithmic utility.

Labor productivity The wage profile throughout the life cycle (see equation **??**) was calibrated directly from the data. Using data from the Panel of Study of Income Dynamics (PSID) data, Brinca et al. (2021b) ran the following regression:

$$ln(w_{it}) = a + \gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 + \epsilon_{it} \tag{34}$$

where j is the age of individual i. Afterwards, they use the residuals of the equation to estimate the parameters governing the idiosyncratic shock ρ and σ_ϵ. The scale parameters of the cost of choosing an occupation ($\mu_{NRC}, \mu_{NRM}, \mu_{RC}, \mu_{RM}$) are set such that they match the employment shares in 2015. The location parameter, μ_{RM}, is normalized to 1.0.

Technology The equipment and structures depreciation rates were estimated following the methodology used by Eden and Gaggl (2018), with the depreciation for structures, $\delta_s = 0.026$, being lower than for equipment, $\delta_e = 0.106$. The estimation strategy for the production function parameters was a two-step Simulated Pseudo Maximum Likelihood estimator, proposed by Ohanian et al. (1997), to match 2015 data. The elasticity of substitution between non-routine cognitive workers and capital is the lowest, $\rho_1 = 0.497$, since their tasks are hard to automate, as opposed to routine-manual workers who have the highest elasticity, $\sigma = 5.564$, and easier to automate tasks. Accordingly, the share of capital is higher in the non-routine cognitive / capital composite, $\phi_1 = 0.378$, and is lower in the non-routine manual / capital composite, $\phi_2 = 0.086$. See Brinca (2020b) for the relevance of changes in factor shares for fiscal policy.

Government The scale and progressivity parameters of the labor income tax schedule, θ_0 and θ_1, are set to the estimates obtained by Wu (2021) for the U.S. economy in 2015. For the social security rates, there is no progressivity: both social security tax rates, on behalf of the employer and on behalf of the employee, are those described in Brinca et al. (2016). Government debt to output is the 2014-2016 average of government debt to GDP provided by FRED. Both the consumption tax and the capital income tax are calculated using the method in Mendoza et al. (1994). Finally, government expenditures to GDP is the 2015 ratio of Federal Net Outlays to GDP.

3.2. Internal Calibration

To calibrate the remaining parameters, for which there are no direct empirical counterparts, $\tilde{\theta} = \{\Phi, \chi, \beta, \sigma_{NRC}, \sigma_{NRM}, \sigma_{RC}, \sigma_{RM}\}$, a simulated method of moments was used, with the following loss function:

$$L(\tilde{\theta}) = |M_m - M_d|, \tag{35}$$

where $\tilde{\theta}$ is the vector of parameters to be estimated and M_m, M_d are the moments in the 2015 data and in the model respectively. By minimizing (35), we obtain the estimate $\tilde{\theta}^*$.

Table 1: External calibration summary

Description	Parameter	Value	Source
Preferences			
Inverse Frisch Elasticity	η	3.000	Assumption
Risk aversion parameter	λ	1.000	Assumption
Labor productivity			
Parameter 1 age profile of wages	γ_1	0.265	Brinca et al. (2021)
Parameter 2 age profile of wages	γ_2	-0.005	Brinca et al. (2021)
Parameter 3 age profile of wages	γ_3	0.000	Brinca et al. (2021)
Variance of idiosyncratic risk	σ_ϵ	0.307	Brinca et al. (2021)
Persistence of idiosyncratic risk	ρ_u	0.335	Brinca et al. (2021)
Location of cost of choosing NRC	μ_{NRC}	-6.882	Brinca et al. (2021)
Location of cost of choosing NRM	μ_{NRM}	2.994	Brinca et al. (2021)
Location of cost of choosing RC	μ_{RC}	-2.027	Brinca et al. (2021)
Location of cost of choosing RM	μ_{RM}	0.000	Brinca et al. (2021)
Technology			
Equipment depreciation rate	δ_e	0.106	Brinca et al. (2021)
Structures depreciation rate	δ_s	0.026	Brinca et al. (2021)
Share NRC	ϕ_1	0.378	Brinca et al. (2021)
Share NRM	ϕ_2	0.086	Brinca et al. (2021)
Share RC	ϕ_3	0.279	Brinca et al. (2021)
Share composite NRC	φ_1	0.160	Brinca et al. (2021)
Share composite NRM	φ_2	0.045	Brinca et al. (2021)
Share composite RC	φ_3	0.023	Brinca et al. (2021)
EOS NRC	ρ_1	0.497	Brinca et al. (2021)
EOS NRM	ρ_2	2.055	Brinca et al. (2021)
EOS RC	ρ_3	5.029	Brinca et al. (2021)
EOS RM	σ	5.564	Brinca et al. (2021)
Latent efficiency NRC	ϱ_1	2.986	Brinca et al. (2021)
Latent efficiency NRM	ϱ_2	4.051	Brinca et al. (2021)
Latent efficiency RC	ϱ_3	33.907	Brinca et al. (2021)
Latent efficiency RM	ϱ_4	0.267	Brinca et al. (2021)
Total factor productivity	A	18.281	Brinca et al. (2021)
Relative price of investment good	ξ	0.405	Brinca et al. (2021)
Government and SS			
Consumption tax rate	τ_c	0.050	Mendoza et al. (1994)
Capital income tax rate	τ_k	0.360	Mendoza et al. (1994)
Tax scale parameter	θ_0	0.922	Wu (2021))
Tax progressivity parameter	θ_1	0.137	Wu (2021)
Government expenditures to GDP	G/Y	0.203	FRED
Government debt to GDP	B/Y	1.020	FRED
SS tax employees	τ_{ss}	0.077	Social Security Bulletin, July 1981
SS tax employers	$\tilde{\tau_{ss}}$	0.077	Social Security Bulletin, July 1981

The target for the utility of bequests parameter is the ratio between average wealth of 65 and older to the average wealth in the economy. The discount factor is set by targetting the capital-to-output ratio. Disutility from work targets hours worked, and the occupation-specific variances of ability target the variance of log earnings observed in the data for each occupation. Table **??** presents the values of the parameters calibrated internally.

Table 2: Parameters calibrated internally

Parameter	Value	Description
Φ	7.093	Bequest Utility
β	0.968	Discount factor
χ	56.57	Disutility of work
$\sigma_{a,NRC}$	0.391	Variance of ability NRC
$\sigma_{a,NRM}$	0.381	Variance of ability NRM
$\sigma_{a,RC}$	0.304	Variance of ability RC
$\sigma_{a,RM}$	0.441	Variance of ability RM

4. Results

This section describes the simulation performed in order to identify the optimal level of Universal Basic Income for the U.S. economy in 2015. Afterwards, we describe the patterns and economic mechanisms behind the results obtained, both for the economy as a whole and for the four different occupations of the model.

4.1. Experiment

Before presenting the main results, it is important to clarify the design of the UBI system and precisely what was the experiment performed. In this work, the level of UBI equals the value of lumpsum transfers from the Government directly to the households, g_t from equation **??**. They are unconditional because all households receive the same value in each period, regardless of their level of income, wealth or other characteristics. Here, the UBI system is financed by capital and consumption taxes and, importantly, by a progressive labor tax.

Thus, given the 2015 calibration of the U.S. economy, the experiment consists in varying the level of g_t and assessing the welfare impact of this policy. One important aspect is that as we change g_t, the level of taxes, θ_0, adjusts to ensure that the government's budget constraint still holds, while labor tax progressivity, θ_1 stays constant. Consequently, as we will see, different levels of UBI will lead to different levels of labor income taxation, generating interesting economic effects.

4.2. Optimal level of UBI

In the 2015 baseline calibration described previously, the tax level parameter, θ_0, is equal to 0.92 and the level of UBI that clears the budget constraint, g_t, is 0.50 which corresponds to a transfer of 5% of GDP per capita, as we can see in Table **??**. Figure **??** compares the welfare under different levels of UBI, with the vertical axis showing the percentage deviation from the welfare under the baseline scenario of $g_t = 5\%$ of GDP.

Table 3: UBI, Tax Level and GDP per Capita

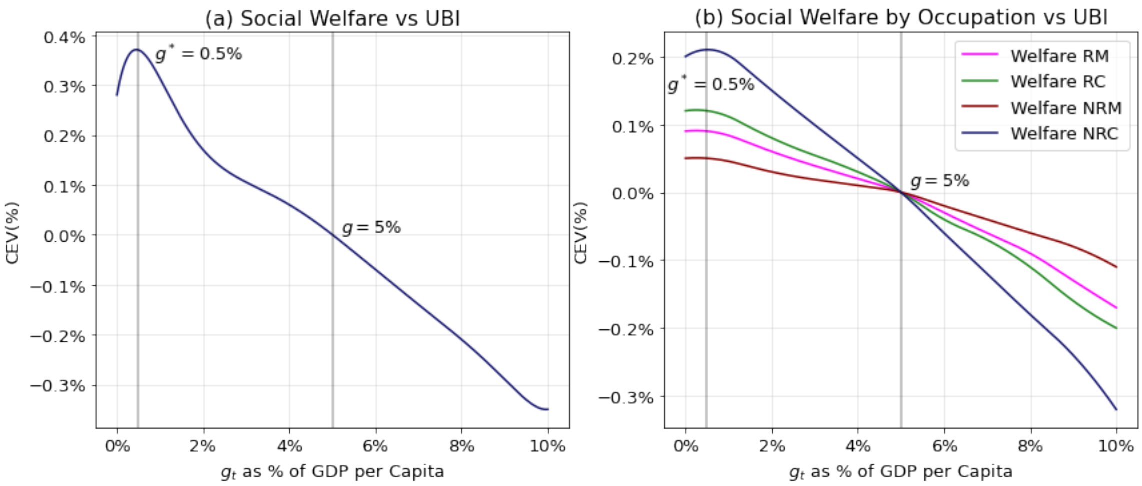
UBI (g_t)	**Tax Level ($1 - \theta_0$)**	**Y / Capita**	**UBI (% of GDP)**
0.05	0.013	10.41	0.5%
0.50	0.078	10.05	5.0%
1.00	0.157	9.57	10.5%

Note: Table 3 shows the tax level, GDP per capita and level of UBI as a percentage of GDP per capita, in the steady state of three different scenarios: the baseline UBI of 0.5, a lower level equal to 0.05 and a higher one equal to 1.00.

The first observation is that a low level of UBI of 0.5% of GDP per capita, maximizes our measure of social welfare. This represents a 0.37% welfare improvement over a UBI of 5% of GDP, when the economy finishes its transition to the steady state. Since household transfers are lower under this scenario, the government budget clearing tax level decreases from 8% to 1.3%. Another interesting conclusion is that increasing the level of UBI above 5% of GDP actually reduces social welfare: for example, if UBI was set at 10% of GDP per capita, welfare would be 0.58% lower compared with the optimal value mentioned before, and output per capita would be 9.57, representing an 8% drop relative to the GDP value of the scenario in which UBI = 0.5%.

Panel (b) shows the decomposition of the welfare function by occupation category. Since the types of workers differ in their position in the wage distribution, it is natural that changing the level of UBI will affect them in different ways. Interestingly, all occupations prefer a level

Figure 2: Optimal level of UBI



Note: Panel (a) plots social welfare as a function of the value of lumpsum transfers to households (our conception of UBI), under the baseline calibration. Social welfare is measured as the consumption equivalent variation required for unborn agents to be indifferent between baseline and the new policy, without accounting for transitions between steady states. The vertical lines indicate current (g_t) and optimal (g_t^*) level of UBI. Panel (b) plots the same measure of welfare for households starting their life in the indicated occupation categories.

of UBI lower than the baseline value of 5% of GDP, with the optimal level being extremely close to the previously mentioned optimal $g_t = 0.5\%$, in the four cases. Compared with the baseline, it is the non-routine cognitive workers, who have the highest wages in the economy due to their complementarity with capital, that experience the highest welfare increase (0.2%) from setting the level of UBI at the optimal 0.5% of GDP, instead of the baseline level of 5%. The routine cognitive and routine manual workers, with a wage closer to the median wage in the economy, would see their welfare increase by around 0.1%, whereas the non-routine manual agents's welfare would only increase by 0.05%. The analysis is symmetric: it is the NRC (NRM) workers who would lose (gain) more welfare from an increase in UBI.

4.3. Economic Mechanisms

In order to make sense of the previous results, it is essential to understand the economic mechanisms in play. We first describe the consequences for the economy as a whole, followed by an analysis of the differences across occupations.

As the government decreases UBI from 5% to 0.5% of GDP, it needs to raise less tax revenues to keep its budget balanced, decreasing the overall level of labor taxes as we saw previously. Because the post-tax return on labor is now higher, households substitute away from leisure, providing more hours of work and increasing their savings, leading to higher capital accumulation. Since labor and capital are increasing, GDP per capita increases. Particularly, the model predicts a larger increase in equipment capital compared with the increase in labor, leading to a higher capital to labor ratio and a rise in the economy's average wage since the marginal productivity of labor is higher. Workers are wealthier, since they have higher wages and higher post-tax earnings, so consumption per worker also increases: due to consumption smoothing, the increase in savings is higher than the rise in consumption. Table **??** illustrates the previous intuition with actual values generated by the model.

Table 4: Model Predictions for Different Levels of UBI

UBI (% of GDP)	0.5%	5%	10%
Tax Level	0.013	0.078	0.125
Y / Capita	103.7	100	95.4
Hours Worked	101.9	100	97.5
Savings / Capita	105.2	100	93.5
Consumption / Capita	103.6	100	95.3
Equipment / Labor	103.5	100	95.5
Average Wage	101.7	100	97.6

Note: Table 4 represents the value of different variables, obtained from the model's steady state predictions, that describe the economy under three levels of UBI. The tax level, $1-\theta_0$, is shown as a decimal from 0 (lower tax level) to 1 (higher tax level). The remaining variables are shown as an index, with UBI = 5% of GDP serving as the baseline. Thus, as an example, lowering UBI from 5% to 0.5% increases GDP per capita by 3.7%, and increasing UBI to 10% would decrease GDP / capita by 4.6%.

Additionally, it is important to distinguish the response of each type of worker to changes in UBI. Firstly, the decrease in UBI and in the level of taxes, leads to an increase of 3.4% in the average wage for the poorest workers in the economy (NRM), but of only 1.3% and 0.8% to RM and RC workers, respectively, who are closer to the middle of the wage distribution. NRC workers actually see their average wage decrease by 0.5%. Due to a larger increase in their wage, and because an extra unit of consumption gives them higher utility, non-routine manual workers are the ones who increase their hours worked the most (2.7%), followed by routine manual and routine cognitive workers and, lastly, by the non-routine cognitive workers (only

1.4%). Appendix A shows more details.

Even though average wages are closer together, since poorer workers end up working more hours, the welfare increase of setting a lower level of UBI is smaller for NRM workers and larger for NRC workers, as mentioned in the previous section. The reduction of taxes across the income distribution and the lower amount of household transfers increases post tax income inequality, whereas the higher wages and hours worked for NRM workers help decrease it. However, as we can see in Table **??**, the first effect dominates and post-tax income inequality, measured by the Gini Index, does go up as UBI decreases. Lastly, since NRC workers have a higher share of the economy's wealth, decreasing the level of taxes helps them increase their savings and capital accumulation, which results in a higher wealth Gini.

Table 5: Inequality

UBI (% of GDP)	**0.5%**	**5%**	**10%**
Post Tax Income Gini	0.449	0.442	0.433
Wealth Gini	0.504	0.498	0.488

Note: Table 5 shows Post Tax Income Gini and Wealth Gini under different levels of UBI, obtained from the model's steady-state predictions. Values closer to 1 indicate higher inequality, and values closer to 0 represent less income or wealth dispersion.

Thus, even though increasing the level of UBI above 0.5% of GDP would not improve the economy or each type's welfare, it would indeed lead to lower income and wealth inequality. However, this would come at a cost of economic efficiency, as discussed previously. This highlights the important role of investment-specific technological change. With our modeling choice, the increase in the productivity of the equipment investment good must be incorporated into the production process via savings and capital accumulation. Thus, decreasing taxes reduces the distortionary effects on savings, promoting the accumulation of capital equipment and the consequent increase in wage growth for all occupations which benefit from equipment-occupation complementarity. This contrasts with other sources of changes in productivity – labor augmenting technology or total factor productivity – since those affect the production function directly and do not rely as heavily on capital accumulation. In models where those two are the main improvements in productivity, the distortionary effects of a higher tax level to finance a higher

UBI would be lower and, presumably, the optimal level of UBI could be higher than predicted in this work.

5. Conclusion

The goal of this work was to assess what was the optimal level of universal basic income for the U.S. economy in 2015 as well as understand its consequences for the economy as a whole and for different types of workers, with different skills and levels of complementarity with capital equipment. To answer this question, a life-cycle, overlapping generations model with uninsurable idiosyncratic earnings risk, multiple sources of technological change, a detailed tax system, and occupational choice was used.

Calibrating the model to match the characteristics of the U.S. economy in 2015, we found that the optimal level of UBI is quite low, only 0.5% of per capita GDP, financed by a progressive labor tax. Furthermore, it was found that the four types of workers in the economy actually prefer a lower level of UBI compared with the baseline level of 5%, which also features a higher level of labor taxes. However, it is the non-routine cognitive workers who benefit the most from the reduction in UBI and taxes, whereas the non-routine manual workers, being at the bottom of the wage distribution, are the ones whose welfare increase is the lowest. Logically, they would prefer an economy with higher taxes to finance larger transfers to households.

Decreasing the level of UBI allows the government to reduce labor taxes, which increases aggregate labor supply and aggregate savings, resulting in higher capital accumulation that eventually leads to a higher average wage in the economy. Nonetheless, the resulting economy with a UBI level of 0.5% is characterized by a higher level of wealth and post-tax income inequality, but this effect is balanced by more efficiency and GDP per capita which, in the end, generates a welfare improvement for the agents, highlighting the classical efficiency - inequality trade-off.

There are of course some caveats to this analysis, which could make the optimal level of UBI be higher than 0.5% of GDP. Firstly, we did not consider other benefits of a UBI system, especially the effect it can have on unemployment and job security which can promote innovation and improvements in human capital, as discussed in the introduction. Taking those factors into account would certainly increase the optimal level of UBI. Secondly, we could also have considered different implementations of a UBI system, namely one with a flat labor tax rate which could lower the administrative costs of the tax system and generate more revenue to transfer to households, or even an age cutoff similar to what some UBI proponents suggest. Finally, it would be interesting to assess whether other changes to the tax system, for example increased labor tax progressivity, or even a negative income tax, could generate a higher increase in welfare.

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Appendix A

UBI (% of GDP)	0.5%	5%	10%
Hours Worked RM	102.14	100	97.30
Hours Worked RC	101.95	100	97.53
Hours Worked NRM	102.73	100	96.52
Hours Worked NRC	101.41	100	98.20
RM Avg. Wage	101.30	100	98.46
RC Avg. Wage	100.83	100	99.08
NRM Avg. Wage	103.38	100	95.90
NRC Average Wage	99.48	100	100.64

Note: The table represents the value of hours worked and average wage per occupation, obtained from the model's steady state predictions, under three levels of UBI. All variables are shown as an index, with UBI = 5% of GDP serving as the baseline. Thus, as an example, lowering UBI from 5% to 0.5% increases the hours worked by non-routine manual workers by 2.14%, and increasing UBI to 10% would decrease the baseline value by 2.7%.