Universal basic income and skill-biased technological change

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Abstract

In the last decades, income inequality has been on the rise in the U.S. The growing skill premium suggests the pivotal role of skill-biased technological change (SBTC) in promoting the observed increase in inequality levels. In this context, labor income tax structures have been central to the policy debate. I develop an overlapping generations model to perform a welfare evaluation of Universal basic income (UBI) tax structures and verify how these interact with SBTC. I find that an UBI system would have improved social welfare in 2010 when compared to the existing tax system and determine that this result is primarily motivated by SBTC.

Keywords: Income Inequality, Skill Premium, Optimal Taxation, Universal Basic Income

JEL Classification: E24; E62; H21;

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1 Introduction

More and more, society is faced with the everyday reality of automation as it has become an issue of outmost relevance. With many of the discussions regarding it being centered around its political and ethical implications, one of the key subjects to these debates is the one of technological unemployment. The process of job destruction due to technological progress has been mentioned since long ago. Keynes (1930) commented that new ways of economizing on labor were increasingly being found faster than new uses for labor itself and even way before, Ricardo (1821) had already discussed this issue voicing his worries for the class of laborers. In addition to this, automation has also been linked to a process named skill-biased technological change (SBTC)[1]. Through this process, the development of new technologies ends up favoring skilled workers in detriment of non-skilled ones and generating a skill premium that has been on the rise as seen in Figure 1. This increase happens at a time when the U.S. is also facing a problem of rising income inequality.

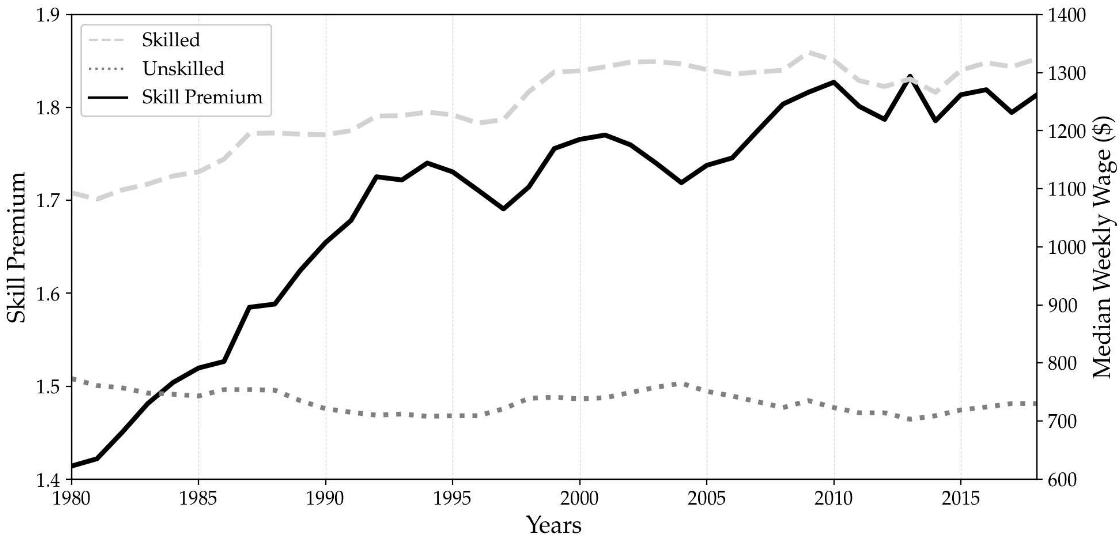

Figure 1: Constant-dollar median weekly earnings of full-time wage and salary workers, 25 years and over. Skilled workers correspond to those with a Bachelor's degree or higher. Non-skilled ones are the others. This skill premium is calculated as the ratio between the two without accounting for composition changes related to gender, sex, etc. Data for the U.S. from: BLS Current Population Survey

This possible relationship between skill-biased technological change and income inequality has been well established and documented in the literature (eg: Mincer (1991), Autor et al. (1998), Katz et al. (1999)). Furthermore, the negative impact of inequality on social welfare is also extensively well reported with it being associated with poorer growth, higher poverty, social and political instability and other negative social and economic factors. Dabla-Norris et al. (2015) IMF report has a comprehensive summary of the negative socioeconomic consequences

[1]The issue of skill-biased technological change is central to this article and therefore, will be better analyzed and explained in the subsequent sections.

of income inequality.

On the other side of the coin, technological change is also largely considered a main proponent of economic growth and consequently, its overall welfare impact can be rather ambiguous as concluded by Eden and Gaggl (2018). All in all, conflicting views on the short and long-run consequences of technological development have been emerging for a long time but due to the higher speed of technological progress experienced recently, this topic has become of much higher importance in recent years.

In the middle of this context, a particular type of tax structure has gained notoriety, that is universal basic income (UBI). UBI consists of a cash transfer from a country's government to all its citizens and it can be either conditional on some requirements or totally unconditional. Its proponents focus their arguments on the fact that it helps low-wage workers by giving them the necessary flexibility to avoid the unemployment trap and make optimal career and life choices, therefore improving literacy and productivity, decreasing crime and stabilizing the economy during economic downturns. Contrarily, its opponents argue that it discourages work and productivity and puts a huge burden on the government budget. Through contrasting lenses of analysis, different articles have weighed these pros and cons (eg: Van Parijs (2004), Van Parijs and Vanderborght (2017)). Furthermore, some pilot programs and experiments have already been tested in countries like Brazil, Canada, Finland, Kenya and even the U.S., with conflicting results being documented, mostly likely due to the difficulty of a full large-scale trial of such system.[2]

This research proposes to compute the optimal level of an UBI system financed with a flat labor tax rate for an economy resembling that of the U.S. in 1980 and 2010. Through this analysis, the article intends to evaluate whether an unconditional basic income could encompass a social welfare improvement over past tax systems, and then, verify whether this pertains to SBTC or not. This will be done by developing an overlapping generations model, similar to that of Brinca et al. (2016), featuring agent heterogeneity, uninsurable idiosyncratic earnings risk and incomplete markets. Additionally, the model will divide labor into skilled and non-skilled categories, a framework akin to that of Krusell et al. (2000), Autor et al. (2003) and Ferrreira (2019). Since the model sets a steady-state, full-employment is assumed and consequently, the issue of job destruction will not be addressed. Instead, the focus will be on the issue of rising inequality and wage dispersion in the context of SBTC.

It is found that an UBI system would have improved U.S.'s social welfare in comparison to 2010's tax-transfer system and that the optimal level of UBI would actually consist of a lump-sum transfer of around 8% of $GDP/Capita$ and a flat income tax rate of 28.5%. Moreover, it

[2]Examples of these experiments in the U.S. include the the Negative Income Tax (NIT) experiments in the 60s and 70s or the Permanent Fund Dividend (PFD) paid to Alaska residents.

was also determined that this result is mainly driven by the process of skill-biased technological change. The rationale behind these conclusions is that, in the modeling choice used, technology is factor-augmenting, therefore creating a positive shock to the permanent component of skilled workers productivity. This raises the skill premium and consequently inequality, therefore motivating the case for more redistribution. The reasoning presented is very similar to the one of Heathcote et al. (2017).

The article will be organized as follows: Section 2 will cite a review of the relevant literature regarding the current article, Section 3 presents the devised theoretical model and Section 4 the calibration procedure, Section 5 details the fiscal experiment, Section 6 exhibits the quantitative results and Section 7 will conclude.

2 Related Literature

This paper develops on the existing literature on skill-biased technological change which builds on the notion that low-skill jobs tend to be more easily automated as they are substitutable by capital, in contrast to high-skill ones which are generally more complementary to capital. Taking that into consideration, as the price of investment decreases due to new and cheaper technology being developed, there will consequently be decreased demand for lower-skilled workers associated with higher demand for high-skilled ones. This is then, largely considered one of the main factors behind increasing skill wage premiums which in turn, are responsible for increasing income inequality (eg: Krusell et al. (2000), Autor et al. (2003)). Brinca et al. (2019a) find that both SBTC and decreases in tax progressivity since the 80's account for more than 30% of the observed increase in income inequality. Figure 2 shows the evolution of income inequality and the price of investment for the U.S. since 1980. It can be promptly seen that the relative price of investment declined from 1 in 1980 to 0.285 in 2018, strongly demonstrating the degree of technological transformation seen in the last decades.[3]

To further deepen this idea, UK's Office for National Statistics provides some data on the probability of automation occurring to certain professions. From this list, the least probable workers to face automation are medical practitioners with a probability of 18.1%, while the most probable are waiters with a probability of 72.8%. By analyzing the full data table, it is clear that jobs that require no degree have, on average, a much higher probability of being automated than the ones who require such degree.[4]

This article is also linked to literature on the decline of the labor share that demonstrates the substitution of labor for capital in the production process. In relation to this, both Karabar-

[3]Through the author's calculations, the relative price of investment was normalized to 1 in 1980 for simplicity purposes.

[4]An excerpt of the full table can be found in Appendix D.

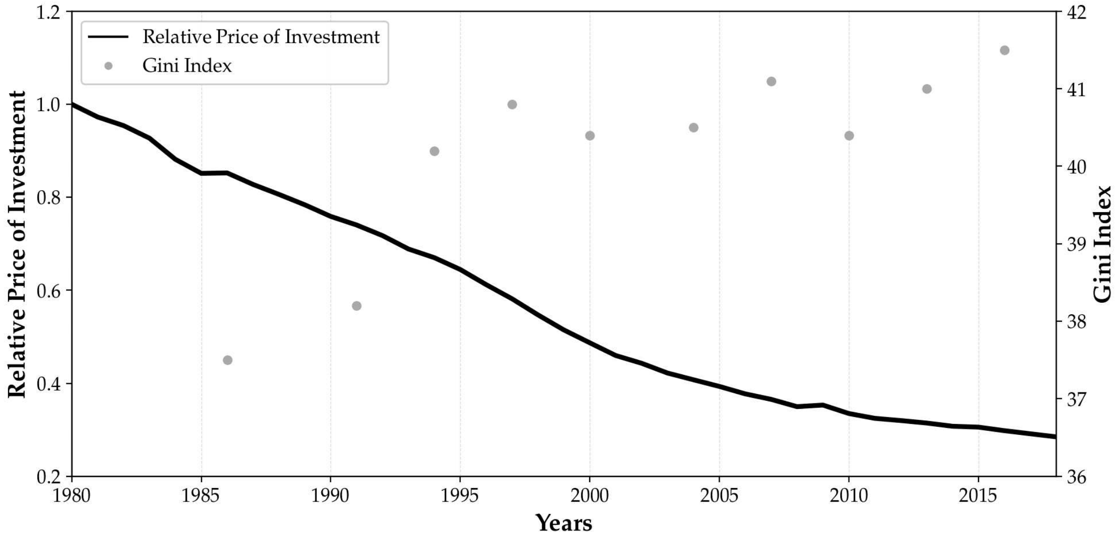

Figure 2: Gini index (world bank estimate) and relative price of investment calculated as the ratio between the CPI and the implicit price deflator on fixed investment on equipment - 1980 is normalized to 1. Data for the U.S. from: The World Bank; BEA

bounis and Neiman (2013) and Eden and Gaggl (2018) conclude with the same result, that the fall in investment price is responsible for around half of the decline in labor share.

Additionally, the present article also builds on the research on optimality of fiscal policy measures. With respect to this, many different tax structures have been researched and suggested with most focusing on taxation of labor and capital.[5]

Concerning optimal labor taxation, Heathcote et al. (2017) concludes that it would be possible for welfare to be improved with a decrease in tax system progressivity. It follows, nonetheless, by suggesting that the model has limiting forces and that optimal progressivity varies with the level of inequality. On the other hand, Saez (2001) concludes by stating that marginal tax rates ought to be raised between the middle and top of the income distribution, a conclusion similar to that of Krueger et al. (2013) which, in a model with endogenous education decisions, states that the labor income tax should be rather progressive. Further relevant literature regarding this topic includes the work of Conesa and Krueger (2006) which concludes that the optimal income tax system can consist of a flat tax rate with a considerable deduction.

Relatively to capital taxation, Chamley (1986) concludes that in the short-run, optimal capital taxation might be positive but in the long-run it should be zero. In contrast Aiyagari (1995) reasons that it should always be positive, including the long-run. In addition, Conesa et al. (2009) conclude that the optimal consists of an heavy capital tax.

Another policy which has been largely suggested as a solution to inequality and has gained considerable mediatic attention recently is the one of protectionism and rising trade barriers. Krusell et al. (2000) conclude, however, that this is not adequate and add that to narrow in-

[5] Most of research on optimal taxation is built on the work of Ramsey (1927) and Mirrlees (1971).

equality, the focus should be on improving training and education for non-skilled workers.

Relatively to the disparities found in the conclusions of optimal taxation papers, it can be verified that one of the major reasons behind them regards the attribution of different causes to income inequality. With regard to this, the present article will also contribute by studying SBTC as one of these possible causes.

To end up with, this paper contributes to the research done on the role of universal basic income as a redistributive policy. Most of this research has been empirical and focused on specific national or regional applications of quasi-UBI programs. In this regard, Marinescu (2018) reviews the possible impact of unconditional transfer implementation in developed countries, more particularly the U.S. Based on the Alaska PFD, she concludes that unconditional transfers affect little the labor supply but might improve children's education. From Hanna and Olken (2018), evidence from Peru and Indonesia suggests that targeted transfer methods dominate universal transfer ones in terms of welfare gains and suggest this evidence might be relevant for developing countries in general. In Iran, Salehi-Isfahani and Mostafavi-Dehzooei (2018) found that the cash transfer program of 2011 entailed a positive impact in labor supply of women and self-employed men and either a positive or non-significant impact in the labor supply of the overall population. For Finland, Koistinen and Perkiö (2014) conclude that the implementation of basic income has been shown to be of great difficulty as it has failed repeatedly.

Finally, in a more recent series of papers, Guerreiro et al. (2017) using a task-based framework confirms the relationship between automation and income inequality and suggests changes ought to be made to the existing U.S. tax system. This article follows by suggesting the implementation of an universal basic income system with lump-sum transfers financed by a tax on robots. Additionally, and in a more similar fashion to the current paper, Lopez-Daneri (2016) analyzes the effects of a negative income tax system implementation through a life-cycle model calibrated to the U.S. and finds the negative income tax to be better in performance than a simple flat tax on labor.

3 Model

The model consists of an incomplete markets economy with overlapping generations of heterogeneous agents and partial uninsurable idiosyncratic risk that generates both income and wealth distributions. The basic setup is that of Brinca et al. (2016) with a more detailed production function as in the case of Ferrreira (2019).

To correctly model the SBTC process, households are divided into 2 different categories: Non-skilled and Skilled. An important aspect of the model is that there is no endogenous education choice, instead the attribution of abilities is done randomly at birth. While skilled households are born with certain abilities that allow them to perform tasks that are more complementary to capital, non-skilled households, on the other hand, are born with abilities that allow them to perform tasks that are substitutable by capital.

Demographics

In this model, the economy is populated by a set of J-1 overlapping generations. A household starts its labor decisions when it is 20 years old and retires at 65. From retirement onwards, households face an age-dependent probability of dying $\pi(j)$ and therefore a probability of surviving $\omega(j) = 1 - \pi(j)$. A period in the model is considered 1 year, thus, j, the household's age, varies between $j = 0$ (for age 20 households) and $j = 80$ (for age 100 households. It is also considered that $\pi(80) = 1$ and equivalently $\omega(80) = 0$, meaning households die for sure when 100 years old. One can also verify that, at any given time, the probability of being alive for a $j \geq 45$ household is given by $\Omega_j = \prod_{i=45}^{i=j} \omega(i)$. By the law of large numbers, this also represents the mass of retired agents of a given age $\{j\}$.

Besides age, households also differ across permanent ability level $\{a\}$, persistent idiosyncratic productivity shocks $\{u\}$, asset holdings $\{h\}$ and a discount factor which takes on two distinct values $\{\beta_1, \beta_2\}$, which are uniformly distributed across agents.[6]

Relatively to permanent ability level $\{a\}$, prior to joining the labor market, agents draw from a uniform distribution with the threshold $\{t_S\}$, such that group employment weights match the data. Therefore, an agent is able to supply skilled labor if its draw is greater than t_S and vice-versa.

Working age agents have to maximize their utility by choosing how much to work $\{n_t\}$, how much to consume $\{c_t\}$ and how much to save $\{k_{t+1}\}$. Retired households only have the consumption and saving decisions and also receive a retirement benefit $\{\Psi_t\}$.

There are no annuity markets, so that a fraction of households leave unintended bequests which are redistributed in a lump-sum manner between the households that are currently alive,

[6] Asset holdings, discount factors and the idiosyncratic shock will later be explained.

denoted by Γ. A bequest motive is included in this framework to make sure that the age distribution of wealth is empirically plausible such as in Brinca et al. (2019b) and Brinca et al. (2019c).

Labor Income

Labor productivity depends on three distinct elements which determine the number of efficiency units each household is endowed with in each period: age $\{j\}$, labor variety group or permanent ability $\{a\}$ and an idiosyncratic productivity shock $\{u\}$ which follows an AR(1) process such as:

$$u_{it} = \rho_u u_{it-1} + \varepsilon_{it}, \;\; \varepsilon_{it} \backsim N(0, \sigma_\varepsilon^2) \tag{1}$$

Household i's wage will then be given by:

$$w_{it}(j, a_i, u_{it}) = w_t^s e^{\gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 + a_i + u_{it}} \tag{2}$$

where γ_1, γ_2 and γ_3 are calibrated directly from the data to capture the age profile of wages. Households' labor income depends on the wage per efficiency unit of labor w_t^s, $s \in S \equiv \{NS, S\}$, where s is the labor variety supplied by the household.

Household Preferences

The utility of households,[7] $U(c_{it}, n_{it})$, is increasing in consumption and decreasing in work hours with $n_{it} \in (0, 1]$, and is defined as:

$$U(c_{it}, n_{it}) = \frac{c_{it}^{1-\lambda}}{1-\lambda} - \chi \frac{n_{it}^{1+\eta}}{1+\eta} \tag{3}$$

Retired households' utility function loses the labor term but gains an extra one, as they gain utility from the bequest they leave to living generations such that:

$$U(c_{it}, n_{it}) = \frac{c_{it}^{1-\lambda}}{1-\lambda} + D(h_{it}^{'}) \tag{4}$$

where:

$$D(h_{it}^{'}) = \varphi \log(h_{it}^{'}) \tag{5}$$

[7]Disutility not dependent on occupation type S or NS.

Production Technology

For the production side of the economy, the modeling strategy used is very close to that found in Krusell et al. (2000) and Karabarbounis and Neiman (2013).

In this economy there are two competitive final goods sectors, consumption and investment goods, which are produced by transforming a single intermediate input using a linear production technology. The single intermediate input used in both sectors is represented as $\{z_t^c, z_t^x\}$ respectively for consumption and investment sectors.

The transformation technologies used are:

(Consumption good)

$$C_t + G_t = z_t^c \tag{6}$$

(Investment good)

$$X_t = z_t^x \tag{7}$$

Given that the final goods are competitively produced, their prices equal the marginal costs of production, such as:

(Consumption good)

$$p_t^c = p_t^z = 1 \tag{8}$$

(Investment good)

$$p_t^x = p_t^z = 1 \tag{9}$$

A representative intermediate goods firm produces $y_t = z_t^c + z_t^x$ using a constant returns to scale technology in capital and labor inputs such that $y_t = F(K_t; N_t^{NS};$
$N_t^S)$ where K_t is capital, N_t^S is skilled labor and N_t^{NS} is non-skilled labor. The firm rents capital at rate r_t and each labor variety at $w_t^s, s \in \{NS, S\}$.

Aggregate demand measured in terms of the consumption good is given by: $Y_t = C_t + G_t + X_t$. Factor prices $\{r_t, w_t^{s\in S}\}$ and the price of the intermediate good $\{p_t^z\}$ are all taken as given. Consequently, the firm maximizes profits by choosing the amount of capital and labor inputs each period:

$$\begin{aligned} max_{\{K_t, N_t^{s\in S}\}} \quad & \Pi_t^z = p_t^z y_t - r_t K_t - w_t^{NS} N_t^{NS} - w_t^S N_t^S \\ s.t. \quad & y_t = z_t^c + z_t^x = C_t + G_t + X_t = Y_t \end{aligned} \tag{10}$$

This implies: $z_t^c = C_t + G_t$, $z_t^x = X_t$ and $y_t = F(.) = Y_t$

We assume that the production function of the intermediate good is constant elasticity of substitution (CES) and takes the following functional form:

$$F\Big(K_t, N_t^{NS}, N_t^S\Big) = A_t\Bigg(\phi_1\Big(Z_t\Big)^{\frac{\sigma-1}{\sigma}} + \Big(1-\phi_1\Big)\Big(N_t^{NS}\Big)^{\frac{\sigma-1}{\sigma}}\Bigg)^{\frac{\sigma}{\sigma-1}}$$
$$Z_t = \Bigg(\phi_2\Big(K_t\Big)^{\frac{\rho-1}{\rho}} + \Big(1-\phi_2\Big)\Big(N_t^S\Big)^{\frac{\rho-1}{\rho}}\Bigg)^{\frac{\rho}{\rho-1}} \tag{11}$$

where A_t is total factor productivity, ϕ_1 and ϕ_2 are factor shares, ρ is the elasticity of substitution between capital and skilled labor, and σ is the elasticity of substitution between the composite of those factors and non-skilled labor.

Firm maximization implies that marginal products equal factor prices such that:

$$r_t = \Big[A_t^{\sigma-1}Y_t\Big]\phi_1 Z_t^{\frac{\sigma-\rho}{\rho\sigma}}\phi_2\Bigg(\frac{1}{K_t}\Bigg)^{\frac{1}{\rho}},$$
$$w_t^S = \Big[A_t^{\sigma-1}Y_t\Big]\phi_1 Z_t^{\frac{\sigma-\rho}{\rho\sigma}}(1-\phi_2)\Bigg(\frac{1}{N_t^S}\Bigg)^{\frac{1}{\rho}}, \tag{12}$$
$$w_t^{NS} = (1-\phi_1)\Bigg(\frac{A_t^{\sigma-1}Y_t}{N_t^{NS}}\Bigg)^{\frac{1}{\sigma}}$$

The capital law of motion is:

$$K_{t+1} = (1-\delta)K_t + X_t, \tag{13}$$

where X_t is aggregate gross investment and δ is the depreciation rate.

Government

In the model, the government runs the social security system as well as the tax system.

The social security system runs a balanced budget. Revenues are collected from taxes on employees at rate $\{\tau_{SS}\}$ and on the representative intermediate good firm at rate $\{\tilde{\tau}_{SS}\}$, which are used to pay for the retirement benefits $\{\Psi_t\}$. Denoting social security revenues by R_t^{SS}, the social security budget constraint is given by:

$$R_t^{SS} = \Psi_t\Bigg(\sum_{j\geq 45}\Omega_j\Bigg) \tag{14}$$

Relatively to the general tax system, the government taxes consumption $\{\tau_c\}$, capital income $\{\tau_k\}$ and labor income $\{\tau_l\}$. Consumption and capital are taxed at flat rates whereas labor income tax follows a non-linear functional form as in Benabou (2002) and recently used in Heathcote et al. (2017):

$$\tau_l = 1 - \theta_1 y^{-\theta_2}, \tag{15}$$

where $\{\theta_1\}$ defines the level of the tax schedule and $\{\theta_2\}$ defines its progressivity. $\{y\}$ is pre-tax labor income while $\{\tau_l\}$ is the average tax rate given a pre-tax income of y. All these revenues are used to finance public consumption of goods $\{G_t\}$, lump-sum transfers to households $\{g_t\}$ and interest payments on public debt $\{R_t B_t\}$. Denoting tax revenues by $\{T_t\}$, the government budget constraint is defined as:

$$T_t - G_t - R_t B_t = g_t \left(45 + \sum_{j \geq 45} \Omega_j \right) \tag{16}$$

Asset Structure

Households hold two types of assets: capital $\{k\}$ and government bonds $\{b\}$. The return rate on the bond must satisfy:

$$1 + (r - \delta)(1 - \tau_k) = 1 + R(1 - \tau_k) \tag{17}$$

which follows from non-arbitrage so that investing in capital yields the same return as investing the same amount in bonds. The state variable for the consumer is:

$$h \equiv [1 + (r - \delta)(1 - \tau_k)]k + [1 + R(1 - \tau_k)]b \tag{18}$$

Using (17), in equilibrium we can re-write the previous equation as:

$$h = [1 + (r - \delta)(1 - \tau_k)](k + b) \tag{19}$$

where we define $q \equiv 1/[1 + (r - \delta)(1 - \tau_k)]$.

Household Problem

On any given period a household is defined by age j, asset position h, time discount factor $\beta \in \{\beta_1, \beta_2\}$, permanent ability a, a persistent idiosyncratic productivity shock u and a time-constant ability to supply a given labor variety $s \in \{NS, S\}$. A working-age household chooses consumption c, work hours n and future asset holdings h' to solve his optimization problem.[8] The household budget constraint is given by:

$$c(1 + \tau_c) + k' + b' = (1 + (r - \delta)(1 - \tau_k))k + (1 + R(1 - \tau_k))b + \Gamma + g + Y^N \tag{20}$$

where Y^N is the household's labor income after social security and labor income taxes. Using

[8] Prime (') is used to denote next period values of a variable.

(18) and (19) we can rewrite the budget constraint as:

$$c(1+\tau_c)+qh' = h+\Gamma+g+Y^N \tag{21}$$

The living household problem can then be formulated recursively as:

$$\begin{aligned}
&V(j,h,\beta,a,u) = max_{\{c,n,h'\}}\left[U(c,n)+\beta E_{u'}\left[V(j+1,h',\beta,a,u')\right]\right]\\
&s.t.:\\
&c(1+\tau_c)+qh' = h+\Gamma+g+Y^N\\
&Y^N = \frac{nw(j,a,u)}{1+\tilde{\tau}_{SS}}\left(1-\tau_{SS}-\tau_l\left(\frac{nw(j,a,u)}{1+\tilde{\tau}_{SS}}\right)\right)\\
&n\in[0,1], \qquad h'\geq -\underline{h}, \qquad h_0=0, \qquad c>0
\end{aligned} \tag{22}$$

The problem of a retired household differs on three dimensions: age dependent probability of dying $\pi(j)$, the bequest motive $D(h')$, and labor income, which is replaced by retirement benefits. Therefore, the retired household's problem is defined as:

$$\begin{aligned}
&V(j,h,\beta) = max_{\{c,h'\}}\left[U(c,n)+\beta(1-\pi(j))V(j+1,h',\beta)+\pi(j)D(h')\right]\\
&s.t.:\\
&c(1+\tau_c)+qh' = h+\Gamma+g+\Psi\\
&h'\geq -\underline{h}, \qquad c>0
\end{aligned} \tag{23}$$

Stationary Recursive Competitive Equilibrium

$\Phi(j,h,\beta,a,u)$ is the measure of agents with corresponding characteristics (j,h,β,a,u). The stationary recursive competitive equilibrium is defined by:

1. Taking factor prices and initial conditions as given, the value function $V(j,h,\beta,a,u)$ and the policy functions, $c(j,h,\beta,a,u), h'(j,h,\beta,a,u)$ and $n(j,h,\beta,a,u)$ solve the household's optimization problem.

2. Markets clear:

$$\begin{gathered}
[1+(r-\delta)(1-\tau_k)](B+K) = \int h+\Gamma d\Phi,\\
N^{NS} = \int_{a>a*} nd\Phi\\
N^{S} = \int_{a\leq a*} nd\Phi\\
C+X+G = F(K,N^{NS},N^S) = Y.
\end{gathered}$$

3. Equilibrium equations in (12) hold.

4. The government budget balances:

$$g\int d\Phi + G + RB = \int \left(\tau_k\Big(r-\delta\Big)\left(\frac{h+\Gamma}{1+(r-\delta)(1-\tau_k)}\right) + \tau_c c + n\tau_l\left(\frac{nw(a,u,j)}{1+\tilde{\tau}_{SS}}\right)d\Phi\right.$$

5. The social security system balances:

$$\int_{j\geq 45}\Psi d\Phi = \frac{\tilde{\tau}_{SS}+\tau_{SS}}{1+\tilde{\tau}_{SS}}\left(\int_{j<45} nwd\Phi\right)$$

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

$$\Gamma\int \omega(j)d\Phi = \int (1-\omega(j))hd\Phi$$

4 Benchmark Economy Calibration

The model was calibrated to match moments of the economy of the U.S. in 1980, the benchmark economy, using a method similar to that of Brinca et al. (2016). Some parameters can be calibrated outside of the model as they have direct empirical counterparts, these are described in table 2. The remaining of parameters are endogenously calibrated using the Simulated Method of Moments (SMM) approach.

Preferences

The value of the Frisch elasticity of labor supply varies greatly in the literature, η. In this calibration it is set to 1, according to a variety of recent studies (e.g. Trabandt and Uhlig (2011)). In addition, risk aversion was set to 1.1. The parameters φ, governing the utility of leaving bequests, χ, governing the disutility of working an additional hour, and the discount factors $\{\beta_1, \beta_2\}$ are calibrated so that the model output matches empirical data moments. This part will be discussed further below.

Labor and Wages

To estimate the life cycle profile of wages, data from the Panel of Study of Income Dynamics (PSID) is used and the following regression is ran:

$$\ln(w_i) = \ln(w) + \gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 + \varepsilon_i, \tag{24}$$

Table 1: 1980 Calibration Summary

Description	Parameter	Value	Source
Preferences			
Inverse Frisch elasticity	η	1.000	Trabandt and Uhlig (2011)
Risk aversion parameter	λ	1.100	Literature
Labor and Wages			
Parameter 1 age profile of wages	γ_1	0.265	Brinca et al. (2016)
Parameter 2 age profile of wages	γ_2	-0.005	Brinca et al. (2016)
Parameter 3 age profile of wages	γ_3	0.000	Brinca et al. (2016)
Persistence of idiosyncratic risk	ρ_u	0.335	Brinca et al. (2016)
Technology			
Depreciation rate	δ	0.060	Brinca et al. (2016)
Share of the composite	ϕ_1	0.550	Eden and Gaggl (2018)
Share of capital	ϕ_2	0.805	Eden and Gaggl (2018)
EOS non-skilled/composite	ρ	1.670	Authors' calculations
EOS skilled/capital	σ	0.670	Authors' calculations
Total factor productivity	A	1.000	Normalization
Government and Social Security			
Consumption tax rate	τ_c	0.054	Mendoza et al. (1994)
Capital income tax rate	τ_k	0.469	Mendoza et al. (1994)
Tax scale parameter	θ_1	0.940	Implied by clearing condition
Tax progressivity parameter	θ_2	0.160	Ferriere and Navarro (2018)
Government debt to GDP	B/Y	0.320	FRED
Military spending to GDP	G/Y	0.053	World Bank
SS tax employees	τ_{ss}	0.061	Social Security Bulletin, July 1981
SS tax employers	$\tilde{\tau}_{ss}$	0.061	Social Security Bulletin, July 1981

where j is the age of individual i. The persistence of idiosyncratic risk is set to 0.335 in light of Brinca et al. (2016). The variance of idiosyncratic risk, σ_ϵ is calibrated through SMM to match the variance of $\ln(w_i)$ to that of the data. The parameter for the variance of ability, σ_a is also calibrated through SMM so that the model's income Gini also matches the corresponding data moment.

Technology

In relation to the calibration of technology and the production function, firstly the depreciation rate δ is fixed in 0.06 following Brinca et al. (2016). Relatively to the CES production function parameters, firstly the share of capital in the capital/skilled-labor composite, ϕ_2, is set to 0.805 and the share of the composite in the composite/non-skilled-labor equation, ϕ_1, is set to 0.550. These go in line with the analogous parameters used in Eden and Gaggl (2018). Then, the elasticity of substitution (EOS) between skilled labor and capital, σ, inside the composite is set to 0.670 and the EOS between the composite and non-skilled labor, ρ, is set to 1.670. These values were found to be adequate in order to allow for the process of skill-biased technological change to be modeled. With a $\rho > 1$ and a $\sigma < 1$ the degree of substitutability between non-skilled labor and capital is considerably higher that that between skilled labor and capital.

Taxes and Social Security

The tax schedule is modeled according to the aforementioned equation (15). From this equation, the progressivity parameter θ_2 is fixed in 0.160 following the method of Ferriere and Navarro (2018). By setting the lump-sum transfer g to 0.000, the value of θ_1 implied by the government budget clearing condition was 0.940. Additionally, the consumption tax rate τ_c and the capital income tax rate τ_k are set to 0.054 and 0.469 consecutively to match the values obtained in Mendoza et al. (1994). For the social security taxes, both values are set to 0.061.

Endogenously Calibrated Parameters

To calibrate the parameters that do not have direct empirical counterparts, discount factors $\{\beta_1, \beta_2\}$, disutility of work χ, utility of leaving bequests φ, variance of ability σ_a and variance of idiosyncratic risk σ_ϵ, the simulated method of moments (SMM) was used. Through it, the following loss function was minimized:

$$L(\beta_1, \beta_2, \varphi, \chi, \sigma_a, \sigma_\epsilon) = ||M_m - M_d|| \tag{25}$$

where M_m and M_d are the moments in the model and in the data respectively. For the system to be just-identified and since there are six model parameters to be calibrated endogenously, the need for six data moments arises. These data moments that will be used as targets are described in table 2. The parameters calibrated with these targets are presented in table 3.

Table 2: Calibration Fit

Data Moment	Description	Source	Data Value	Model Value
$\bar{a}_{75-80}/\bar{a}$	Mean wealth age 75-80 / Mean wealth	LWS	1.51	1.51
K/Y	Capital-output ratio	BEA	3.00	3.00
$\mathtt{Var}(\ln w)$	Variance of log wages	CPS[9]	0.29	0.29
$\bar{n}$	Fraction of hours worked	OECD	0.33	0.33
Q_{90}	Income share of the bottom 90%	WID	0.66	0.65
Gini	Gini Index	WID	0.46	0.46

Table 3: Parameters Calibrated Endogenously

Parameter	Value	Description	Data Target
Preferences			
φ	5.850	Bequest utility	$\bar{a}_{75-80}/\bar{a}$
β_1	0.978	Discount factor 1	K/Y
β_2	0.100	Discount factor 2	Q_{90}
χ	8.200	Disutility of work	$\bar{n}$
Labor and Wages			
σ_a	0.355	Variance of ability	Gini
σ_ϵ	0.100	Variance of risk	$\mathtt{Var}(\ln w)$

Besides the calibration of the benchmark economy, the model was later calibrated to match the tax-transfer system, social security, level of debt, government expenditure and TFP of the U.S. in 2010. All other parameters were kept constant between steady-states. For the exogenously calibrated values of government and social security parameters, these are presented in table 6 in appendix A.

Relatively to TFP, this is the model's representation of technological change, and a crucial element of this paper's analysis. The TFP was calibrated for 2010 to replicate the growth of $GDP/Capita$ from 1980 to 2010. Since the TFP is normalized to 1.000 in 1980, the resulting TFP for 2010 was 1.720.[10]

Additionally, to substantiate the good performance of the model, some of the statistics were verified to check whether they match the empirical data. The model predicted that from 1980 to 2010, both the income and wealth Gini increased, the wage premium for skilled workers increased and wage dispersion increased. All these match the empirically observed data and therefore support the model's robustness.

5 Fiscal Experiment

The focus of this experiment is centered on the evaluation of the welfare effects deriving from the implementation of an universal basic income system. Consequently, the design of this UBI system ought to be clarified. In this paper, the analyzed system will be comprised of a universal

[9]According to Katz et al. (1999).

[10]The data used for GDP per capita was taken from: World Bank national accounts data, and OECD National Accounts data files.

and unconditional lump-sum transfer which is paid for by consumption and capital taxes and also by a flat labor tax with no progressivity. Consequently, the experiment consists of a steady-state analysis comparing the optimal level of UBI for the years of 1980 and 2010 in the U.S. These years were chosen grounded on the literature and also due to the fact that the gap between them is considerably representative of the high increase in U.S.'s income inequality. Taking into account the main purpose of this analysis, the fact that more recent years were not used is decidedly not detrimental to results.

It is relevant to note that in both of the analyzed years, 1980 and 2010, the tax system has no universal transfer to households, $g = 0$, but has some degree of progressivity, $\theta_2 > 0$. Therefore, firstly the optimal lump-sum transfer (and associated labor tax level), will be calculated for an hypothetical UBI system in both years. This will tell whether the optimal level of UBI changed from 1980 to 2010 in light of the process of skill-biased technological change. Secondly, a baseline comparison will be done between the actual 1980 and 2010 tax systems and the UBI one. This will then answer the question on whether the implementation of UBI would entail an welfare gain in one, both or none of the years. The procedure used will be further explained in the following subsections.

5.1 Welfare Criteria

With the purpose of comparing different lump-sum transfer levels and whether they are beneficial or not to society, a proper welfare measure is needed. In this paper, two different ones are used. The first one is the expected social welfare which can be expressed as follows:

$$SW_t^1 = E[V]_t = \frac{1}{\int d\Phi}\left[\int_{j<45} V(h,\beta,a,u,j)_t d\Phi + \int_{j\geq 45} V(h,\beta,j)_t d\Phi\right] \tag{26}$$

This is the criteria which determined the results. However, for completeness and confirmation, a second measure is also employed which was borrowed from McGrattan and Aiyagari (1997) and can be expressed as:

$$SW_t^2 = \Omega = \int\int V(h,\beta,a,u,j)dH(h,\beta,a,u,j) \tag{27}$$

With regard to notation, V is the optimal value function and H is the steady-state joint distribution of assets and productivity.

5.2 Optimal Evaluation

To compare the optimal level of UBI in 1980 and 2010, the evaluation procedure undergone was the following:

1. Computation of social welfare for the benchmark economy (U.S. 1980) with the existing tax system.
2. Computation of the optimal lump-sum transfer with the UBI system in 1980, through an welfare evaluation.
3. Computation of social welfare for the U.S. 2010 economy with the existing tax system.
4. Computation of the optimal lump-sum transfer with the UBI system in 2010, through an welfare evaluation.

5.3 Causality

It is highly relevant to note that after comparing the optimal UBI levels for 1980 and 2010, one can not immediately conclude that this difference is attributed to technological change. As previously mentioned, the year of 2010 was calibrated to match not only the technological development but also the tax system, social security, debt and government spending of that year. Therefore, to avoid the identification problem that would arise from this analysis, an intermediate step was done in the process. This involved re-calibrating 1980's economy to include the value of 2010's technology parameters and then calculating the optimal UBI level. This procedure was able to establish a causal relationship between technological change and UBI and accordingly, the rest of the analysis followed. The full results of this procedure are displayed in Appendix B.

6 Results and Discussion

In this section, results from the aforementioned experiment will be presented and the main economic mechanisms explained. Firstly, the optimal evaluation procedure was conducted with its main results being displayed in figures 3 and 4.

To begin with, the most immediate result is that, considering an UBI system implementation, the optimal lump-sum transfer level rises from $g = 0$ in 1980 to $g = 0.125$ in 2010. For 1980, what this effectively means is that the optimal is actually the nonexistence of an UBI system. Therefore, one can say that in this year, for a system with a flat labor tax rate without progressivity, society's welfare would be maximized with no lump-sum transfer and a tax on labor income of as low as 8%.[11]

The striking difference for 2010 is that the optimal is actually positive with society's welfare being maximized with a lump-sum transfer of $g = 0.125$ corresponding to around 8% of $Y/Capita$.

[11] Henceforth, it is relevant to take into account that all social welfare comparisons are done in % terms of a baseline level that should be indicated (e.g. an 100.1% of a $g = 0$ baseline means that that point entails a 0.1% improvement over a system with $g = 0$).

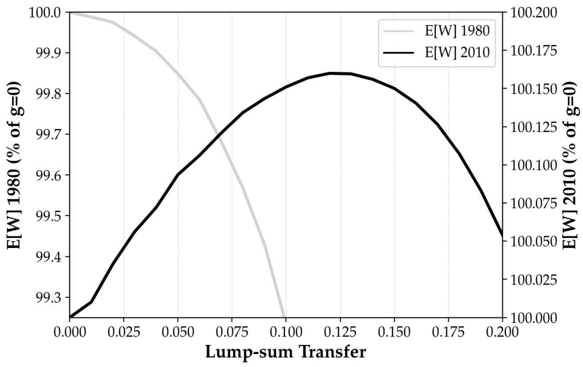

Figure 3: Optimal UBI level: 1980 and 2010

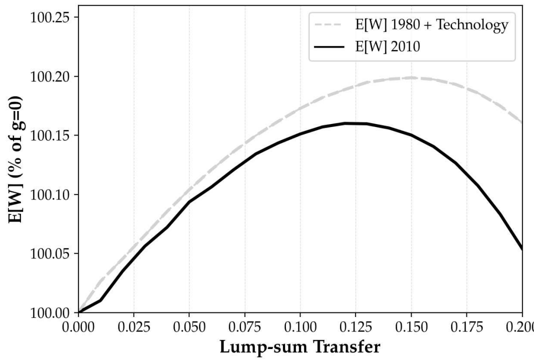

Figure 4: Optimal UBI level: 1980 + Tech. and 2010

This, in turn, leads to an optimal government budget clearing labor tax of 28.5%. The welfare gain from this optimal over a $g = 0$ is of 0.163%[12]

Table 4: 2010 Optimal Evaluation Results

g	0.00	0.04	0.08	0.12	**Optimal** **0.125**	0.14	0.16	0.20
$1-\theta_1$[13]	13.0	17.0	22.0	27.7	**28.5**	30.6	33.7	40.4
$Y/Capita$	1.66	1.64	1.60	1.57	**1.56**	1.54	1.52	1.47
$g\%(Y/Capita)$	0.0	2.4	5.0	7.7	**8.0**	9.1	10.5	13.6

By analyzing the results presented in table 4, one can infer on the economic intuition behind this optimal solution. As stated in section 4, the differences between the 1980 and 2010 steady-states are the government and tax system, and technological level measured through the TFP and SBTC. Even though all these parameter changes affected optimality, through the curves presented on figure 4, one can conclude that it is the technological change driving most of this result. The technology change, in this case, winds up being factor-augmenting since it generates a positive shock to the permanent component of skilled worker's productivity. Through market clearing conditions, this will, in turn, permanently increase their average earnings over non-skilled workers which explains the observable skill premium rise from 1980 to 2010. Accordingly, this skill premium rise increases wage dispersion and income inequality. By taking into account the concave profile of agent's utility, it becomes clear how an additional unit of consumption benefits the poor more than the rich and therefore, for an utilitarian social planner, having an economy with high inequality ends up being detrimental to social welfare.

In this type of context, it is straightforward to understand why in an UBI system, the optimal lump-sum transfer level is actually positive and equal to 8% of GDP per capita. Since the productivity shock from technological growth is permanent, the social planner has an higher

[12]Full results of the welfare evaluation procedure are displayed in Appendix C.

[13]Taking into consideration the modelled tax schedule, $1-\theta_1$ corresponds to the flat tax rate on labor income.

motive for the application of redistribution. Taking this into account, from $g = 0$ until $g = 0.125$, the gains from redistribution are large and social welfare improves. However, from that point onwards, the fact that the labor tax level starts rising above the 30% mark, generates an intense distortion of agent's choices and discouragement of work which ends up being detrimental to welfare. Since the most productive agents are the ones paying an higher labor tax net of transfer, these are the most discouraged and as a consequence, the economy will tend do produce less and $Y/Capita$ will decrease, as seen in table 4. This clearly shows the trade-off between social equity and efficiency since higher redistribution comes associated with lower output.

With regard to the result observed in figure 4, one can see that while the optimal level of the UBI system for 2010 is comprised of a $g = 0.125$, the one for an economy with 2010's technology inputted into 1980's characteristics, consists of a $g = 0.150$ corresponding to 9.55% of GDP per capita. The main takeaway from here is that 2010's social security, capital and consumption taxes, debt and government spending, decrease, in some away, the necessity for an high lump-sum transfer.

Table 5: Government parameters in the optimal: 2010 and 1980 + ΔTechnology

	g	$1-\theta_1$	τ_c	τ_k	B/Y	$Y/Capita$	$g\%(Y/Capita)$
1980 + ΔTechnology	**0.150**	20.4	0.054	0.469	0.320	1.57	9.55
2010	**0.125**	28.5	0.050	0.360	0.879	1.56	8.00

By looking at table 5, it is possible to construct an explanatory hypothesis for this result. In 1980, both consumption and capital income taxes are higher than in 2010 while the debt is lower. As in the model, the tax level $1 - \theta_1$ is responsible for the clearing of the government budget constraint, with 1980's more balanced government budget, even if g is rather high, the level of labor tax needed to pay for it will be fairly lower. Thus, it may be optimal for this economy to have an higher lump-sum transfer than in the 2010 case since the associated labor tax level is not as high, which means that it is feasible to attain an higher level of UBI without as much distortion in terms of labor choices.

6.1 UBI vs. Actual Tax System

It is imperative to reinforce that the optimal evaluations of the preceding section were merely focused in computing the optimal level of the lump-sum transfer for an UBI system with no progressivity on labor taxation. Even though this facilitated the comparison of these optimal values, the actual tax systems of 1980 and 2010 have some degree of progressivity to them. As a consequence, the question of whether the implementation of UBI would result in an welfare improvement over the actual systems still remains unanswered. This subject will be approached in this part of the paper.

Figure 5 presents the social welfare comparisons between 1980's tax system (the baseline) and an UBI system with different levels of lump-sum transfers. Figure 6 presents the social welfare comparisons between 2010's tax system (the baseline) and an UBI system with different levels of lump-sum transfers.[14]

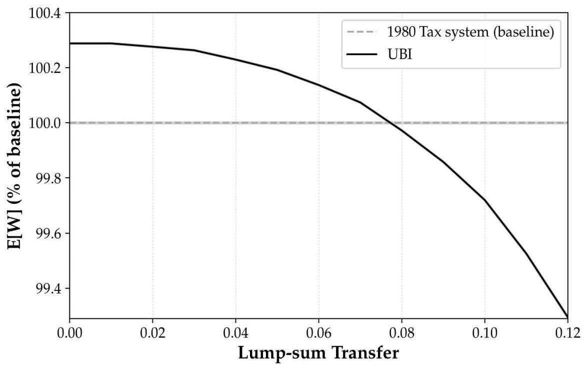

Figure 5: UBI vs. Actual Tax System (1980)

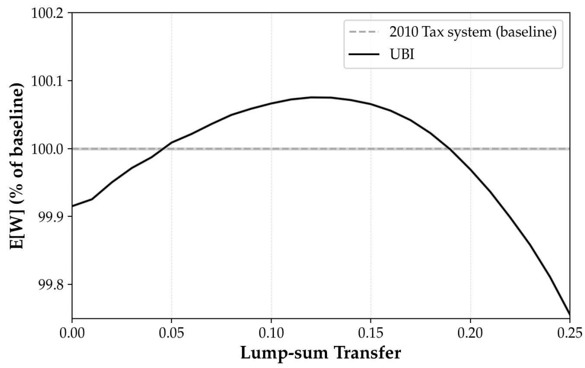

Figure 6: UBI vs. Actual Tax System (2010)

From these results, one can conclude that according to the model used, an UBI system would improve societal welfare both in 1980 and 2010.

For 1980, as concluded above, the optimal would be to have neither a progressive labor tax nor UBI. However, if the UBI lump-sum does not surpass the level of $g = 0.078$ or 7.62% of $GDP/Capita$ with an associated labor tax of 33%, society in 1980 would still be better off with an UBI system than with the existing system at the time.

More importantly, for 2010, even though the optimal is the aforementioned lump-sum of $g = 0.125$ corresponding to 8% of $GDP/Capita$, society would be better off with anywhere in the interval of $g \in [0.050; 0.188]$ corresponding to $g(\%) \in [3.07\%; 12.85\%]$ of $GDP/Capita$ and with associated labor tax levels of $1 - \theta_1 \in [18.5\%; 38.7\%]$, in comparison to the existing system at the time.

6.2 Application to reality

This section will analyze the results found by translating them to a real-world application. The main result gathered from the above-mentioned experiment is that an UBI implementation with the right level of labor tax and lump-sum transfer would be optimal as a way of mitigating negative social welfare effects from skill-biased technological change. This optimal, for 2010, would consist of a lump-sum corresponding to 8% of $GDP/Capita$ with an associated labor tax level of 28.5%. Applied to the U.S. economy of 2010, this would mean an annual transfer of

[14] Note that in these figures, the grey lines just represent the baseline level of welfare with that year's actual tax system, they do not depend on the lump-sum displayed in the x-axis. The areas where the black line is above the grey line represent UBI levels that would entail an welfare improvement over the actual systems. Vice-versa for areas where the black line is below.

around 3,877$ per person. The tax schedule in figure 7 depicts this system.

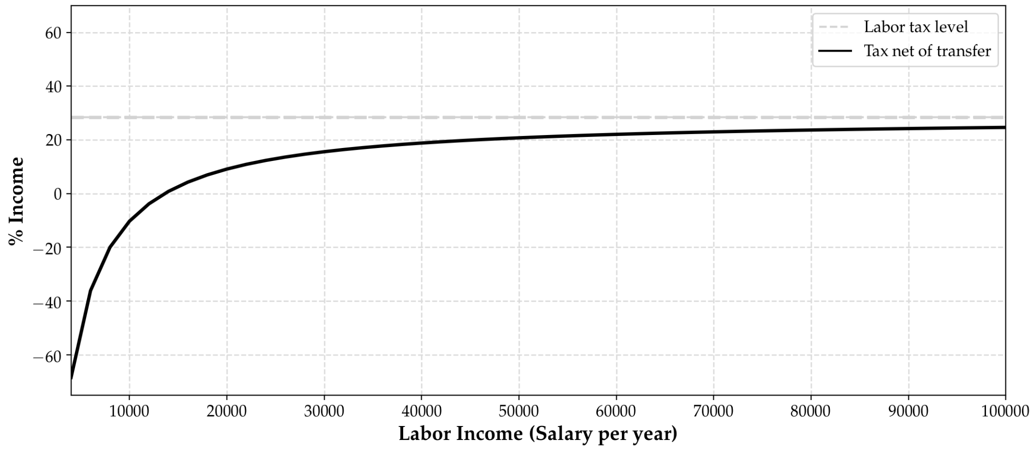

Figure 7: Tax schedule with the optimal UBI system

Looking at the represented schedule, one can see the labor tax level of the optimal, $1-\theta_1 = 0.285$ and then the actual shape of the tax rate net of the lump-sum transfer. What can be concluded is that this UBI system with a flat labor tax rate and fixed universal lump-sum transfer, ends up creating a tax schedule similar to one of a system with a progressive labor tax. The main difference is that in this case, the tax rate can reach negative values, which happens when the tax rate paid on labor is inferior to the aforementioned transfer of 3,877$.[15] This is very identical to a negative income tax schedule, except for the fact that in the UBI fiscal system everyone pays the same tax in percentage, and everyone receives the same transfer in absolute terms.[16]

It is worth of notice that the value of 3,877$ for the lump-sum transfer appears to be rather small. For contextualization, U.S.'s median household income in 2010 was 49,445$ and presidential candidate Andrew Yang's "Freedom Dividend" proposal consists of a transfer of 1,000$ per month. This indicates that this paper's value would, most likely, be rather smaller than the amount needed to attain the main objectives of universal basic income. The reasoning behind this might be that the model should be expanded for a more complete analysis of these mechanisms. One relevant aspect regards the fact that UBI is generally discussed within the context of unemployment, something which is not modelled here. Nevertheless, this does not, in any way, invalidate the main results that were found, mainly the relationship between an optimal positive lump-sum transfer and the process of skill-biased technological change. The following section will summarize these results while concluding the research.

[15] This would be the case of workers earning an income below 13,603$.

[16] Some author's argue that in psychological terms this is beneficial since it reduces the stigma of social support from the state. Since everyone pays and everyone receives, the ones benefiting more would not feel as wrongly in doing so.

7 Conclusion

This research intended to analyze whether a universal basic income system could improve social welfare in the context of skill-biased technological change and additionally, evaluate the optimal level of this UBI system. With this purpose, a life-cycle model was calibrated to resemble the economy of the U.S. in 1980 and 2010 and within this framework, two major results were found.

Firstly, it was found that a UBI system comprised of a flat tax rate on labor and a lump-sum transfer could have improved social welfare in 2010 in relation to the existing tax-transfer system at the time. In addition, the optimal level would actually consist of a lump-sum transfer of 8% of GDP per capita paid for by a flat labor tax rate of 28.5%. Even though there are disparities between 2010 and today's economy, it can be logically hypothesized that today's optimal transfer would not differ exceedingly and if so, it would most likely be fairly higher.[17]

Secondly, it was also established that the above-mentioned result is primarily motivated by the process of skill-biased technological change. This was concluded through an analysis of technological progress alone, which predicted an optimal UBI transfer consisting of an even higher value of 9.55% of GDP per capita. This result is of great relevance as it establishes a strong positive relationship between SBTC and universal basic income which can be further examined in future work.

The mechanism found to be driving these results was mainly the factor-augmenting technological growth. This process occurs when technological progress ends up widening the gap between skilled and non-skilled workers' productivity. This, in turn, also widens the gap between their wages, elevating the skill premium and consequently, income inequality.

In light of these results, there are some thoughts worth of discussion. First of all, as referred earlier, redistributive policies in general, with UBI being no exception, highlight the trade-off between efficiency and equity. When applying this paper's results to reality, the optimal policy might change considerably. This is due to the fact that the weight the social planner attributes to equity or efficiency varies a great deal, depending on many other socioeconomic factors not reviewed in this paper. Additionally, one might ask whether another redistributive system such as increased tax progressivity or a negative income tax would entail an even higher welfare gain than UBI. Even though that type of comparison was not as deeply approached in this article, it is in fact a compelling point for future research. To end up with, as UBI is deeply discussed in association with social support for the unemployed, an extension of this model to relax the full-employment assumption would also be of great interest for posterior work.

[17] The basis for this statement is that income Gini has increased even more since 2010, giving strength to the argument in favor of redistribution.

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Appendices

A Parameter Shifts

Table 6: Government and SS calibration 1980 - 2010

Description	**Parameter**	**1980**	**2010**	**Source**
Consumption tax rate	τ_c	0.054	0.050	Mendoza et al. (1994)
Capital income tax rate	τ_k	0.469	0.360	Mendoza et al. (1994)
Tax scale parameter	θ_1	0.940	0.895	Implied by clearing condition
Tax progressivity parameter	θ_2	0.160	0.095	Ferriere and Navarro (2018)
Government debt to GDP	B/Y	0.320	0.879	FRED
Military spending to GDP	G/Y	0.053	0.045	World Bank
SS tax employees	τ_{ss}	0.061	0.077	Social Security Bulletin, July 1981
SS tax employers	$\tilde{\tau}_{ss}$	0.061	0.077	Social Security Bulletin

B Causality Inference

Table 7: Welfare evaluation for 1980's characteristics with 2010's technology

g	0	0.01	0.02	0.03	0.04	0.05
$E[W]$	1.00000	1.00026	1.00046	1.00065	1.00085	1.00104
g	0.06	0.07	0.08	0.09	0.10	0.11
$E[W]$	1.00121	1.00136	1.00150	1.00162	1.00173	1.00182
				Optimal		
g	0.12	0.13	0.14	**0.15**	0.16	0.17
$E[W]$	1.00189	1.00195	1.00197	**1.00199**	1.00197	1.00193
g	0.18	0.19	0.20			
$E[W]$	1.00186	1.00175	1.00161			

Table 8: Welfare evaluation for 1980

	Optimal					
g	**0**	0.01	0.02	0.03	0.04	0.05
$E[W]$	**1.00000**	0.99988	0.99975	0.99941	0.99904	0.99849
g	0.06	0.07	0.08	0.09	0.10	0.11
$E[W]$	0.99785	0.99683	0.99569	0.9943	0.99235	0.99003

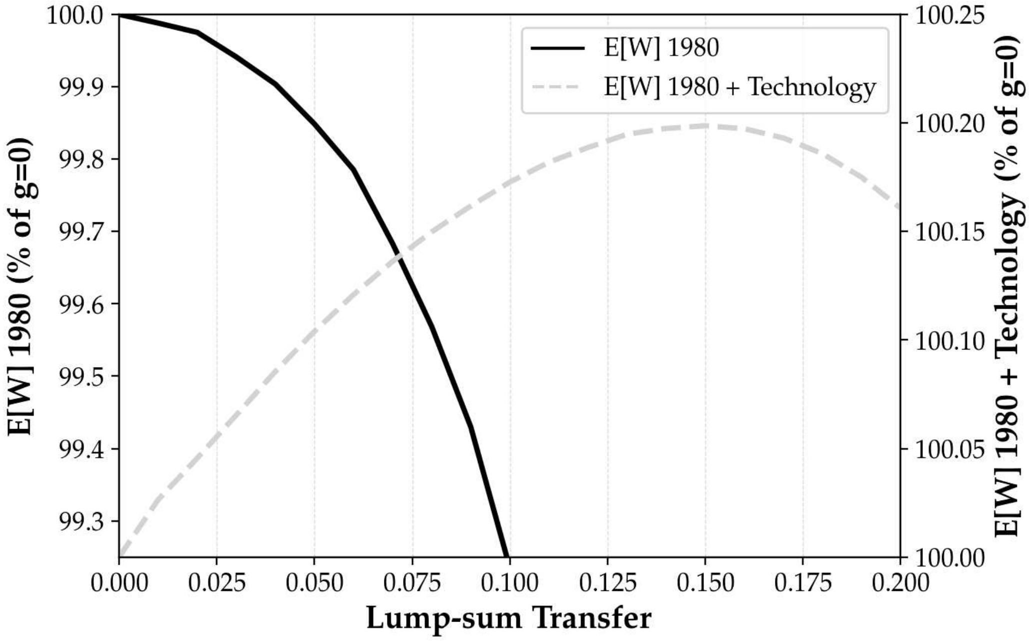

Figure 8: Welfare evaluation for causality experiment

C Detailed Welfare Evaluation Results

Table 9: Welfare evaluation for 1980 with UBI

	1980 (UBI system)										
g	0.000	0.010	0.020	0.030	0.040	0.050	0.060	0.070	0.080	0.090	0.100
E[W]	1.00000	0.99988	0.99975	0.99941	0.99904	0.99849	0.99785	0.99683	0.99569	0.99430	0.99235
Tabor Tax	0.080	0.115	0.135	0.170	0.198	0.230	0.260	0.300	0.337	0.375	0.420
Y/Capita	1.020	1.007	1.000	0.987	0.976	0.963	0.950	0.933	0.915	0.896	0.872
g % (Y/Capita)	0.000	0.010	0.020	0.030	0.041	0.052	0.063	0.075	0.087	0.100	0.115

Table 10: Welfare evaluation for 1980 with 2010 technology and an UBI system

	1980 with technological change (UBI system)										
g	0.000	0.010	0.020	0.030	0.040	0.050	0.060	0.070	0.080	0.090	0.100
E[W]	1.00000	1.00026	1.00046	1.00065	1.00085	1.00104	1.00121	1.00136	1.00150	1.00162	1.00173
Tabor Tax	0.030	0.045	0.054	0.064	0.075	0.086	0.097	0.108	0.119	0.130	0.142
Y/Capita	1.681	1.672	1.667	1.661	1.655	1.648	1.642	1.635	1.628	1.622	1.614
g % (Y/Capita)	0.000	0.006	0.012	0.018	0.024	0.030	0.037	0.043	0.049	0.055	0.062
g	0.110	0.120	0.130	0.140	0.150	0.160	0.170	0.180	0.190	0.200	
E[W]	1.00182	1.00189	1.00195	1.00197	1.00199	1.00197	1.00193	1.00186	1.00175	1.00161	
Tabor Tax	0.154	0.165	0.179	0.191	0.204	0.217	0.231	0.245	0.260	0.275	
Y/Capita	1.607	1.600	1.591	1.583	1.574	1.566	1.556	1.547	1.536	1.525	
g % (Y/Capita)	0.068	0.075	0.082	0.088	0.095	0.102	0.109	0.116	0.124	0.131	

Table 11: Welfare evaluation for 2010 with UBI

	2010 (UBI system)										
g	0.000	0.010	0.020	0.030	0.040	0.050	0.060	0.070	0.080	0.090	0.100
E[W]	1.00000	1.00010	1.00035	1.00056	1.00072	1.00093	1.00106	1.00121	1.00134	1.00143	1.00151
Tabor Tax	0.130	0.135	0.148	0.160	0.172	0.185	0.195	0.208	0.220	0.234	0.247
Y/Capita	1.661	1.658	1.650	1.643	1.636	1.627	1.620	1.612	1.603	1.595	1.586
g % (Y/Capita)	0.000	0.006	0.012	0.018	0.024	0.031	0.037	0.043	0.050	0.056	0.063

g	0.110	0.120	0.130	0.140	0.150	0.160	0.170	0.180	0.190	0.200
E[W]	1.00157	1.00160	1.00160	1.00156	1.00150	1.00140	1.00126	1.00107	1.00083	1.00054
Tabor Tax	0.262	0.277	0.293	0.306	0.322	0.337	0.353	0.370	0.387	0.404
Y/Capita	1.576	1.565	1.554	1.543	1.532	1.521	1.508	1.495	1.481	1.466
g % (Y/Capita)	0.070	0.077	0.084	0.091	0.098	0.105	0.113	0.120	0.128	0.136

D UK ONS's Table Excerpt

Table 12: UK ONS's probability of automation by professional group for the UK in 2017

Lower Probability		Higher Probability	
Medical practitioners	0.181	Industrial cleaning process occupations	0.640
Higher ed. teaching professionals	0.203	Fork-lift truck drivers	0.644
Senior professionals of ed. establishments	0.206	Textile process operatives	0.646
Secondary ed. teaching professionals	0.206	Food, drink and tobacco process operatives	0.650
Dental practitioners	0.208	Other elementary services occupations n.e.c.	0.653
Psychologists	0.209	Elementary agriculture occupations n.e.c.	0.654
Medical radiographers	0.210	Retail cashiers and check-out operators	0.655
Physiotherapists	0.212	Van drivers	0.655
Occupational therapists	0.215	Elementary administration occupations n.e.c.	0.657
Primary and nursery ed. teaching professionals	0.220	Agricultural machinery drivers	0.658
Clergy	0.221	Launderers, dry cleaners and pressers	0.662
Physical scientists	0.221	Leisure and theme park attendants	0.665
Natural and social science professionals n.e.c.	0.221	Weighers, graders and sorters	0.672
Research and development managers	0.222	Packers, bottlers, canners and fillers	0.672
Speech and language therapists	0.222	Vehicle valeters and cleaners	0.678
Architects	0.225	Tyre, exhaust and windscreen fitters	0.681
Education advisers and school inspectors	0.225	Cleaners and domestics	0.681
Solicitors	0.226	Sewing machinists	0.686
Biological scientists and biochemists	0.228	Farm workers	0.690
Town planning officers	0.229	Kitchen and catering assistants	0.692
Senior police officers	0.230	Bar staff	0.707
Officers in armed forces	0.230	Elementary sales occupations n.e.c.	0.707
Further education teaching professionals	0.231	Shelf fillers	0.717
Actuaries, economists and statisticians	0.232	Waiters and waitresses	0.728