The Impact of a Universal Basic Income System on Aggregate Capital, Labor, Welfare, and Inequality

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Abstract

Universal Basic Income (UBI) is a program in which all residents of a country receive a regular transfer of money from the government. This pure and unconditional basic income has no means test, is distributed automatically to all residents and thus, is easy to administer. In this paper, I use general equilibrium model of heterogeneous agents to evaluate the impact of the UBI system, on aggregate levels and distributions of wealth, consumption, labor, and welfare. I contrast this with a targeted transfers system where people need to meet certain eligibility criteria (usually, income) to qualify for transfers. I find that in the UBI system with $1,000 monthly payments, the level of aggregate capital falls by 16% and the inequality of wealth increases no matter how the UBI system is financed: through taxes or through foreign aid. Guaranteed payments induce people to save less because of less precautionary needs. As precautionary savings motive is stronger for the asset poor, people in the lowest wealth quintiles reduce their savings more, which increases the inequality of wealth. Even though the welfare of the least skilled and the asset poor increases significantly because of unconditional transfers, the tax-financed UBI system requires a consumption tax rate to be equal to 43% that slightly reduces the welfare of the wealthier. Even though consumption tax rate is unrealistically high, the effective consumption tax rate (consumption tax net of transfers) decreases on average and aggregate welfare increases by 15.7% as measured by consumption equivalent variation. A hybrid model with both targeted transfers and partial UBI (monthly payments of $500) with low, 5% capital income tax rate (to encourage savings) is more efficient as it provides significant, almost 8% gain in welfare with only 22% consumption tax rate and without compromising output or welfare of the asset rich.

1 Introduction

Universal Basic Income (UBI) is a program in which individuals receive a regular sum of money, usually from the government. The transfer amount is thought to be unconditional of income and enough to cover all subsistence needs. Such a system is easy and cheap to administer because the government does not need to check the eligibility of each applicant. UBI programs are growing as more cities, states and countries (Stockton, California, Kenya, Finland) implement experiments of such programs. Additionally, one of the main responses of the U.S. to high unemployment caused by the COVID-19 pandemic and quarantine was a modified version of a temporary country-wide UBI program in 2020 (CARES Act). Also, 16 mayors across the U.S. created a coalition - Mayors for a Guaranteed Income - to explore cash payment programs and address the racial wealth inequality[1]. Thus, it is important to have a macroeconomic model of UBI to analyze how it works, what we can expect, and what is the best approach to implement such programs.

In most countries, including the United States, the government pays targeted transfers usually to people with low or no income, a disability or to caregivers of disabled individuals. These targeted transfers can take different forms such as cash assistance, food stamps, health insurance, tax credit or tuition subsidy. However, transfers in this system may create disincentives in the labor market. The UBI system is less distortionary because the transfer is unconditional. Therefore, it could be expected in the UBI model that the least skilled and the asset poor will be better off because they have an opportunity to work and earn income in addition to the transfer. Additionally, this program has many supporters because of the increasing fear of automation or artificial intelligence, which can substitute workers and create massive unemployment[2].

There are some concerns with UBI. Guaranteed income might create a wealth effect that will induce people to, on average, work less, leading to lower output and tax revenue. However, there is little to no evidence that people reduce work when they receive unconditional cash transfers Marinescu (2018)[3]. Another concern is that the government will need more funds to finance such a system, implying an increase in distortionary taxation.

In this paper, I evaluate the impact of a universal basic income system on output and inequality in the economy. I use an Aiyagari (1994) type heterogeneous agent model, where agents differ in abilities and wealth and face idiosyncratic earnings risk. Individuals also have a minimum consumption requirement[4]. I calibrate the model to match the key statistics of the US economy and introduce a universal basic income scheme, where the UBI covers the basic consumption requirement. The UBI is financed (in the baseline model) by a consumption tax, although I explore several alternative financing schemes.

My results show that the introduction of a UBI system reduces capital by 16% and therefore, output by 6.9%. The guaranteed payments reduce precautionary savings because of wealth effect. Since the reduction of precautionary savings is the largest for the lowest ability individuals, the introduction of the UBI increases wealth inequality, even while it reduces consumption inequality. Targeted transfers recipients in a UBI system start to work because transfers are unconditional, and thus, total hours worked increases. However, more productive workers slightly reduce their work hours because of wealth effect of UBI and aggregate labor supply decreases slightly (by 1.4%). Therefore, the earnings inequality increases. It is

[1]https://www.mayorsforagi.org

[2]I abstract the issue of automation in this paper. For the effects of UBI in the presence of technological unemployment, see Mukbaniani (2020)

[3]Marinescu (2018) surveys results from a large number of UBI programs through the world and finds little to no labor supply effects. These programs range from dividends to local residents (Alaska Permanent Fund Dividend and Eastern Band Cherokees casino) to guaranteed payments through Negative Income Tax experiments in the U.S. and Canada

[4]A minimum consumption requirement plays a crucial role in heterogeneous agent models because it determines precautionary savings and is necessary to predict changes in aggregate capital and inequality.

important to note that these results are independent of the method of financing the UBI, they hold even if the system is financed entirely through foreign aid.

The baseline model assumes a consumption tax, which, also reduces long run aggregate consumption by 3.4%. However, aggregate welfare (as measured by consumption equivalent variation, CEV) increases significantly, by 15.7%. The lower tails of the wealth distribution benefits from the additional income they receive, while welfare of the asset rich decreases because of high consumption tax rates.

I also show that a hybrid system with partial targeted transfers and partial UBI payments, which covers only part of the subsistence requirement is less demanding for output and capital accumulation and provides significant, 8.8% gain in welfare. I also show that financing this hybrid system with a combination of capital income and consumption taxes is output and inequality neutral, while generating significant welfare gains.

There are several caveats to my analysis. I do not consider the issue of automation, which proponents of UBI argue is an important reason to provide such programs (Lowrey 2018, Yang 2018). Second, I ignore individual social welfare programs such as social security, Medicaid and unemployment benefits and collapse them all into one category that I call targeted programs. Third, I do not incorporate life cycle variation in earnings[5] and capital income risk that are necessary to replicate the skewness of the income distribution (see Benhabib et al. 2015, Cagetti and De Nardi 2006, Quadrini 2000)[6]. Also, even though the investment decisions on education and health are very important aspects of the UBI, this paper excludes human capital accumulation[7]. Despite these, this paper is important because it sets out a framework to analyze different aspects of the UBI, and allows us to understand its implications for the macroeconomy.

The rest of the paper is organized as follows: Section 2 reviews the related literature, Section 3 introduces a model with targeted transfers system, and section 4 provides a model with UBI. Section 5 investigates the mechanisms of UBI to understand the results, while Section 6 provides robustness analysis, and Section 7 concludes. In the Appendix I show how UBI affects prudence and precautionary savings.

[5] Luduvice (2019) estimates a richer model with life cycles and finds similar results: precautionary savings and output fall while welfare increases with a UBI when transfers equal poverty threshold ($12,000 a year). He also discusses revenue-neutral transformation of targeted transfers system to the UBI system. However, Luduvice (2019) does not consider different financing methods of UBI nor alternative transfers systems with partial UBI or Hybrid transfers that allow policy makers to implement such programs in the best way.

[6] The lack of life cycle variation and capital income risk do not affect the behavior of individuals in the lowest quintiles. By underestimating top incomes, I also underestimate tax revenues and over estimate the tax rates necessary to finance UBI. Hence including these features should strengthen my conclusions.

[7] Daruich and Fernandez (2020) discuss investment decisions of UBI in child's education and find that households invest significantly less in skills in the UBI system and thus, the welfare of future generations fall while welfare of the first generation of UBI recipients increases. This is a very important finding that is a result of reduced precautionary behavior of households. However, Daruich and Fernandez (2020) does not consider the hybrid transfers system that reduces precautionary savings motives in a much smaller magnitude and that potentially has interesting implications for educational investment decisions too.

2 Literature Review

Different forms of Universal Basic Income programs have been experimented with worldwide. However, the implications of UBI for developed world might be different especially when it is financed by a tax system. Jones and Marinescu (2018) analyze the unconditional cash transfers program of Alaska to its residents. Each resident receives a payment of \$2,000 from the Alaska Permanent Fund Dividend that is a diversified portfolio investment in oil reserves royalties. The authors find that the overall labor supply does not change, while part-time employment increases. Likewise, the Eastern Band of Cherokee Indians Casino Dividend program that has been paying \$4,000 \$6,000 to every tribal member of the tribal land in North Carolina since 1997 did not reduce hours worked (Marinescu, 2018). Iran conducted a nation-wide UBI program in 2011, where the government paid 29% of median income to family accounts. Salehi-Isfahani and Mostafavi-Dehzooei (2017) found no evidence of reduced labor supply while they found increased hours of work in the service sector. Also Kangas et al. (2019) find no effect on employment and improvement of well-being in the Finland's basic income experiment that gave unconditional transfers to randomly selected 2,000 unemployed individuals.

Even though multiple experiments have been conducted world-wide (Banerjee et al. 2019, Hoynes and Rothstein 2019, Marinescu (2017), etc), there has been no long-run experiment eliminating all other transfer programs and providing tax-financed unconditional basic transfers to every resident. Thus, macroeconomic models are useful to understand the impact of such programs. However, this literature is relatively sparse. Tondani (2009) compares income tax financed Universal Basic Income systems to Negative Income Tax (NIT) and determines that these two schemes lead to an identical impact on income distribution. Thus, the economic literature on NIT is also helpful. Lopez-Daneri (2016) discusses a revenue-neutral transition of the U.S. tax/transfers system to the NIT regime, where all current transfers are changed to a universal transfer. He finds that with a welfare maximizing optimal NIT system GDP, the stock of capital, and the supply of labor fall, while there is a significant gain in welfare. Considering that NIT and UBI provide the same distributional effect, the paper by Lopez-Daneri (2016) is very close to my own paper, it analyzes the macroeconomic outcome of a universal transfer. However, Lopez-Daneri (2016) does not consider a subsistence requirement, and the universal transfer does not guarantee subsistence. If people have subsistence needs, their responses of saving and labor supply to transfers will be different. People whose total income is less than subsistence, will not save at all and will work more to push their consumption up to the subsistence in order to survive and gain considerably in welfare. On the other hand, if the transfer amount is not guaranteed to meet the subsistence needs, people with no source of income will not survive. Thus, agents, especially those with low income, will save and work more for precautionary reasons. As a result, Lopez-Daneri (2016) model will have different results than my model, where the transfer amount is equal to the subsistence. Additionally, I discuss different types of financing, while Lopez-Daneri (2016) analyses his models only with changes in income tax. Also, my analysis is not revenue-neutral, and changes in taxes to finance the UBI can have significant welfare implications.

In the contemporaneous paper Luduvice (2019) uses a richer model with finite horizon and life cycle variations of earnings and his findings are similar to this paper. He discusses both the revenue-neutral transformation of targeted transfers system to a UBI system and an "Andrew Yang's[8] (AY) UBI" where every household receives a transfer of subsistence ($12,000 annually) and UBI programs are financed by a consumption tax. Luduvice (2019) finds that in the revenue neutral UBI system output increases and welfare decreases, while in an AY UBI precautionary savings and therefore, output fall and aggregate welfare as CEV increases. The welfare gain in Luduvice (2019) is much lower than the welfare gain in this paper. This could be attributed to the differences in the definitions of welfare and the utility function[9]. However, Luduvice (2019) does not consider alternative financing methods of UBI nor the variations in UBI and targeted transfers that are useful to find optimal transfers system and are discussed in this paper.

Daruich and Fernandez (2020) discuss the impact of a UBI policy in the presence of intergenerational linkages of parental education and skills and the incentives to invest in children's skill formation and transfer funds. Daruich and Fernandez (2020) do not explicitly model targeted transfers, however they introduce progressivity of the marginal income tax rates that accounts for the deductions and public cash transfers as in Heathcote et al. (2017). Daruich and Fernandez (2020) find that in the same progressive income tax system (when implicitly modelled targeted transfers are not eliminated), introduction of a UBI policy that pays income equivalent to the poverty level reduces the long-run output by 12.9% and welfare as CEV by up to 9% because future generations reduce savings and invest less in their skills. When they eliminate progressivity of taxation (and thus, implicitly, targeted transfers), which is the scenario closer to the discussion of this paper, they find only 1.9% loss of welfare as CEV. The difference in welfare outcomes in Daruich and Fernandez (2020) and this paper comes from the differences in endogeneity of the labor productivity. In this paper, labor productivity is purely an exogenous shock and precautionary behavior is limited to only savings, while in Daruich and Fernandez (2020) precautionary behavior includes formation of skills too. As UBI reduces precautionary motives, it has stronger effect on the economy in Daruich and Fernandez (2020). When they use consumption tax to finance the UBI system (that I use in this paper), aggregate welfare increases in their model too, however, they attribute this welfare gain to the change in the tax system[10] and not the UBI. Reduced skills formation by future generations is a very important finding by Daruich and Fernandez (2020) and the hybrid system framework with low capital income tax that is suggested by this paper should provide an interesting setting for future research. As the Hybrid system affects precautionary savings in much lower magnitude than the UBI system, it is likely to have smaller negative affects on skills formation. Also,

[8] Yang (2018) proposes a UBI system where every adult will receive $1,000 monthly.

[9] In contrast with this paper, Luduvice (2019) does not use minimum consumption requirement that has consequences on the welfare too. If I use the utility function of Luduvice (2019) the welfare gains coincide.

[10] They discuss that, in general, if economy switches to low income tax rate and balance the budget using higher consumption tax rate, the welfare will increase in a bigger magnitude in the system without UBI.

reduction of capital income tax rate, that is suggested by this paper, might actually increase investment in skills.

Hanna and Olken (2018) compare the welfare of a UBI and a targeted transfers system with a fixed total transfer amount in both models. They discuss that in developing countries, where many people work in the informal sector, it is hard to collect income data. Thus, in the targeted transfers system, the government usually uses a proxy income measure based on the information collected about the capital owned by people. Because the proxy income might be inaccurate, this system is subject to an "exclusion error" (missing people who are eligible for the transfer) and an "inclusion error" (giving transfers to people who do not qualify). Thus, UBI might perform better because it guarantees that all income poor will receive a transfer. Hanna and Olken (2018) compare welfare in the targeted transfers system to the UBI, based on data from Peru and Indonesia and found that the former provides higher welfare. Since total transfers are fixed, low income individuals receive more generous transfers in a targeted transfer program than in a UBI program. However, in my model, everyone receives a subsistence transfer, and the total transfers in a UBI system are much higher than total transfers in the targeted transfers system. Therefore, my findings will differ. In addition, I consider not only welfare, but other macroeconomic outcomes as well.

Nikiforos et al. (2017) simulate the U.S economy with UBI using the Levy Institute Macroeconometric model and found a permanent positive impact of UBI on growth. However, their work does not take into account the behavioral responses of household labor supply or savings in response to the UBI.

Fabre et al. (2014) compare unemployment insurance (UI) and universal basic income and find supportive evidence for the UI because costs of UBI cannot compensate for the administrative cost of UI. However, in their model the only risk is unemployment, otherwise, agents are equally productive. Thus, Fabre et al. (2014) cannot provide a full picture of UBI.

3 A Standard Model with Targeted Transfers

My model follows Aiyagari (1994) and Heer and Trede (2003) with some modifications. As in Aiyagari (1994) and Heer and Trede (2003), in my benchmark model, I assume that there are infinitely lived households of measure one who are heterogeneous in wealth and face endogenous earnings shocks. Earnings risk follows first order autoregressive process. To maximize their lifetime utility, in each period, households decide how much to work, how much to consume and how much to save. In addition, in each period households earn labor income and interest income on their assets. They pay income tax on their transfers, labor and capital income, and a consumption tax on purchases. In this model, people have minimum consumption requirement to survive and thus, the government makes sure that everyone has sufficient income to be at the subsistence and provides transfers if necessary. Budget is balanced in every period.

My model is different from Heer and Trede (2003) in terms of the unemployment risk. The only risk people face is the earnings risk, and labor force participation is a choice. Some of the least skilled workers stay unemployed because they want to qualify for the transfer payments. There is no work requirement to qualify for the transfers.

I distinguish between subsistence consumption, $\bar{y}_t$ and subsistence income $\frac{\bar{y}_t(1+\tau_c)}{(1-\tau_y)}$ that would be sufficient to cover subsistence consumption and also to pay income and consumption taxes, τ_y and τ_c respectively (with saving=0)[11]. An individual receives a transfer equal to the difference between her income and the subsistence requirement.

3.1 Baseline Model

3.1.1 Households Problem in a Benchmark model

I assume that there are infinitely lived households of measure one with idiosyncratic productivity risk, $e_{i;t}$. To maximize their lifetime utility, in each period, households decide how much to work $l_{i;t}$, how much to consume $c_{i;t}$ and how much assets to hold $a_{i;t+1}$. In addition, in each period, households earn labor income of $w_t l_{i;t} e_{i;t}$ (where w_t is a wage rate and is same for all households), and interest income net of depreciation $(r_t - \delta)$ on their assets $a_{i;t}$. They pay income tax equal to τ_y on their transfers and labor income, capital income tax τ_k and consumption tax τ_c. Households have minimum consumption requirement $\bar{y}_t$ and thus, government transfers guarantee a minimum income of $\bar{y}_t \frac{(1+\tau_c)}{(1-\tau_y)}$[12] to be at subsistence and provides a transfer if necessary.

In each period infinitely lived households maximize their lifetime utility

$$\max_{c_{i;t}; l_{i;t}} E_0 \sum_{t=1}^{\infty} \beta^t U(c_{i;t} - \bar{y}_t; 1 - l_{i;t}) \tag{1}$$

subject to

$$(1-\tau_y) w_t l_{i;t} e_{i;t} + (1 + r_t - \delta) a_{i;t} - \tau_k (r_t - \delta) a_{i;t} + (1-\tau_y) tr_{i;t} = (1+\tau_c) c_{i;t} + a_{i;t+1} \tag{2}$$

where

$$c_{i;t} \geq \bar{y}_t \tag{3}$$

$$\bar{y}_t = \gamma C_t; \tag{4}$$

where C_t is aggregate level of consumption,

$$a_{i;t} \geq 0 \tag{5}$$

[11] For computational convenience I assume that people pay income tax on transfer payments too.

[12] If all income is earned through capital, then, subsistence requirement without a transfer is $\bar{y}_t \frac{(1+\tau_c)}{(1-\tau_k)}$. however, for simplicity, I ignore that difference.

$$tr_{i,t} = \begin{cases} \frac{\underline{y}_t(1+\tau_c)}{(1-\tau_y)} - (w_t l_{i,t} e_{i,t} + (r_t - \delta) a_{i,t}) & if \;\; w_t l_{i,t} e_{i,t} + (r_t - \delta) a_{i,t} \le \frac{\underline{y}_t(1+\tau_c)}{(1-\tau_y)} \\ 0 & otherwise \end{cases} \tag{6}$$

Thus, to qualify for the transfer from the government, total labor and capital income should be less than the subsistence requirement. The maximum transfer to an agent is the subsistence requirement net of wage and interest income. Of course, if households qualify for transfers, they will not work as they receive a utility from leisure and work will reduce the size of transfers.

Productivity, $(e_{i,t})$, follows a first order finite state Markov chain with conditional transition probabilities and is given by

$$\pi(e'|e) = Pr(e_{t+1} = e'|e_t = e) \tag{7}$$

where

$$e, e' \in E = \{1, 2, ..., n\}. \tag{8}$$

As funding of transfers programs play important role in this paper, I define an effective policy tax rate. I define a policy tax as the tax policy that is used to balance the budget equation. In the baseline model I use consumption tax to balance the government's budget constraint[13]. Thus, an effective policy tax rate in the baseline model is calculated as a percentage of consumption taxes net of transfers in consumption. Thus, an effective policy tax rate, $\tau_{i,t}$, is defined as

$$\tau_{i,t} = \frac{\tau_c c_{i,t} - (1-\tau_y) tr_{i,t}}{c_{i,t}}. \tag{9}$$

The effective consumption tax rate will be negative when transfers received are greater then the consumption tax paid. In the baseline model with targeted transfers, the effective tax rate for transfer recipients with no wealth is -100% as they consume at the minimum. While equals consumption tax rate for non-recipients of transfers.

3.1.2 Firms

There is a representative firm that employs labor L_t and capital K_t to produce output Y_t to maximize profit, using the constant returns to scale production technology

$$F(K_t, L_t) = K_t^{\alpha} L_t^{1-\alpha} \tag{10}$$

Setting the price of final goods to unity, the profit maximization problem for the firm is

[13] In Section 5.1 I discuss alternative tax policies too.

the following:

$$\max_{L_t, K_t} K_t^{\alpha} L_t^{1-\alpha} - w_t L_t - r_t K_t \tag{11}$$

3.1.3 Government

The government follows a balanced budget every period. They earn revenue from the tax on transfers, labor, capital, and consumption. Outlays consist of government spending G_t and total transfer payments to households TR_t. Government spending G_t is a constant γ share of GDP. Total transfers to households are

$$TR_t = \int_0^1 tr_{i,t} da_{i,t} \tag{12}$$

Thus, in each period the budget constraint for the government in the benchmark model will be

$$\int_0^1 (\tau_y w_t l_{i,t} e_i + \tau_k (r_t - \delta) a_{i,t} + \tau_y tr_{i,t} + \tau_c c_{i,t}) da_{i,t} = \int_0^1 tr_{i,t} da_{i,t} + G_t \tag{13}$$

where

$$G_t = \gamma Y_t \tag{14}$$

The budget is balanced by varying the consumption tax rate, while labor and capital income tax rates are fixed[14].

3.1.4 Value Function

The households problem can be written in recursive form as:

$$v(a_{i,t}, e_{i,t}) = \max_{c_{i,t}, l_{i,t}} (u((c_{i,t} - \bar{y}_t), (1 - l_{i,t})) + \beta \sum_{e' \in E} (\pi(e_{i,t+1} | e_{i,t}) v(a_{i,t+1}, e_{i,t+1})) \tag{15}$$

subject to the budget constraint in Equation 2.

3.1.5 Preferences

I use the separable preferences with the following period utility function:

$$U(c_t - \bar{y}_t, 1 - l_t) = \frac{(c_t - \bar{y}_t)^{1-\sigma}}{1-\sigma} + \chi_0 \frac{(1 - l_t)^{1-\chi_1}}{1-\chi_1} \tag{16}$$

As discussed in Castaneda et al. (1998) and Heer and Trede (2003), the above utility function is more in accordance with empirical observations than Cobb-Douglas functional form of utility because it predicts variability in hours worked more accurately.

[14] As I show in later sections, consumption tax financing causes less distortions to the economy.

3.1.6 Market Clearing

For a given government tax policy and a constant distribution $F(e;a)$ with associated density $f(e;a)$ over the individual state space $(e;a) \in E \quad [0;\infty)$, the stationary equilibrium in the baseline system with targeted transfers is characterized by the value functions $v(e;a)$, decisions rules $c(e;a)$, $l(e;a)$, $a'(e;a)$ for consumption, labor supply, and next-period assets, respectively, time-invariant relative factor prices $w;r$, effective policy tax rates $\quad(e;a)$, the average effective policy tax rate $\quad$, total transfers (TR), aggregate capital (K), aggregate labor (L), government spending (G) such that:

$i)$ The value function and decision rules solve agents' utility maximization problem.

$ii)$ Factor prices solve the firm's profit maximization problem and equal to marginal product of each factor.

$$r_t = F_k(K;L) = \quad K^{\quad(1\quad)}L^{1} \tag{17}$$

$$w = F_L(K;L) = (1 \quad)K \quad L \tag{18}$$

$iii)$

$$\sum_{e \in E} \int_0^{\infty} af(e;a)da = K \tag{19}$$

$$\sum_{e \in E} \int_0^{\infty} el(e;a)f(e;a)da = L \tag{20}$$

$$\sum_{e \in E} \int_0^{\infty} c(e;a)f(e;a)da = C \tag{21}$$

$$\sum_{e \in E} \int_0^{\infty} tr(e;a)f(e;a)da = TR \tag{22}$$

$$\sum_{e \in E} \int_0^{\infty} \quad(e;a)f(e;a)da = \tag{23}$$

$$C + K' + G = F(K;L) + (1 \quad)K \tag{24}$$

$iv)$ Budget is balanced:

$$_y(1 \quad)K \quad L^{(1\quad)} + \;_k(\quad K \quad L^{1} \quad\quad K) + \;_yTR + \;_cC = TR + G \tag{25}$$

$v)$ The distribution of the individual state variables is constant:

$$F(e';k') = \sum_{e \in E} \quad(e'|e)F(e;k) \tag{26}$$

Average Consumption (2017)	42,785
28% of Average Consumption	11,980
Federal Poverty Threshold for individuals(2017)	12,060

Table 1: Minimum Consumption Requirement

Parameters	Values	Description
	0.9546	Discount Factor (Alvarez-Pelaez and Diaz, 2005)
	1.8	Relative risk aversion (Alvarez-Pelaez and Diaz, 2005)
	0.28	Minimum consumption as % of C (Alvarez-Pelaez and Diaz, 2005)
$_0$	0.13	Utility parmeter (Heer and Trede, 2003)
$_1$	10	Utility parameter (Heer and Trede, 2003)
	0.36	Capital share (Heer and Trede, 2003)
	0.04	Capital depreciation rate (Heer and Trede, 2003)
$_y$	0.25	Income tax rate for labor income and transfers
$_k$	0.15	Capital income tax
	0.196	Share of government expenditures in output (Heer and Trede, 2003)

Table 2: Parameters

for all $k' \in [0, \infty)$ and $e' \in E$ and with $k' = k'(e, k)$.

3.2 Calibration

Most of the calibrated parameters are as suggested by Heer and Trede (2003). The choice for the parameters of discount rate, relative risk aversion, and subsistence consumption comes from Alvarez-Pelaez and Diaz (2005), who include minimum consumption requirement in the utility function. As they discuss, the minimum consumption is equal to the 28% of average consumption and the parameters of relative risk aversion and discount rate should be equal to 1.8 and 0.9546, respectively. As presented in Table 1, federal poverty level is very close to the 28% of average consumption, and it justifies once more, my choice of minimum consumption parameter.

I set the income tax rate, $_y$, to equal 0.25, capital income tax rate, $_k$ to be 0.15, and the consumption tax rate, $_c$ to balance the government budget constraint. The model parameters are given in Table 2.

As in De Nardi (2004), logarithm of income follows AR(1) process with persistence parameter to be equal to 0.95 and variance of earnings to be the Gini coefficient of earnings 0.38. Cagetti and De Nardi (2006) approximate the income process (normalized to 1) with a five state Markov chain. Thus,

$$e = (0.2468, 0.4473, 0.7654, 1.3097, 2.3742) \tag{27}$$

The annual transition matrix of productivities is also based on Cagetti and De Nardi (2006):

$$
\begin{bmatrix}
0.7376 & 0.2473 & 0.0150 & 0.0002 & 0.0000 \\
0.1947 & 0.5555 & 0.2328 & 0.0169 & 0.0001 \\
0.0113 & 0.2221 & 0.5333 & 0.2221 & 0.0113 \\
0.0001 & 0.0169 & 0.2328 & 0.5555 & 0.1947 \\
0.0000 & 0.0002 & 0.0150 & 0.2473 & 0.7376
\end{bmatrix}
$$

3.3 Results

My benchmark model simulates the distribution of wealth quite accurately except for the top percentiles. As De Nardi (2004), Cagetti and De Nardi (2006), Benhabib and Bisin (2016), and others claim, in order to match the distribution of wealth in the top tails, in addition to earnings risk, we need to include life-cycle variation in earnings, a bequest motive, and capital income risk. Although it is important to match distributions accurately, in order to better understand and disentangle the impact of a UBI, I keep the model simple and include only idiosyncratic earnings risk. Thus, the inequality measures such as wealth, earnings, income and consumption are much smaller than suggested by the data (Rios-Rull and Kuhn 2016, Krueger and Perri 2001). However, as we can observe from Table 3, the behavior of the income poor, transfers and the poverty rate are quite well-explained by the benchmark model. The poverty rate in the US in 2018 was 13.1[15], and my model predicts 15.3%. The share of total transfers in aggregate output is also close to the data[16]: 3.6% of the nominal GDP goes to all welfare programs including SNAP and Medicaid (excluding social security because agents in my model are infinitely lived). Labor force participation rate is also accurately matched. 84.7% of working age population are predicted to work, while in the data, labor force participation rate is 83.1%[17].

As expected, people with lowest level of productivity and low wealth do not work because their earnings would be less than subsistence requirement and they qualify for the transfer anyway. Recall that in this model the transfer is equal to the difference between subsistence and earnings. People receive utility from leisure and thus, those who qualify for the transfer, prefer not to work because their total income will be at subsistence anyway. This is also confirmed by the data. The mean value of total income (the sum of labor earnings, interest or other business income, and transfers) of recipients of welfare - $12,186 (IPUMS Data: 2011, 2012, 2013 [18]) is around the poverty threshold - $12,060.

Interestingly, the least productive people with zero wealth (0.3% of households or 1 million people for the U.S.), work so much (50-55% of their time) that they earn slightly above

[15] https://www.census.gov/data-tools/demo/saipe//?map$_{g}eoSelector = aa_{c}$

[16] http://federalsafetynet.com/welfare-budget.html

[17] U.S. Bureau of Labor Statistics, Labor Force Participation Rate - 25-54 Yrs.(January, 2020) [LNS11300060], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/LNS11300060, April 28, 2020.

[18] Steven Ruggles, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas, and Matthew Sobek. IPUMS USA: Version 9.0 [dataset]. Minneapolis, MN: IPUMS, 2019. https://doi.org/10.18128/D010.V9.0

	Benchmark Model	Data
Wealth Gini	0.53	0.85
Earnings Gini	0.40	0.67
Income Gini	0.42	0.58
Consumption Gini	0.20	0.31
Transfers as % output	2.4%	3.6%
% of adult welfare recipients	15.3%	13.1%
Labor Force Participation Rate	84.7%	83.1%

Table 3: Benchmark Model with Targeted Transfers vs Data

subsistence and thus, do not qualify for the transfers. They do so in order to push their consumption slightly above the subsistence requirement and increase their utility significantly. On the other hand, households with some low level of wealth can reduce their wealth in order to consume slightly above the subsistence and therefore, rely on transfers. Thus, the targeted transfers system do not really achieve its goal and do not help the asset poorest (This issue will be addressed again in Section 4.4, Figure 3).

4 Baseline Model with Universal Transfers

I consider a UBI model that is financed by a balanced budget. My UBI model is not revenue neutral. Because everyone receives a universal basic transfer, the government needs to finance such a system, and thus, with the UBI, both, revenue and costs of the government rise. At the same time, there is no other targeted transfer in the model because the UBI system substitutes all the safety net programs. The framework of the basic model is provided in the next subsection.

4.1 Basic Model

4.1.1 Households

The set up of the model is the same as in the previous model with the difference that everyone receives the benefit of $\bar{y}_t \frac{(1+\tau_c)}{(1-\tau_y)}$. The transfer is supposed to be sufficient to survive without any labor or capital income.

Thus, in each period households maximize lifetime utility as in Equation (1) subject to

$$(1-\tau_y) w_t l_{i;t} e_{i;t} + (1 + r_t - \delta) a_{i;t} - \tau_k (r - \delta) a_{i;t} + (1-\tau_y) \bar{y}_t \frac{(1+\tau_c)}{(1-\tau_y)} = (1+\tau_c) c_{i;t} + a_{i;t+1} \quad (28)$$

where

$$a_{i;t} \geq 0 \tag{29}$$

and

$$c_t \geq max\{\bar{y}_{Bench}; 28\% C_{UBI}\} \tag{30}$$

Where C_{UBI} is average consumption in the stationary equilibrium, and e is again a productivity process that follows a first order finite state Markov chain with conditional transition probabilities given by Equations (7) and (8). $\bar{y}_{Bench}$ is the minimum consumption requirement in the stationary equilibrium of the benchmark model with targeted transfers. With this condition, the minimum consumption in the UBI system is at least the minimum consumption in the benchmark model with targeted transfers because standards of living is not likely to decrease if economy transits to a UBI system.

An effective policy/consumption tax rate, τ, is calculated as

$$\tau_{i;t} = \frac{\tau_c c_{i;t} - \bar{y}_t(1+\tau_c)}{c_{i;t}}. \tag{31}$$

For asset poor households whose consumption is closer to the minimum consumption requirement, the effective consumption tax rate will be negative, while it will be positive for wealthier households who consume more and thus, pay high consumption taxes.

4.1.2 Firms

The firm's problem is the same as in the benchmark model.

4.1.3 Government

The government follows a balanced budget every period. They earn revenue from income tax on labor, capital, and transfers as well as from consumption tax. Government outlays consist of transfers TR_t to households that is equal to the subsistence income, and government spending G_t that is a constant share of GDP. With UBI the total transfers to households are

$$TR_t = \bar{y}_t \frac{(1+\tau_c)}{(1-\tau_y)} \tag{32}$$

Thus, in each period the budget constraint for the government with UBI would be

$$\int_0^1 \left(\tau_y w_t l_{i;t} e_{i;t} + \tau_k(r_t - \delta)a_{i;t} + \tau_y \bar{y}_t \frac{(1+\tau_c)}{(1-\tau_y)} + \tau_c c_{i;t}\right) da = \bar{y}_t \frac{(1+\tau_c)}{(1-\tau_y)} + G_t \tag{33}$$

where G_t is defined as in Equation (14) and, again, the consumption tax rate is used to balance the budget.

Preferences, value functions and the market equilibrium conditions are all similar to the benchmark model with transfers.

4.1.4 Calibration

Calibration parameters are the same as in the benchmark model. Income tax rates are fixed and the consumption tax rate is calibrated to balance the budget constraint. In Section 5.1 I relax this assumption to study the effects of alternative models of financing UBI.

4.2 Welfare

In the stationary equilibrium, welfare gain from a UBI system for a household i with asset level of a_i and productivity e_i is denoted by λ_i and shows the percentage of consumption required to equalize the value function in the benchmark system to the value function in the UBI system for the same level of assets and productivity. Thus, I calculate welfare gain for each household as Consumption Equivalent Variation (CEV) and then, I calculate an average welfare gain for the distribution of households in the benchmark model.

I follow the methodology described in Mukoyama (2011) and Jones and Pratap (2020), add the minimum consumption requirement and calculate a welfare gain, λ_i as:

$$v^{Bench}_{a_i,e_i}((c_{a_i,e_i} - \bar{y})(1+\lambda_i), (1 - l_{a_i,e_i})) = v^{UBI}_{a_i,e_i} \tag{34}$$

To find λ_i, I first find an asset equivalent a_j (Jones and Pratap (2020)) so that

$$v^{Bench}_{a_j,e_i}((c_{a_j,e_i} - \bar{y}), (1 - l_{a_j,e_i})) = v^{UBI}_{a_i,e_i} \tag{35}$$

Then, I take corresponding consumption, c_{a_j,e_i} from the decision rules and calculate

$$\lambda_i = \frac{c_{a_j,e_i} - c_{a_i,e_i}}{c_{a_i,e_i}}. \tag{36}$$

Average welfare gain Λ is then calculated as

$$\Lambda = \sum_{e \in E} \int_0^{\infty} \lambda_i f^{bench}(e, a) da, \tag{37}$$

where f^{bench} is the distribution function in the benchmark economy with targeted transfers.

4.3 Results

Table 4 summarizes the results of the UBI model in comparison to the benchmark model. The benchmark model outcomes are normalized to 100. The third column presents results for the UBI model in comparison to the benchmark model. As we see, under the UBI system, aggregate capital falls by 16%. This happens because guaranteed payments create the wealth

	Benchmark	UBI
Agg. Capital	100	84
Agg. Labor	100	98.6
Hours worked	100	109.4
Agg. Output	100	93.1
Agg. Consumption	100	96.6
Interest Rate	100	113.5
Wage Rate	100	93.1
Wealth Gini	0.402	0.447
Earnings Gini	0.339	0.351
Income Gini	0.299	0.238
Consumption Gini	0.176	0.141
Transfers as % output	2.4%	33.7%
Consumption tax rate	5.6%	43.1%
Avg Effective policy tax rate	-0.3%	-2.1%
Welfare gain as CEV	-	15.7%

Table 4: Benchmark and UBI Models.

effect that reduces the prudence of households and therefore, precautionary savings[19]. As aggregate capital falls, output falls too by 6.9%. Because now everyone receives a subsistence transfer, the required transfer amount equals to 33.7% of the output. UBI system is financed by a consumption tax rate of 43.1%. Because of a raise in the tax rate and a decrease in output, aggregate consumption falls by 3.4%.

Even though consumption tax rate in the UBI system is very high, the effective consumption tax rate that is consumption tax net of transfers[20] does not increase as much. It even decreases for asset poorer and low income households who consume less and thus, pay low consumption taxes and who could not qualify for transfers in the baseline system with targeted transfers. The average effective policy/consumption tax rate[21] decreases from -0.3% to -2.1%[22]. Thus, financing such a system is not as a big challenge as it seems. The effective policy tax rate decreases for the asset poor households and increases for the asset rich. Overall, the effective consumption tax rate decreases for 42% of households. The lowest effective policy/consumption tax rate in the UBI system is -47% and highest is 24%. Effective policy tax rates in the UBI system for different level of wealth and productivity is given in Figure 1.

The UBI system causes the inequality of wealth to expand by 4.5 percentage points and the Gini index of wealth inequality becomes 0.447. The wealth distribution is shown in Figure 2. Because the least skilled and asset poor reduce their precautionary savings more as discussed in Appendix A, the inequality of wealth increases.

[19] A detailed description of the effect UBI on precautionary savings can be found in Appendix A.

[20] The effective tax rate for the benchmark system with targeted transfers and for the UBI system is defined in Equation 9 and Equation 31 respectively.

[21] The average effective tax rate is defined in Equation 23.

[22] Low effective consumption tax rate is not necessarily good. Partially, it indicates the existence of many low income households who cannot afford high levels of consumption.

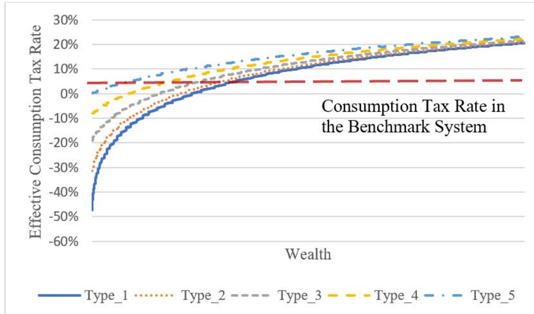


Figure 1: Effective Consumption Tax Rates in the UBI System
The effective consumption tax rate in the baseline system with targeted transfers coincides with the consumption tax rate for transfer non-recipients and equals to -100% for transfer recipients who hold no wealth. The efective consumption tax rate in the UBI system is negative for asset poor and low income households who consume less and thus received transfers are greater than the consumption taxes they pay.

The Distribution of Wealth

Percentiles	0-20%	20-40%	40-60%	60-80%	80-100%
Data (SCF 2007)	0%	0%	5%	11%	84%
Bench: shares	3.3%	9.8%	17.6%	26.8%	42.5%
UBI: shares	1.8%	8.4%	17.1%	27.3%	45.4%
Mean Values					
Bench	0.148	0.442	0.790	1.203	1.91
UBI	0.067	0.317	0.646	1.032	1.712

Table 5: The wealth quintiles in Benchmark and UBI models.
Percentages show the share of the wealth of the given quintile in total wealth. The Wealth distribution for the U.S. is taken from Benhabib et al. (2015).

Table 5 shows the distribution of wealth for different wealth quintiles. Neither benchmark nor UBI models fit the data on the top percentiles, however, this should not be a concern for my analysis. As Quadrini (2000), De Nardi (2004), Cagetti and De Nardi (2006), Benhabib et al. (2015) and others have suggested, in order to get more accurate distribution of the top tail of the wealth, we need a richer model with finite horizon, bequest motives and capital income risk. As the wealth effect created by a UBI policy is stronger for the least skilled and asset poorer households, this simple model should be sufficient to explain the mechanisms of UBI.

The mean values of assets and corresponding standard deviations for each type of productivity is given in Table 6. With UBI all agents in each productivity type save less, on average, but standard deviations slightly fall. Also, as shown in Table 6, under the UBI system less productive people reduce their asset holding more than productive people (recall that agents are ex ante heterogeneous in wealth too for each type of productivity). This is because UBI payments affect permanent income as well as absolute prudence of less productive people more.

Even though inequality of wealth increase with the UBI system, Gini indices of income

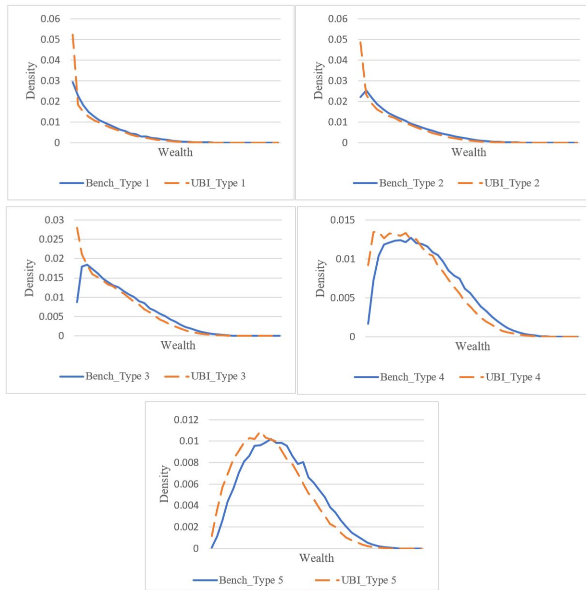


Figure 2: The Distributions of Wealth

The Distribution of Wealth

Productivity Types	Type 1	Type 2	Type 3	Type 4	Type 5
Bench: Mean	0.434	0.695	0.957	1.200	1.208
UBI: Mean	0.356	0.569	0.794	1.015	1.040
% change	-18%	-18.1%	-17%	-15.4%	-13.9%
Standard Deviations					
Bench	0.0003	0.0003	0.0004	0.0005	0.0006
UBI	0.0002	0.0003	0.0004	0.0005	0.0005

Table 6: Mean values of assets and standard deviations by productivity types for Benchmark and UBI models.

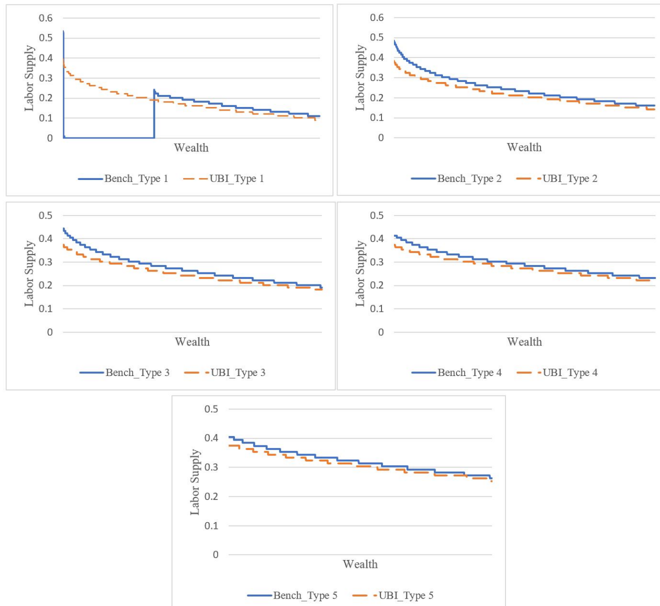


Figure 3: The Decision Rules of Labor Supply by Wealth and Productivity Type

(the sum of labor earnings, interest income, and transfers) and consumption are reduced by 6.1 and 3.5 percentage points respectively. With the UBI system, the least skilled and asset poor have an opportunity to earn above the subsistence transfers by working (while in the targeted transfers system, they could not consume above the subsistence without working extensive hours that would disqualify them from transfers). Thus, the inequality of total income falls with the UBI system. Similarly, because of higher income, the least skilled and asset poor have access to higher levels of consumption and the inequality of consumption falls too.

With the UBI system the labor force participation rate increases to 100%. The former recipients of targeted transfers start to supply labor and total hours worked increases, while more skilled labor slightly reduce hours worked because of the wealth effect. Therefore, aggregate labor is almost unaffected (reduced by 1.4%) as the empirical literature on the UBI experiments suggests[23]. As total hours worked increases mainly because of the least skilled workers, and aggregate labor is almost unaffected in the UBI model, the inequality of labor earnings expands by around 1.2 percentage points.

Labor supply decisions for agents with different levels of wealth and productivities are shown in Figure 3. As discussed in Section 3.3, in the benchmark model with targeted transfers the least skilled and the asset poorest workers (with zero wealth) work more than 50% of hours available to consume above the subsistence requirement that automatically disqualifies them from the transfer, while the least skilled workers with low positive level of wealth prefer not to work and receive the transfer from the government (15.3% of households). Thus, the benchmark model does not quite achieve its goals to support the income poor households.

[23]As discussed in Marinescu (2018), Salehi-Isfahani and Mostafavi-Dehzooei (2017), Kangas et al. (2019), labor supply does not reduce, while part-time employment increases.

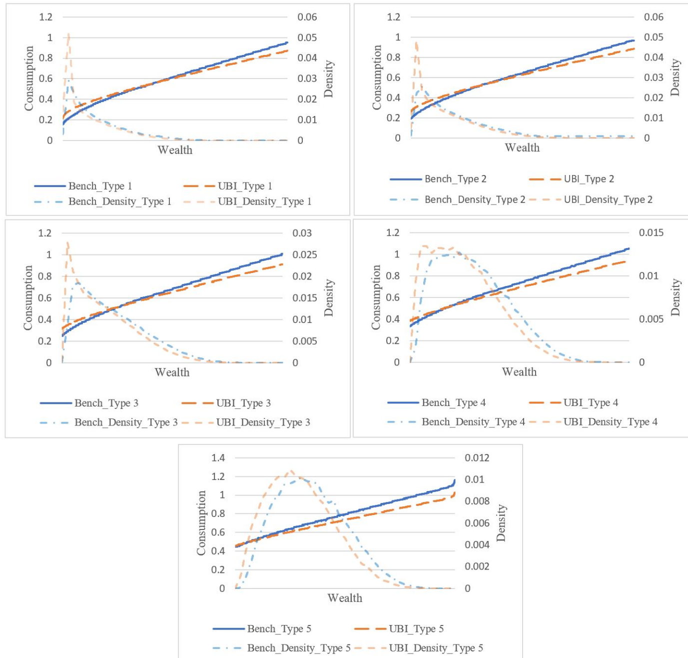


Figure 4: The Decision Rules of Consumption by Wealth and Productivity Type
Wealth density functions are given in order to illustrate the relative importance of a change in consumption.

The labor supply decision rules for the households with the productivity type 1 in Figure 3 make it clear that some small positive level of wealth creates incentives for the less productive workers not to work and receive a transfer in the benchmark model, while they would work with the UBI transfers system. While the distortions of the labor supply for the least skilled workers (Productivity Type 1) caused by targeted transfers system are noticeable in Figure 3, with the UBI model, the decision rules are smooth because the transfer is unconditional.

In the UBI system, consumption is higher for the asset poorer, while it is lower for the wealthier than in the benchmark system (Figure 4). The welfare gains as CEV on Figure 5 make it clear that the asset poor and the least productive households benefit significantly with the UBI system. While the utility of the asset high households is barely affected. Additionally, as the distribution of wealth is skewed to the right, the aggregate welfare measured a CEV increases significantly, by 15.7%.

5 Model Mechanisms

In order to understand why aggregate capital and consumption falls in the economy with a UBI, I now evaluate different models with alternative financing methods of UBI.

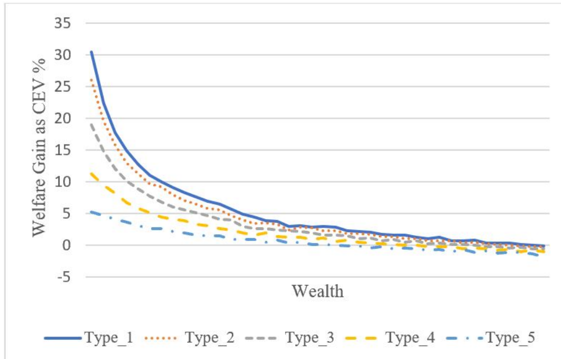


Figure 5: Welfare Gains as CEV

5.1 Alternative Financing of UBI

5.1.1 Foreign Aid Financing

First, I want to investigate if a higher consumption tax rate is the reason why people save less because with a high consumption tax, they have to spend more on the same basket of goods. To address this, I assume that the UBI system is fully financed by a foreign aid, so that there is no issue with financing.

With foreign-aid financed UBI, households and firms problems are same, only the government's budget constraint changes. For computational convenience, they do not receive the income tax from the UBI and they give no transfer. Thus, the budget constraint is the following:

$$\int_0^1 {}_{y\,t} n_t e_i + {}_k (r_t \quad) a_t + {}_c c_t \, da = G_t \tag{38}$$

As Table 7 summarizes, all macroeconomic variables change by the same direction as in the consumption tax-financed UBI model with the exception of the consumption and consumption tax rate. Because UBI is financed by foreign aid, aggregate consumption increases. Because of no targeted transfers and higher tax base, consumption tax rate is actually lower than in the benchmark system with targeted transfers. As a result, the welfare gain as CEV is 51.1%. However, even if there is no financing issue, under the UBI system, savings fall anyway by 19.3% due to the elimination of precautionary savings motive. Thus, this model shows that the availability of funds is not a main determinant of the model outcomes presented in the previous section.

5.1.2 Income-Tax Financing

In this subsection, capital income tax rate is fixed at 15% and the consumption tax rate is fixed at 5.6%, the consumption tax rate needed to balance the budget in the benchmark model. I use the labor income tax to balance the budget in the UBI model. This model is similar to

	Benchmark	Tax-Financed UBI	UBI-Foreign Aid
Agg. Capital	100	84	80.7
Agg. Labor	100	98.6	94.5
Hours worked	100	109.4	104.5
Agg. Output	100	93.1	89.3
Agg. Consumption	100	96.6	128.8
Interest Rate	100	113.5	110.7
Wage Rate	100	93.1	94.5
Wealth Gini	0.402	0.447	0.448
Earnings Gini	0.339	0.351	0.353
Income Gini	0.299	0.238	0.241
Consumption Gini	0.176	0.141	0.142
Transfers as % output	2.4%	33.7%	32.1%
Consumption tax rate	5.6%	43.1%	1.4%
Welfare gain as CEV	-	15.7%	51.1%

Table 7: Benchmark Model VS Tax-Financed and Foreign Aid Financed UBI

Negative Income Tax (NIT). An effective policy tax rate for this section is calculated as

$$\tau_{i;t} = \frac{\tau_y w_t l_{i;t} e_{i;t} - (1+\tau_c)\bar{y}_t}{w_t l_{i;t} e_{i;t}} \tag{39}$$

and the average effective policy tax rate is

$$\bar{\tau} = \sum_{e \in E} \int_0^{\infty} \tau(e;a) f(e;a) da; \tag{40}$$

where $f(e;a)$ is a density associated with the distribution function in the income-tax financed UBI system.

Results are given in Table 8. With the proportional income tax, to finance transfers in the UBI system, income tax rate doubles and reaches 51.8%. However, the average effective policy/income tax rate is -8%. As marginal income is subject to higher income tax, marginal product of labor falls and as a result, the supply of labor falls in a bigger magnitude, by 2.6% and hours worked increases in slightly lower magnitude, by 6.7%. However, aggregate capital falls in a bigger magnitude, by 26.7% because on average, the effective income tax rate is very low that creates wealth effect and relaxes precautionary savings motives. As a result, output and consumption fall too by 12.5% and 6.8% respectively. Welfare, as measured by CEV increases and equals 19%.

	Bench Cons	UBI Income	UBI Progressive	UBI low $_k$
Agg. Capital	100	73.3	82.7	89
Agg. Labor	100	97.4	97.1	98.4
Hours worked	100	106.7	94.7	90.3
Agg. Output	100	87.5	91.6	94.9
Agg. Consumption	100	93.2	92.4	97.6
Interest Rate	100	89.8	110.8	96.4
Wage Rate	100	121	94.4	106.6
Wealth Gini	0.402	0.412	0.468	0.444
Labor Income Gini	0.339	0.358	0.352	0.352
Income Gini	0.299	0.218	0.243	0.242
Consumption Gini	0.176	0.138	0.143	0.142
Capital Income tax rate	15%	15%	15%	5%
Labor Income tax rate	25%	51.8%	25%	25%
Consumption tax rate	5.6%	5.6%	34.5%	45.7%
Avg Effective Policy tax rate	-0.3%	-8%	-10%	0.1%
Welfare as CEV	-	19%	7.5%	15.9%

Table 8: Benchmark Model VS UBI Model Financed with Various Tax Policies
In the second column we see the benchmark model with targeted transfers. In the third column, the consumption tax rate is fixed at the benchmark rate, while an income tax rate is calibrated to balance UBI payments. In the fourth column, a progressive income tax scheme is introduced, while in the last column, lower, 5% tax rate applies to capital income.

5.1.3 Progressive Income Tax

The U.S income tax system is progressive, thus we might need to test how UBI will work with a progressive income tax system. Here, again I use consumption tax rate to balance the budget. The progressive income tax brackets in this model imitate and simplify the U.S progressive tax brackets[24]. Progressive tax is determined as:

$$\tau_y = \begin{cases} 0 & if \quad w_t l_{i;t} e_{i;t} + (r_t - \delta) a_{i;t} \leq \frac{\bar{y}_t (1+\tau_c)}{(1-\tau_y)} \\ 0.15 & if \quad \frac{\bar{y}_t (1+\tau_c)}{(1-\tau_y)} < w_t l_{i;t} e_{i;t} + (r_t - \delta) a_{i;t} \leq C_t \\ 0.25 & if \quad C_t < w_t l_{i;t} e_{i;t} + (r_t - \delta) a_{i;t} \leq 4C_t \\ 0.35 & if \quad w_t l_{i;t} e_{i;t} + (r_t - \delta) a_{i;t} > 4C_t \end{cases} \tag{41}$$

where C_t is average consumption.

Column 4 of Table 8 presents results that compares to the benchmark model with progressive taxation. Now, with a progressive taxation, a lower consumption tax rate, 34.5%, is required to finance the UBI system. The aggregate level of capital drops by 17.3% while the aggregate supply of labor is decreases by 2.9%. In the benchmark model with progressive taxation no one qualifies for targeted transfers. As income tax rate for low income is 0, households have stronger incentive to work and thus, do not qualify for transfers in the benchmark model. Therefore, when UBI system is introduced, the wealth effect of UBI applies to the least skilled workers too and thus, total hours worked decreases by 5.3%. For the same reason, the inequality of labor income increases by a smaller magnitude, by 1.2 percentage points. However, the inequality of wealth rises by a bigger magnitude of 7.6 percentage points with the progressive taxation (compared to a benchmark model with progressive tax). As with the progressive tax, the income and consumption inequalities are lower in the benchmark model, they reduce by smaller magnitudes, by 3.6 and 2.1 percentage points, in the UBI system with progressive tax. The welfare gain, measured as CEV is positive and equals 7.5%.

5.1.4 Low Capital Income Tax

As one of the main flaws of the UBI system is a reduction of precautionary savings, governments should encourage savings by other means when implementing such programs. One potential tool for this could be reducing capital income tax. For this section, I assume lower, 5% capital income tax rate (τ_k) in the UBI system, while labor income tax rate is maintained at 25%.

The results of such financing are in the last column of Table 8. Now, aggregate capital does not fall as much. In contrast with the benchmark model with 15% capital income tax, aggregate capital falls by only 11%. Therefore, a reduction in the aggregate output is smaller too, 5.1%, and the wealth Gini increases by 4.4 percentage points, by almost the same magnitude as in the UBI model with 15% capital income tax. Consumption inequality is still reduced effectively

[24] https://www.investopedia.com/terms/t/taxbracket.asp

by 3.4%, and welfare increases by 15.9% as CEV. However, as capital income tax rate is lower, consumption tax rate has to be higher and equals 45.7%.

5.2 Alternative Transfer Schemes

5.2.1 Variations in Transfers in the UBI Model

Now, I want to discuss the impact of different universal transfer amounts on macroeconomic outcomes. What if we give people smaller universal transfer so that less funding is needed to finance the UBI system and also, people have a stronger need for precautionary savings? On the other hand, one might argue that, in order to reduce poverty, when income is less than subsistence, we should give people transfer above the subsistence so that they have a chance to save for inter-temporal motive and accumulate wealth. One might also want to discuss the model with no transfer and see how a UBI system performs in comparison.

Thus, here, again, the budget constraint of households is:

$$(1-\tau_y)w_t l_{i,t} e_{i,t} + (1+r_t-\delta)a_{i,t} - \tau_k(r-\delta)a_{i,t} + s\bar{y}_t(1+\tau_c) = (1+\tau_c)c_{i,t} + a_{i,t+1} \quad (42)$$

where

$$c_{i,t} \geq \bar{y}_t, \quad (43)$$

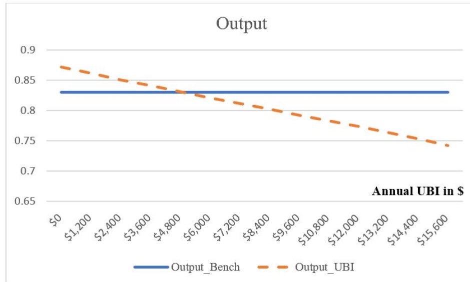
and

$$a_{i,t} \geq 0 \quad (44)$$

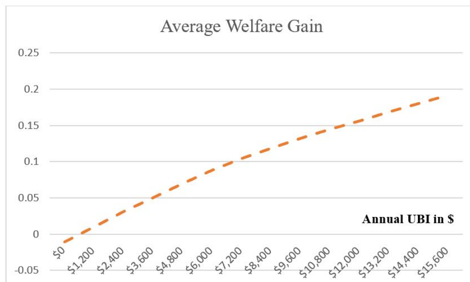
and s varies with the policy.

Because UBI payments change lifetime earnings and, as a response, households reduce precautionary savings, savings decrease in s. However, because we compare our analysis to the benchmark model with means-tested transfer of subsistence, an interesting special case to consider is when s<1, that is when UBI payments do not guarantee subsistence. For s<1, in the worst realization of the productivity shock, households with low levels of wealth will need to work harder to survive because there are no targeted transfers. This increases their absolute prudence that induces precautionary savings as well as labor supply to rise for the least skilled and asset poor.

I vary s from 0 to 1.3 with an increments of 0.1. Output is decreasing in s (Figure 6, Panel (a)). However, for low s, (from 0 to 0.3) output is higher than in the benchmark model because of higher precautionary savings and $s = 0.4$ would constitute to the same level of output as in the benchmark model. For s=0.4 (or about UBI of $4,800 per adult per year), the change in welfare gain measured as CEV is 7%. The change in welfare for different annual UBI payments is given in Figure 6: Panel (b). With the UBI system the welfare is always



(a)



(b)

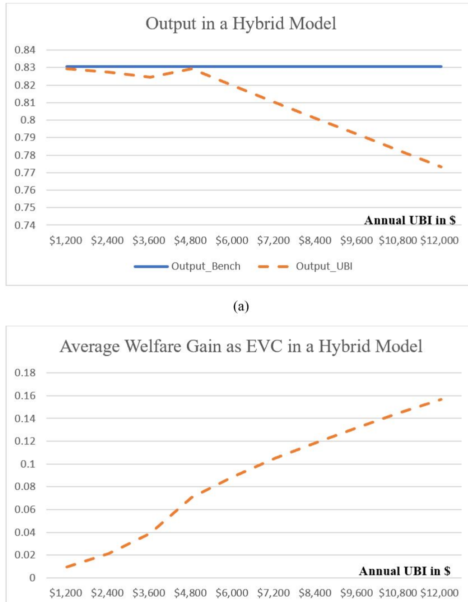
Figure 6: Output and Welfare with Different Annual UBI Transfers

higher than in the benchmark system, however, it increases faster with s for $s < 0.60$, or 60% of the subsistence requirement (or about UBI of $7,200 per adult per year). $s > 1$ does not encourage savings and the output continues to fall[25]. The inequality of consumption is lower than in the benchmark model for any s and it decreases with s (for the range of s=0, ..., 1.3).

5.2.2 Combination of a Targeted Transfers and UBI Schemes

As both benchmark and UBI transfers systems have advantages and disadvantages, a combination of the two transfers schemes might be beneficial. UBI is effective at reducing the inequality of consumption, however, requires significant increases in tax rates and reduces the precautionary savings motives. As discussed in section 5.2.1, partial UBI is more effective than full UBI because it creates smaller wealth effect and is cheaper. While more generous targeted transfers system would provide a significant gain in welfare, it does not reduce the inequality of consumption and is demanding for output. Thus, I want to discuss a hybrid model where every household will receive a partial UBI payment from the government, and eligible households will receive targeted transfers in addition to UBI. More precisely, in the mixed model, transfers are defined as

[25] Allowing entrepreneurship in the model might change this result



(b)

Figure 7: Output and Welfare in Hybrid Models with Different Annual UBI Transfers

$$tr_{i;t} = \begin{cases} (1-h)\frac{\bar{y}_t(1+\tau_c)}{(1-\tau_y)} - (w_t l_{i;t} e_{i;t} + (r_t - \delta) a_{i;t}) & if \; w_t l_{i;t} e_{i;t} + (r_t - \delta) a_{i;t} \leq (1-h)\frac{\bar{y}_t(1+\tau_c)}{(1-\tau_y)} \\ h\frac{\bar{y}_t(1+\tau_c)}{(1-\tau_y)} & otherwise \end{cases} \tag{45}$$

Figure 7 shows output (Panel (a)) and a change in welfare measured as CEV (Panel (b)) for the hybrid model with different UBI payments. Hybrid model shows an interesting pattern of output for different h. For low h, or when UBI is below 30% of subsistence requirement, output falls in contrast with the benchmark model and welfare gain is small. This is the range where UBI is too low to change the behavior of the least skilled poor. Thus, they do not work and still qualify for the targeted transfers too. However, at 40% of UBI, the need for targeted transfers is eliminated and every household earns above the eligibility threshold ((1-h) share of subsistence requirement). Thus, the supply of labor increases and for h=0.4 output is at the benchmark level. However, for UBI higher than 40%, output gradually decreases because higher transfers reduce precautionary savings and the effect of a fall of capital outweighs the effect of an increase of labor supply.

If the hybrid model is implemented by reducing capital income tax rate to 5%, output is at the benchmark model level for h=0.5. I provide outcomes for partial UBI and Hybrid models with unconditional transfers equal to 50% of subsistence requirement in Table 9. I call the first one a 50% partial-UBI model, and the other - 50% Hybrid model. For both, 50% partial-UBI and 50% Hybrid models, a fall in aggregate capital, and therefore output is smaller because precautionary savings do not drop as much. Required consumption tax rate

	Bench	UBI 100%	Partial UBI 50%	Hybrid 50%, $_k = 15\%$	Hybrid 50%, $_k = 5\%$
Agg. Capital	100	84	94.7	94.5	99.7
Agg. Labor	100	98.6	101.2	101.1	101
Hours worked	100	109.4	113.6	113.6	113.2
Agg. Output	100	93.1	98.9	98.7	100.5
Agg. Consumption	100	96.6	100.2	100.2	100.7
Interest Rate	100	113.5	104.3	104.4	100.9
Wage Rate	100	93.1	97.6	97.6	99.5
Wealth Gini	0.402	0.447	0.413	0.412	0.409
Labor Income Gini	0.339	0.351	0.345	0.345	0.346
Income Gini	0.299	0.238	0.265	0.266	0.265
Consumption Gini	0.176	0.141	0.159	0.159	0.159
Consumption tax rate	5.6%	43.1%	18.8%	18.8%	21.9%
Avg Effective Policy tax rate	-0.3%	-2.1%	0.2%	0.2%	2.8%
Welfare as CEV	-	15.7%	8.8%	8.9%	7.9%

Table 9: Different Transfers Schemes

to finance such systems is also within a reasonable range 18-22% and welfare gain as CEV is significant, between 8-9%. The 50% Hybrid model with 5% capital income tax rate works best because aggregate capital, output, and consumption as well as the wealth gini index are almost unaffected, while welfare gain is significant, 7.9% as CEV. Consumption inequality decreases and the aggregate welfare as well as the welfare of the least skilled and asset poor as CEV improve. The average effective policy/consumption tax rate is 2.8%, and the highest effective consumption tax rate is 14%. Effective consumption tax rates for different levels of wealth and productivity is in Figure 8.

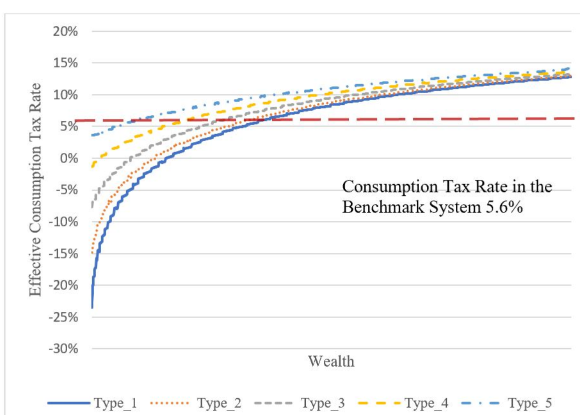


Figure 8: Effective Tax Rates by Wealth and Productivity Type in the Hybrid System with 50%-UBI.

6 Robustness

6.1 Natural Borrowing Limit

It is interesting to check how a UBI system would work with complete markets. As Aiyagari (1994) discusses, when borrowing is allowed, people save less for precautionary reasons because borrowing allows them to smooth consumption when bad shocks occur. As in Aiyagari (1994), I will now assume that the borrowing limit is at the natural level so that households are guaranteed to consume at the minimum consumption requirement given the worst realization of the future productivity shocks (no default allowed).

$$a_{i;t} \qquad \frac{(1 \quad _y)w_t e_{1;t} \quad (1 + \; _c) y_t}{(r \qquad)} \tag{46}$$

As there are no entrepreneurs in this model, the debt is mainly held by the least skilled and asset poorest workers. Borrowers have to earn enough to repay their debt, interest and consume at the subsistence. Thus, they cannot rely on the government transfer because it does not cover all their needs: the maximum transfer amount is equal to the subsistence requirement and does not cover interest payments. Thus, households with high debt levels will need to give up on transfers and work to cover all their needs.

To show this, let us denote debt by $d_{i;t}$. Then, if a debt holder qualifies for the transfer, the budget constraint is:

$$(1 + r_t \qquad)d_{i;t} + y(1 + \; _c) \quad (1 \quad _y)w_t l_{i;t} e_{i;t} + (1 \quad _y) \; y\frac{(1 + \; _c)}{(1 \quad _y)} \quad w_t l_{i;t} e_{i;t} \; + d_{i;t+1} \tag{47}$$

This is same as:

$$(1 + r_t \qquad)d_{i;t} \quad d_{i;t+1} \tag{48}$$

Thus, if debt holders qualify for transfers, the only way to repay the debt and interest is to take a new, higher level of debt. This violates the No Ponzi game condition.Thus, these households need to work to earn enough to repay debt and consume at the minimum consumption requirement. And, by earning above subsistence, households do not qualify for transfers. Thus, the natural borrowing limit for transfer recipients equals zero in the baseline system.

As transfer recipients are the least skilled and asset poorest households, relaxing borrowing constraints do not change results in the baseline system as there is no borrowing in the stationary equilibrium for the given utility function[26].

[26] For other types of utility functions, such as Cobb-Douglas type utility function, there is borrowing in the baseline system. Borrowers are the least productive and asset poorest workers who do not receive transfers and work almost all their time to repay their debts.

	Bench No borr.	UBI No Borr.	UBI Borr
Agg. Capital	100	84	77.4
Agg. Labor	100	98.6	99.1
Agg. Output	100	93.1	94.1
Agg. Consumption	100	96.6	95.8
Wealth Gini	0.402	0.447	0.599
Consumption Gini	0.176	0.141	0.152
Welfare gain as CEV	-	15.7%	18.3%

Table 10: Benchmark and UBI Models with and without Borrowing.

In the UBI system, as guaranteed income increases in every period, minimum income increases too and thus, borrowing limit increases. Thus, UBI cancels the minimum consumption requirement in Equation (46) and the borrowing limit becomes[27]

$$a_{i;t} \qquad \frac{(1 \quad _{y}) w_t e_{1;t}}{(r \quad)} \tag{49}$$

The results of a UBI model with borrowing in contrast to a benchmark model are in the last two columns of Table 10. With or without borrowing, the direction of the changes are, mainly, similar. However, because borrowing is allowed, capital drops more with the UBI system than it does with incomplete markets. In the UBI system aggregate capital falls with or without borrowing because of less precautionary needs; however, with no borrowing, aggregate capital falls by around 16%, while with natural borrowing limit it drops by 22.6%. These results are in line with the discussion by Aiyagari (1994): with no borrowing agents will need more precautionary savings and thus, under a UBI system they reduce savings by a lower magnitude than with natural borrowing limit. The inequality of wealth is much higher too in the UBI model with borrowing. The UBI model with borrowing predicts the wealth Gini coefficient to increase by almost 20 percentage points. Even though aggregate capital falls in a bigger magnitude With borrowing allowed, the UBI model predicts 18.3% gain in welfare.

6.2 Changes in Minimum Consumption Requirement

6.2.1 Minimum Consumption Requirement in Benchmark Model

Researchers often ignore the minimum consumption requirement. When the interest is to analyze the high-end wealth, then, the role of minimum consumption requirement might be negligible because it is not a constraint for the asset rich. However, when we analyze public policies with transfers, and our target is to analyze the welfare and the poverty, positive minimum consumption requirement is crucial because it affects decision-making of the least productive and asset poor. To see that it is really the case, I now analyze the models with

[27] The results with the borrowing limit as in Equation (46) predicts similar results for our utility function

Minimum consumption	0% of C_t	28% of C_t	40% of C_t
Agg. Capital	73.6	100	105.3
Agg. Labor	91.7	100	104.2
Agg. Output	84.7	100	104.6
Agg. Consumption	88.8	100	104.4
Interest Rate	115.1	100	99.3
Wage Rate	115.1	100	100.4
Wealth Gini	0.499	0.402	0.393
Earnings Gini	0.353	0.339	0.351
Income Gini	0.319	0.299	0.295
Consumption Gini	0.198	0.176	0.163
Welfare gain as CEV	51.4%	-	-14.9%

Table 11: Benchmark Models with and without Minimum Consumption Requirement.

zero minimum consumption requirement. For robustness, I also consider the economy with higher minimum consumption requirement. In the model with no minimum consumption requirement, eligibility threshold for targeted transfers is again 28% of average consumption adjusted with taxes. In the model with higher consumption requirement, minimum consumption equals 40% of the average consumption and eligibility threshold to qualify for transfers equals subsistence requirement (40% of average consumption adjusted with tax rates). Thus, first,

$$c_{i,t} \geq 0 \tag{50}$$

and then,

$$c_{i,t} \geq 0.4 \sum_{e \in E} \int_0^\infty (c_{i,t}) f(e,a) da \tag{51}$$

The outcomes of the benchmark model with higher and zero subsistence requirement is given in Table 11. Because there is no minimum consumption requirement for survival, there is less need for precautionary savings and thus, in the model with zero minimum consumption requirement aggregate capital as well as aggregate labor are much smaller than in the models with this requirement. Welfare is much higher with zero minimum consumption model because any positive level of consumption contributes to the utility significantly. Thus, aggregate capital, labor, and output are higher, and welfare is lower in the models with higher minimum consumption requirement.

It is important to note that analyzing the model with zero minimum consumption requirement would lead to almost 10 percentage points higher wealth inequality and we might misinterpret it as a success of the model in explaining the inequality. This happens because precautionary savings motives are much lower with zero minimum consumption requirement

Min Consumption	Bench 28%	UBI 28%	Bench 40%	UBI 40%	Bench 0	UBI 0
Agg. Capital	100	84	100	81.5	100	91.6
Agg. Labor	100	98.6	100	96.8	100	96.8
Agg. Output	100	93.1	100	91	100	95.4
Wealth Gini	0.402	0.447	0.393	0.446	0.499	0.50
Consumption Gini	0.176	0.141	0.163	0.117	0.198	0.155
Welfare gain as CEV	-	15.7%	-	15.1%	-	17%

Table 12: Benchmark and UBI Models with Different Minimum Consumption Requirements.

and it is more likely that the asset poor stay poor in the model. However, as in real life people do have positive minimum consumption requirement, the models with zero minimum consumption requirement intrinsically generate higher wealth Gini coefficient that should not be attributed to the success of the model.

6.2.2 UBI and Minimum Consumption Requirement

Now, I want to check how UBI would perform in economies with higher or with no minimum consumption requirement. Results are in Table 12. For comparison, the outcomes of the benchmark models of high and zero minimum consumption requirements are normalized to 100s. The results, again, emphasize the importance of minimum consumption requirement in heterogeneous agents macroeconomic models. By not including minimum consumption requirement, the UBI model (with no borrowing) predicts only 8.4% drop in aggregate capital, only by 0.001 percentage point increase in the inequality of wealth, and higher, 17% gain in welfare as CEV. As precautionary saving motives are weaker with zero minimum consumption requirement in the benchmark system, a fall in precautionary savings is lower too in the UBI system. Alternatively, with higher, 40% minimum consumption requirement, aggregate capital falls more (by 18.5%) and the inequality of wealth increases more, by 6.3 percentage points; the welfare gain is about the same (15.1%).

6.3 GHH Preferences

As one of the main concerns for a UBI program is its wealth effect on the supply of labor, it is interesting to find out how a UBI would work for a utility function where labor supply decisions depends only on wages and not on the level of wealth. For this I use GHH preferences (Greenwood et al. (1988)) that takes the following form:

$$u(c_{i;t} \quad y_t; l_{i;t}) = \frac{(c_{i;t} \quad \frac{}{1+} l_{i;t}^{1+} \;)^{1}}{1} : \qquad (52)$$

= 5 as in Heer and Maussner (2008) and is calibrated so that a stationary fraction of working hours equals 0.33 as people usually work $\frac{1}{3}$ of their time.

Results are in the second and third columns of Table 13. With no wealth effect of labor, in overall, households slightly reduce their work because wage rate falls by 9.7%. However, the supply of unskilled labor increases significantly because households that used to receive targeted transfers start to work. Total hours worked increases in a bigger magnitude than with the benchmark utility function in Equation 16 and therefore, aggregate labor increases too. Because of a rise in low skilled labor, the earnings inequality increases significantly, by 5.6 percentage points.

On the other hand, the aggregate capital drops in a bigger magnitude (by 23.6%) than with the utility function that exhibits the wealth effect. This happens because households in the benchmark system with no wealth effect of labor supply do not increase work if bad shock occurs (because labor supply depends only on the wage rate), and thus, need higher precautionary savings. Therefore, the impact of a UBI system on precautionary savings is stronger. While an option to supply more labor in bad times reduces prudence in the benchmark model with wealth effect of labor supply. Therefore, a change in prudence is smaller with the UBI system in such economy.

Another main difference is that the inequality of wealth increases in a smaller magnitude, by 2.3 percentage points, while income inequality and consumption inequalities decrease in a bigger magnitudes, by 11.2 and 6.3 percentage points respectively. Welfare as CEV increases in a bigger magnitude by 25.6%.

6.4 Small Open Economy

Now, I evaluate the impact of a UBI program for a small open economy so that the interest rate is exogenous. I fix the interest rate at 7%. Results are in 4^{th} and 5^{th} column of Table 13. Though preferences are again the same as in Equation 16 and exhibit wealth effect, aggregate labor supply increases by 4.8%. However, aggregate capital falls in a bigger magnitude, by 43.2%, because interest rates do not adjust when precautionary savings fall[28]. As in a small open economy capital and output fall drastically, aggregate welfare falls by 7.5%.

7 Conclusions

The impact of a permanent Universal Basic Income program is more complicated than expected: while the concerns regarding UBI is not limited to funding of such a program, it is not unrealistic. With a proper administration, a UBI system can provide a huge gain in welfare without compromising output.

I discussed the UBI system where every individual receives a transfer of subsistence and targeted transfers system is eliminated. In such a system aggregate capital and output fall, and the inequality of wealth and labor earnings increases regardless of the financing method

[28] In a closed economy or a big open economy, when precautionary savings fall, interest rates increase and attract inter-temporal savings. Thus, aggregate capital falls in a lower magnitude when interest rates can adjust.

	Bench GHH	UBI GHH	Bench SOE	UBI SOE
Agg. Capital	100	76.4	100	56.8
Agg. Labor	100	101.3	100	104.8
Hours worked	100	124.8	100	116.7
Agg. Output	100	91.5	100	84.1
Agg. Consumption	100	96	100	76
Interest Rate	100	119.8	100	100
Wage Rate	100	90.3	100	80.2
Wealth Gini	0.39	0.413	0.394	0.461
Labor Income Gini	0.32	0.376	0.343	0.346
Income Gini	0.363	0.251	0.295	0.22
Consumption Gini	0.235	0.172	0.175	0.128
Consumption tax rate	7.1%	41.6%	2.3%	45.5%
Avg Effective Policy tax rate	-5.7%	-5%	-1.1%	-1.1%
Welfare as CEV	-	25.6%	-	-7.5%

Table 13: Benchmark Model VS UBI Model
Column 3 and 4 present results for a benchmark and UBI models with GHH preferences. While Columns 4 and 5 present results of benchmark and UBI models for small open economy (SOE). Aggregate variables are normalizes to 100s in benchmark models.

of the program: even if it is financed entirely through the foreign aid. However, a UBI system reduces inequalities of total income and consumption. The aggregate welfare, measured as consumption equivalent variation increases by 15.7% in the UBI system. A welfare gain is larger for the less productive and asset poorer people. To finance the UBI system, government needs resources and requires significant increases in the tax rates. As a result, aggregate consumption falls by 3.4%.

With the UBI system the level of aggregate capital falls because guaranteed payments reduce precautionary savings motive. Because precautionary savings are more relevant for the least productive and asset poor, the savings of the asset poor decrease more and thus, the inequality of wealth increases. I also showed that the minimum consumption requirement plays a crucial role in determining aggregate capital, welfare and the inequality of wealth because it determines precautionary savings.

On the other hand, while the targeted transfers system demotivates the transfer recipients (who are, usually, the least skilled workers) to work because they will lose transfers, the UBI system increases employment of such low skilled workers and total hours worked increases. However, aggregate labor supply is almost unaffected because, more skilled households slightly reduce their labor supply. This finding is also confirmed by the data (Marinescu 2018, Salehi-Isfahani and Mostafavi-Dehzooei 2017, Kangas et al. 2019).

Although consumption tax rate is the least distortionary to output to finance a UBI system, it would require consumption tax rate to be equal to about 43% with proportional taxation and 34.5% with progressive taxation. However, the effective consumption tax rate, which calculates consumption tax net of transfers, decreases on average from -0.3% to -2%. Thus, the pressure of a UBI system on the economy is much weaker than expected. However, as high consumption tax rate is still a concern, I discuss a hybrid system where every resident receives partial UBI ($500 monthly) and qualified, income-poor households receive targeted transfers. The eligibility threshold of targeted transfers is reduced by $500 monthly and capital income tax rate is reduced to 5% in order to encourage savings. Such hybrid system does not require any compromise of aggregate capital or output, requires only a 22% consumption tax rate (the highest effective consumption tax rate equals 14%), and increases aggregate welfare by 7.9% as CEV. More interestingly, such a system does not reduce the welfare of the asset rich and eliminates targeted transfers as every household earns above the threshold.

This paper is pioneering in the analysis of the UBI system in a macroeconomic model framework. My analysis shows that regardless of the scepticism, a UBI system is feasible, and with a proper administration it increases welfare without affecting output and welfare of the asset rich. Because of its potential, this topic requires more research. The benefits and costs, as well as incentives associated with the UBI system should be explored more for different types of risks (unemployment or aggregate shocks) and different groups of people (Families with children, single mothers, people with disabilities, people with health issues, retirees) in different scenarios (for developing economies, or economies with big informal sector, or with high immigration).

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Appendix A: UBI as a Shock to Permanent Income and Prudence

In the UBI system, people receive a guaranteed payment from the government in each year that changes the minimum value of the lifetime income for any given shock. Thus, for the fixed income tax rate, UBI increases the present value of lifetime income, that households want to smooth across time. Because UBI payments increase permanent income, the expected marginal utility of consumption decreases, and thus, agents tend to consume more for any given consumption tax rate. When households are impatient and $(1 + r) < 1$, they would like to borrow against future income, thus, the UBI system reduces savings.

In addition to inter-temporal substitution and smoothing motives, the level of saving is determined by precautionary reasons too and is associated with the coefficient of absolute prudence. For the CRRA class of utility functions, the value of absolute prudence, which is associated with the convexity of marginal utility function, determines the level of precautionary savings and is decreasing in permanent income. Households are said to be prudent if the third derivative of the utility function is positive, which means that the marginal utility function is convex. Prudent households reduce consumption and increase savings for self-insurance reasons when uncertainty increases (Leland (1968), Kimball (1989)). Because, a UBI system (with $\tau_y = 0$) rises the expected value of permanent income, households will reduce savings for self-insurance motives for the same level of uncertainty or variance of future earnings. Thus, with a UBI system, in addition to smoothing motive and impatience to consume, savings fall for precautionary reasons too.

To see this intuition, for simplicity, let's assume that $l = 1$, households live for two periods and labor income and capital income tax rates are zero ($\tau_y = 0$ and $\tau_k = 0$), consumption tax rate is τ_c, and depreciation rate, $\delta = 0$. By differentiating the value function to find optimal consumption, we will get the following Euler equation

$$u_1(c_{i,t}) = \beta(1 + r)Ev_1\left(c_{i,t+1}\right), \tag{53}$$

where with no UBI payments

$$c_{i,t+1} = \frac{(1 + r)\left(a_{i,t} + w_t e_{i,t} - (1 + \tau_c)c_{i,t}\right) + w_{t+1}e_{i,t+1}}{1 + \tau_c} \tag{54}$$

and u is the first period utility function, while v is the second period utility function, u_1 is the first derivative of the utility function with respect to consumption in period t, and v_1 is the first derivative of v with respect to c_{t+1}. Ev_1 is an expected marginal utility in period t+1.

As Leland (1968) shows, if we apply Taylor's expansion, the above Euler condition with uncertain income can be approximated by

$$u_1(c_{i,t}) \approx \beta(1 + r)\left(v_1(Ec_{i,t+1}) + \frac{1}{2}v_3\sigma^2_{c_{i,t+1}}\right), \tag{55}$$

,

where Ec_{t+1} is expected value of consumption (when labor income is known to be equal to its expected value with no uncertainty) and v_3 is the third derivative of v with respect to Ec_{t+1} and $\sigma^2_{c_{t+1}}$ is the variance of consumption in t+1. Thus, for a given level of uncertainty, the impact of a change in income or initial level of wealth depends on three terms: $\beta(1 + r)$, v_1, and v_3.

v_3 determines the prudence of households and their precautionary savings for self-insurance when future income stream is uncertain. When $v_3 > 0$ (that is true with our CRRA utility function), people are prudent and save more as a response to a rise in risk.

For now, let us assume that there is no change in τ_c. With the UBI system, lifetime income increases by $\bar{y}_t + \frac{\bar{y}_{t+1}}{1+r}$, and for any given level of c_t, c_{t+1} becomes

$$c_{i,t+1} = \frac{(1 + r)\left(a_{i,t} + w_t e_{i,t} + \bar{y}_t - (1 + \tau_c)c_{i,t}\right) + \bar{y}_{t+1} + w_{t+1}e_{i,t+1}}{1 + \tau_c}. \tag{56}$$

When c_{t+1} increases, both v_1 and v_3 decrease and in order to balance the Euler equation, consumption in period t should increase. Thus, it is clear that consumption will rise as a response to a change in permanent income (when tax rates are fixed), but we need to evaluate the impact of a UBI system on savings that is to see whether the first derivative of consumption with respect to UBI payments is greater or less than 1.

To show this, let's take a total differential of the Euler equation above with respect to future (y_{t+1}) and current (y_t) UBI payments.

$$u_2(c_t)\frac{dc_t}{dy_{t+1}} = (1+r) \frac{1}{1+ \ _c} (1+r)\frac{dc_t}{dy_{t+1}} v_2(Ec_{t+1}) + \frac{1}{2}v_4 \ {}^2_{c_{t+1}} ; \tag{57}$$

where u_2 is the second derivatives of u with respect to c_t, and v_2 and v_4 are the second and the fourth derivatives of v with respect to Ec_{t+1} (or the first derivative of prudence v_3).

Denote:

$$= \frac{u_2(c_t)}{(1+r) \ v_2(Ec_{t+1}) + \frac{1}{2}v_4 \ {}^2_{c_{t+1}}} \tag{58}$$

.

As, u_2, v_2, and v_4 are negative, > 0.

The response of consumption to a change in next period's UBI is

$$\frac{dc_t}{dy_{t+1}} = \frac{1}{(1+ \ _c)(\ + 1 + r)} > 0; \tag{59}$$

and thus, people want to borrow or dis-save against future income. On the other hand, the response of consumption to current UBI payment is

$$\frac{dc_t}{dy_t} = \frac{1+r}{(1+ \ _c)(\ + 1 + r)}; \tag{60}$$

and total response of consumption to current and future UBI payments is

$$\frac{dc_t}{dUBI} = \frac{dc_t}{dy_t} + \frac{dc_t}{dy_{t+1}} = \frac{2+r}{(1+ \ _c)(\ + 1 + r)} \tag{61}$$

The impact of the UBI payments on the savings depends on . If $< \frac{1 \ \ _c(1+r)}{1+ \ _c}$, the savings will fall, otherwise, savings will rise. If I calibrate this model with $_c = 0.056$ taken from the benchmark model, r=0.0425, and $\frac{1 \ \ _c(1+r)}{1+ \ _c} = 0.892$.

If prudence were zero

$$^{NoPrudence} = \frac{u_2(c_t)}{(1+r)v_2(Ec_{t+1})} > \tag{62}$$

.

because v_4 is no longer in the denominator. Thus, as $^{NoPrudence} <$, with prudent households savings are more likely to fall in the UBI system. Prudence (v_3) as well as change in prudence with wealth (v_4) are largest for the least productive and asset poorest individuals and thus, is lowest for the households in the lower tail of the wealth distribution. Also, is lower when the variance of consumption is higher.