Universal Basic Income: Inspecting the Mechanisms*

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Abstract

We examine the mechanisms driving the aggregate and distributional impacts of Universal Basic Income (UBI) through model analysis of various UBI programs and financing schemes. The main adverse effect is the distortionary tax increase to fund UBI, reducing labor force participation. Secondary channels are a decline in demand for self-insurance, depressing aggregate capital, and a positive income effect that further deters labor force participation. Due to these channels, introducing UBI alongside existing social programs reduces output and average welfare. Partially substituting existing programs with UBI mitigates the adverse effects, increases average welfare, but does not deliver a Pareto improvement.

Keywords: Universal Basic Income, Labor Force Participation, Inequality.

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1. Introduction

Discussions about universal basic income (UBI) have become prevalent in recent years within policy circles and across popular media outlets. While UBI provides support to low income individuals, it is also costly and hence requires potentially dramatic changes in taxation.[1]

To date, no UBI program has ever been implemented on the aggregate level with a long-term commitment. This lack highlights the need for a quantitative macroeconomic analysis. Yet, the literature evaluating UBI's macroeconomic impact is still at its early stages. Our paper presents a comprehensive modeling framework designed to analyze a broad spectrum of UBI programs and financing schemes. This approach not only fills a critical void in the current literature but also brings to light the key mechanisms that shape UBI's impact on the economy, an area that has remained underexplored.

To begin, in section 2 we develop a quantitative, production-based general equilibrium model. It is characterized by incomplete markets, individual productivity shocks, and endogenous unemployment and labor force participation. In the model, individuals, as is common in the incomplete markets literature (in the spirit of Aiyagari (1994)), are subject to a borrowing constraint, and they self insure by accumulating capital. Moreover, they make optimal decisions about whether to participate in the labor market and, conditional upon doing so, face a labor-matching friction as in Diamond (1982), Mortensen (1982) and Pissarides (1985) (DMP hereafter). On the government side, we model in detail existing public insurance programs funded by labor and capital distortionary taxation. Our model nests different scenarios, ranging from UBI implementation on top of current social assistance programs to implementation partially or fully replacing existing social assistance payments. In our analysis, total transfers to those outside the labor force can only increase.

We discuss the calibration of this model in section 3. Importantly, our calibration targets micro moments crucial to disciplining the realistic elasticities of labor force participation. Furthermore, our rich setting for idiosyncratic uncertainty, including productivity and unemployment shocks generates a realistic wealth distribution; this is important for capturing UBI insurance benefits in an empirically relevant way. Finally, we also show that the calibrated model matches the empirical evidence regarding the impact of UBI in a partial equilibrium experiment as in the Alaska setting discussed in Jones and Marinescu (2022).

In Section 4 we employ our framework as a "laboratory" to evaluate two alternatives for the introduction of UBI, both have some traction in the policy debate: First, the introduction of UBI in the economy while holding constant existing social assistance programs; and second, assuming that UBI is a relevant substitute to some social assistance transfers but not others, we consider a *partial* replacements of such transfers with

[1] Hoynes and Rothstein (2019) provide an excellent review of the subject.

UBI.[2] The first alternative allows us to identify the mechanisms at play. We show that in this case, the introduction of UBI leads to a large decline in various macroeconomic variables such as output, aggregate capital, and labor force participation.

What are the mechanisms via which UBI depresses economic activity? We identify three main channels. First, financing UBI by increasing distortionary taxation induces a substitution effect, pushing workers out of the labor force. Due to the capital-labor production complementary in our model, aggregate capital falls as well. We show that the distortionary taxation channel accounts for about two-thirds of the overall decline in output due to UBI. The remaining impact is due to an "insurance" channel and an "income effect" channel. The former, which plays a more important role, refers to how UBI provides additional public insurance, reducing demand for self insurance through savings and leading to a fall in aggregate capital. The latter channel refers to the way UBI induces a positive income effect, inducing workers to leave the labor force. Finally, we note that although UBI programs can reduce inequality and increase consumption for various segments of the population, we find that they have a negative effect on welfare.

Given the channels via which UBI operates, we show that partially substituting social assistance directed at those outside the labor force with UBI mitigates the negative effect on labor force participation. This is due to two channels. First, the direct effect of replacing programs that condition on *not* participating in the labor force with UBI, which is unconditional, incentivizes labor force participation. Second, given the partial substitution of existing programs in favor of UBI, the tax increase required to finance UBI is smaller. As such, we find that a moderate amount of UBI can boost economic activity and average welfare. That said, delving deeper into the distributional welfare impact, and taking into account transition dynamics, we show that UBI does not provide a Pareto improvement, and some high-productivity workers lose.

Our paper relates to an emerging macroeconomic literature evaluating the economic impact of UBI. In addition to a our different approach to the labor market, modeling search frictions, in what follows, we highlight key differences with this literature. Daruich and Fernández (forthcoming) focuses on how UBI affects intergenerational linkages and skill formation. Besides the different focus, our paper takes a different modeling approach (e.g., modeling extensive margin labor supply which is central to our analysis). Two papers explore UBI in an economy with fixed interest rate. Lopez-Daneri (2016) is an early study, analyzing the impact of different degrees of negative income tax in a small open economy. Guner, Kaygusuz and Ventura (2023) provides a careful analysis of the welfare system in the U.S, emphasizing household, gender and family considerations. One of the programs considered in their paper is UBI. Our paper complements

[2]While discussion of the latter dates back at least to Friedman (1962), recent UBI pilots in the US highlighted UBI as a supplement, rather than substitute for existing social safety nets (e.g, West et al. (2021)).

these by studying the impact of UBI in an economy with endogenous interest rates. The two papers closest to ours are Luduvice (2019) and Conesa, Li and Li (2023). Luduvice (2019) offers a rich, production-based, overlapping-generations model with labor force participation. He analyzes a few specific UBI implementations, financed through consumption tax. In contrast, we study the interaction of multiple UBI levels with multiple financing schemes through labor income. Conesa, Li and Li (2023) concentrate on full substitution of the welfare system with UBI – as such, the two papers study different UBI implementations.

Beyond the differences discussed above, our focus is distinct and complementary to this literature. Rather than examining a specific set of reforms, our goal is to systematically uncover and quantify key mechanisms that influence the outcomes of UBI. In line with this objective, our study delves into three key mechanisms to understand UBI's impact: (i) the rise in distortionary taxation, (ii) the decline in self-insurance, and (iii) the income effect on labor force participation. By providing a thorough analysis of these fundamental forces, we offer a crucial integrated approach. This perspective not only contributes to the theoretical discourse on UBI but also provides a valuable framework for policymakers and economists, enabling a multifaceted evaluation and understanding of UBI's economic effects.

2. Model

We consider a heterogeneous-agent search-and-matching model with incomplete markets in the spirit of Krusell, Mukoyama and Şahin (2010) without aggregate risk, and add an endogenous labor force margin. Workers are born (and die) with exogenous probability. Newborns have no assets, are out of the labor force, and draw a permanent cost to enter the labor force. While in the labor force, as in the Bewley-Huggett-Aiyagari incomplete-markets model and the DMP model of frictional unemployment, individuals are subject to both uninsurable productivity and unemployment risks.[3] To self-insure against such risk, they accumulate assets. The rate of return on these assets, the distribution of asset holdings, the wage, and the probability of finding a job are objects determined in general equilibrium. The government collects taxes from labor and capital income and uses the revenues to fund payments to workers out of the labor force, unemployment benefits, government expenditures, and UBI.

2.1. Matching and market tightness

Workers who participate in the labor force are either employed or unemployed who search for a job. Let u denote the unemployed and v the number of vacancies posted by firms. A constant returns to scale matching

[3] See also Setty and Yedid-Levi (2021).

function determines the number of new matches in a period. We define market tightness $\theta \equiv v/u$, as the ratio of the number of vacancies to the number of unemployed workers. Let $\lambda^w(\theta)$ denote the probability that a worker meets a vacant job, where λ^w is strictly increasing in θ. Similarly, let $\lambda^f(\theta)$ be the probability that a firm with a vacancy meets an unemployed worker, where λ^f is strictly decreasing in θ.

Matches separate at a constant and exogenous probability s each period. Matches formed in the current period become productive in the next one.[4] Workers die with probability ϕ and are replaced by workers born out of the labor force who instantly make a decision whether to enter it.

2.2. Idiosyncratic productivity

A worker's log-productivity in the labor force, $\log(p)$, evolves according to an AR(1) process $\log(p_t) = \rho \log(p_{t-1}) + \varepsilon_{p,t}$, where ρ denotes the persistence and $\varepsilon_{p,t}$ is an i.i.d. shock with mean zero and standard deviation σ_{ε_p}. A new ε_p is drawn every employment period and when transitioning from unemployment to employment. A worker who transitions from employment to unemployment maintains the most recent p throughout the unemployment spell. New entrants to the labor force have the lowest level of p, denoted by $\underline{p}$.

2.3. Asset structure

Workers have access to two types of assets: capital (k) and claims on aggregate profits (equity, x). The pre-tax return on capital is the rental rate r net of depreciation δ. The pre-tax return on equity is $\frac{d+\pi}{\pi}$, where d denotes dividends and π denotes the price of equity. Workers cannot directly insure against the idiosyncratic risk they face.

A standard no-arbitrage condition implies that the returns on holding capital and equity are equal. This allows us to track the pre-tax "total financial resources," $a \equiv (1+r-\delta)k + (\pi + d)x$, as a single-state variable for each worker. Finally, there exists an ad-hoc borrowing constraint $a \geq 0$.

2.4. Government transfers and taxes

The government collects labor and capital income taxes. The labor taxes are collected according to the tax function suggested by Benabou (2002) and used by Heathcote, Storesletten and Violante (2017),

$$t_l(y_l) = 1 - \lambda_l \left(\frac{y_l}{\bar{y}_l}\right)^{-\tau_l} \tag{1}$$

[4] Our model includes idiosyncratic productivity shocks and so allows endogenous separations. However, in our calibration such separations are never optimal. We therefore describe the model only with exogenous separations.

where y_l is the flow income consisting of wage or unemployment benefits, $\bar{y}_l$ is the average flow income in the economy, and $t_l(y_l)$ is the tax rate. In this formulation $1-\lambda_l$ is the tax rate levied on a person who earns the average labor income and τ_l governs the degree of progressivity. In addition, the government collects taxes on financial income flow at a flat rate t_a.

Proceeds from the labor and capital income tax are used to finance a fixed amount of government expenditures (G), unemployment benefits (UI), the benefits to workers out of the labor force (b^{NLF}), and UBI, which is a lump sum transfer.

The UI system consists of a replacement rate h and a ceiling on the benefits κ. As long as the cap does not bind, the UI benefit is a fraction h of the average wage $\overline{w}(p)$ earned by employed workers with productivity p.[5]

We allow for UBI to function as a replacement for some social assistance payments. Specifically, we assume that social assistance programs up to a threshold level $\overline{UBI}$ are phased out dollar-for-dollar with UBI, such that:

$$\text{Income outside the LF} = \begin{cases} b^{NLF} & \text{if } UBI \leq \overline{UBI} \\ b^{NLF} + UBI - \overline{UBI} & \text{if } UBI > \overline{UBI} \end{cases}$$

It is useful to consider two instructive cases for $\overline{UBI}$. When $\overline{UBI} = 0$, UBI is an add on to social assistance programs. When $\overline{UBI} = b^{NLF}$, as UBI increases, it gradually substitutes all social assistance programs, completely substituting for the welfare system when $UBI \geq b^{NLF}$. Importantly, income outside of the labor force never goes below b^{NLF}. In the quantitative analysis (Section 4) we evaluate different cases of $\overline{UBI}$.

2.5. Workers' optimization

Workers' period utility is represented by an increasing and strictly concave function $u(c)$. They discount future streams of utility by a discount factor $\beta \in (0,1)$.

Let $W(a,p)$ denote the value function of an employed worker who owns a assets and has a current productivity p. Similarly, $U(a,p)$ denotes the value function of an unemployed worker who owns a assets,

[5] We use the average wage to avoid the need to track workers' individual histories. Our model results in wage functions with little variation in wages *within* a given productivity level.

and had productivity p in her last job. We specify the employed worker's problem:

$$\begin{aligned} W(a,p) &= \max_{c,a'}\{u(c)+\beta(1-\phi)\left[sU\left(a',p\right)+(1-s)\mathbb{E}\left[W\left(a',p'\right)\right]\right]\} \\ \text{s.t.} &: \\ & c+qa' = w(a,p)\left(1-t_l\left(w(a,p)\right)\right)+a\left(1-t_a\times(1-q)\right)+UBI \\ & a'\geq 0 \end{aligned} \tag{2}$$

That is, an employed worker begins a period with some level of assets (a), earns the period wage (w), pays taxes, and receives the lump sum transfer. The worker's wage – determined by Nash bargaining as explained below – is a function of the worker's productivity and asset holdings. Therefore, the beginning of period asset holdings a is the endogenous state variable, and p is the exogenous state variable of the problem. We denote the inverse of the gross real interest by $q\equiv\frac{1-\phi}{1+r-\delta}$, assuming that the assets of the deceased are distributed to survivors according to their asset holding. Flow income, $(1-q)\,a$, is taxed at the flat tax t_a.

Similarly, an unemployed worker begins a period with some level of assets (a), receives unemployment benefits $b(p)=\min\{h\overline{w}(p),\kappa\}$, pays taxes, and gets the lump sum transfer. The unemployed worker's problem is:

$$\begin{aligned} U(a,p) &= \max_{c,a'}\{u(c)+\beta(1-\phi)\left[(1-\lambda^w)U(a',p)+\lambda^w\mathbb{E}\left[W(a',p')\right]\right]\} \\ \text{s.t.} &: \\ & c+qa' = b(p)\left(1-t_l\left(b(p)\right)\right)+a\left(1-t_a\times(1-q)\right)+UBI \\ & a'\geq 0 \end{aligned} \tag{3}$$

Turning to the labor force participation decision, recall that workers are born out of the labor force without assets.[6] Those who choose to stay out of the labor force receive a periodic transfer and do not accumulate assets. Staying out of the labor force yields the value $V^{NLF}=\frac{u(b^{NLF}+UBI)}{1-\beta(1-\phi)}$. The workers who choose to enter the labor force pay a utility cost Γ drawn from a normal distribution $N(\mu_\Gamma,\sigma_\Gamma)$. A worker who enters the labor force is unemployed and has the lowest level of productivity.

Given these assumptions, the entry decision is characterized by $\max\{V^{NLF},U(0,\underline{p})-\Gamma\}$, resulting in a cutoff cost Γ^*, such that workers with $\Gamma<\Gamma^*$ choose to enter the labor force.

[6]This assumption allows us to solve separately for the labor force participation and wealth accumulation, which greatly simplifies the solution.

2.6. Firms and production

A large number of firms can post vacancies, which cost ξ per vacancy. The value of an open vacancy, V, is

$$V = -\xi + q\left[(1-\lambda^f)V + \lambda^f(1-\phi)\mathbb{E}\left[J(a',p')\right] + \lambda^f\phi V\right], \tag{4}$$

where $J(a,p)$ denotes the value of a filled job for a firm matched with a worker with current asset level a, and productivity p:

$$J(a,p) = \max_{k(p)}\{pf(k(p)) - rk(p) - w(a,p) + q(1-\phi)\left[sV + (1-s)\mathbb{E}\left[J(a',p')\right]\right] + q\phi V\}. \tag{5}$$

We note that firms discount future profits by q – the marginal rate of substitution of equity owners. In order to produce, a firm with a filled vacancy has to rent capital. Let $k(p)$ be the capital per worker with productivity p. We assume a standard production function $f(k)$ with $f' > 0, f'' < 0$, such that a match produces $pf(k(p))$ units of output. Finally, we assume there is a free entry into vacancy posting so in equilibrium, firms post new vacancies until $V = 0$.

2.7. Wage determination

As common in the DMP literature, we assume that the wage is determined by Nash bargaining. In our model wages also depend on asset holdings because the workers' value function depends on a. The resulting wage function is a solution to the problem

$$\max_{w(a,p)} \left(W(a,p) - U(a,p)\right)^{\gamma}\left(J(a,p) - V\right)^{1-\gamma} \tag{6}$$

where $\gamma \in (0,1)$ represents the bargaining power of workers.

2.8. Equilibrium

We consider a stationary equilibrium. We refer the reader to Appendix A.1 for a formal equilibrium definition.

3. Calibration

In what follows we discuss the calibration of the model. We set a period in the model to equal a month.

Sample definition To calibrate the labor market moments we use the Current Population Survey (CPS) and the Annual Social and Economic Supplement (ASEC) data 2000-2019. We restrict our sample to those aged 18 to 65 at the time of the interview and drop those in the armed forces. For our definition of the relevant population we exclude three groups not in the labor force that we do not model: students (defined as everyone out of the labor force under age 25), retirees below the age of 65, and married individuals not in the labor force and not receiving any social assistance. The latter group is excluded because we assume it consists mostly of household spouses.

Hence, our sample definition is such that it concentrates on individuals who are more likely to be attached to the labor market. We note that the high labor force participation implied by this sample choice mitigates the costs associated with the UBI since it implies a low dependency ratio. Overall our sample definition implies a labor force participation rate of 0.90.

Production function The production function is set with one worker who produces with capital according to $f(k) = k^{\alpha}$. We calibrate $\alpha = 0.3$ and $\delta = 0.007$ to generate a capital share of 0.3 and an investment–output ratio of 0.23.

Death rate We calibrate the death rate $\phi = 0.00029$ to match the weighted average of the death rate with regard to the number of people at each age of male and female separately in ages 18-65.[7]

Preferences We use log-utility from consumption. We set the two parameters that determine the distribution of the cost of joining the labor force such that we match the labor force participation rate and the micro elasticity of labor force non-participation with respect to social assistance. This latter moment can be calculated analytically in the model in our setting. We choose it to match an elasticity of 0.3, consistent with labor force elasticity presented in Gruber (2000). Overall, we estimate $\mu_{\Gamma} = -68.51$ and $\sigma_{\Gamma} = 171.51$. Finally, we set $\beta = 0.9965$. This value, together with the death rate and depreciation rate, results in an annual interest rate of 3.1%.

Matching We assume a Cobb-Douglas matching function $M(u,v) = \chi u^{\eta} v^{1-\eta}$, so that $\lambda^{w} = \theta \lambda^{f} = \chi \theta^{1-\eta}$. We apply the Shimer (2005) approach that utilizes short-term unemployment in CPS to calculate an average job-finding rate of 0.362 for our sample.[8] We set the vacancy cost ξ to 2.29 to normalize market tightness

[7] Available at `https://www.ssa.gov/OACT/NOTES/as116/as116_Tbl_6_2010.html#wp1085673`.

[8] Following Polivka and Miller (1998) and Elsby, Michaels and Solon (2009), we apply a 1/0.83 correction factor to finding rates given the CPS 1994 redesign.

at 1, which identifies (χ) as the job-finding rate.

We set η to 0.6.[9] and the exogenous separation rate $s = 0.022$ to match the unemployment rate of 5.8% given the job-finding rate of 0.362 and ϕ according to the formula:

$$u = \frac{s + \phi - s\phi}{s + \phi - s\phi + \lambda^w(1 - \phi)}$$

Finally, we set the worker's bargaining power parameter γ to 0.6.[10]

Productivity process We adopt the process estimated by Krueger, Mitman and Perri (2017) to our specification, which excludes the transitory component. The resulting parameters (at a monthly frequency) are $\rho = 0.9905$ and $\sigma_{\varepsilon_p} = 0.1095$. We approximate the AR(1) process for individual productivity using the method described by Rouwenhorst (1995) with five points.

Policy parameters The parameters of the labor income-tax function are set to $\lambda_l = 0.9$ and $\tau_l = 0.15$ in accordance with Holter, Krueger and Stepanchuk (2019), who use US labor income tax data. This parameterization allows for negative income tax rates for low income, mimicking features of the EITC program. Finally, we use $t_a = 0.36$ following the discussion in Trabandt and Uhlig (2011).

We set the level of social assistance in the model, b^{NLF}, exogenously, using the same ASEC sample defined above. Specifically, we match the ratio of average social assistance for those outside the labor force to average earnings of those in the labor force, using ASEC weights. The ratio of the two is 0.17.[11]

In our benchmark calibration of the UI system we set the replacement rate to 40%, as is typically used to describe the replacement rate in the US economy. We also set the ceiling on unemployment benefits $\kappa = 1.83$, which amounts to a fraction of about 60% of the median wage in the model.[12]

Summary and model fit We highlight the model's fit with regard to three sets of untargeted moments, which are especially relevant when evaluating the macroeconomic response to UBI, which is set to zero in the benchmark.

First, we evaluate the model-implied income elasticity of labor force participation in an empirically relevant UBI setting. Specifically, in a setting of cash windfall (not financed through taxation), similar to the

[9] See Petrongolo and Pissarides (2001), and Brügemann (2008).

[10] We follow the literature that equating bargaining power to the matching elasticity even though the (Hosios (1990)) condition does not necessarily hold due to the market incompleteness.

[11] For the social assistance calculation, we include: Social Security income, welfare (public assistance) income, Supplemental Security Income (SSI), income from workers' compensation, income from disability benefits, and the market value of food stamps. Earnings include income from labor, business, and farm.

[12] See Section 3.1 in Setty and Yedid-Levi (2021) for a discussion of this calibration.

Alaska experiment studied by Jones and Marinescu (2022), our model implies a small labor supply response consistent with their empirical findings.[13]

Second, to characterize the insurance benefits from UBI in a meaningful way, it is important for the model to capture both idiosyncratic uncertainty and self insurance. As discussed above, and following Krueger, Mitman and Perri (2017) and Setty and Yedid-Levi (2021), the model includes death probability, a realistic productivity process, and unemployment risk, all of which are important for improving the fit of the wealth distribution. As we discuss in Appendix A.2 the model accounts reasonably well for key wealth-distribution moments, especially with respect to the lower two quintiles of the wealth distribution, who stand to benefit the most from a UBI.

Finally, we note that the precautionary motive is well-calibrated; In our benchmark economy, the capital-output ratio is about 17% higher relative to a full insurance representative agent economy, well within range of the empirical evidence regarding precautionary wealth (see for example Carroll and Kimball (2008) for a survey).

4. Policy results

In this section we present our main results regarding the impact of UBI on the economy. We consider two different scenarios that are of policy relevance: first, the introduction of UBI in the economy without any other policy change ($\overline{UBI} = 0$); and second, a partial substitution of UBI for existing welfare programs ($\overline{UBI} > 0$). We start with the first scenario, which enables us to identify the mechanisms at play while holding constant all other existing programs. Since our interest is to study a wide range of UBI programs and financing schemes, our main focus is on the steady state equilibrium following each candidate policy. We later solve for the full transition for the steady state welfare maximizing specification.

4.1. The impact of UBI: keeping social assistance fixed ($\overline{UBI} = 0$)

In each exercise, we solve for the new general equilibrium steady state keeping the government budget balanced by adjusting the tax rate on the average person while maintaining constant progressivity.[14] As we discuss below, taxes play a crucial role in UBI's effect on the economy.

[13] Using their estimates, and assuming that part time is 50% of full-time position, implies less than 1 p.p decline in full time equivalent. Running a similar exercise in our model, we get a response of about 0.5 of a p.p. for labor force participation.

[14] In doing that, we follow Holter, Krueger and Stepanchuk (2019), who show that for the tax function we use, this is akin to holding τ_l constant, and changing λ_l to keep the budget balanced.

The solid blue lines in Figure 1 depict the results from these exercises. On the x-axis the different UBI experiments are expressed in percentage of the steady-state GDP per capita prior to UBI introduction. On the y-axis we depict the impact on different macroeconomic variables, expressed in terms of deviations from the no-UBI economy.

Starting from the top left, we see that UBI has a large negative effect on GDP per capita. Consider a 10% UBI, equivalent to roughly \$640 monthly (using 2022 GDP per capita). Such a program results in a 18% decline in GDP per capita. The general pattern that emerges from this figure is of a major GDP per capita drop even when UBI interventions are small; for example, a 2% UBI induces a 3% decline and 5% leads to a 8% fall.

To understand this large decline in GDP, it is essential to understand the large reductions in capital and labor (middle and right plots of the first row in Figure 1). They are an artifact of different direct and equilibrium effects, which we discuss as follows.

First, UBI needs to be financed via higher labor taxes. This higher labor tax rate induces a substitution effect that pushes workers outside of the labor force. Second, the UBI implies smaller differences in marginal utility of consumption across different idiosyncratic states. This results in reduced demand for self insurance through savings and a further fall in aggregate capital. Third, for the marginal person who makes the labor force participation decision, UBI leads to a positive income effect, inducing workers to stay outside the labor force.

Capital-labor complementarity amplifies many of these effects and contributes to the large decline in GDP. The decline in the labor force participation present in the first and the third channels implies a decline in aggregate capital. Given the Cobb-Douglas production function, the fall in labor force participation does not directly affect capital-per-worker, and hence does not affect wages. In contrast, the decline in the demand for savings, due to the insurance channel, leads to lower capital per worker, and hence to lower labor productivity. The reduced productivity per worker induces a lower match surplus and pre-tax wages (Figure 1, bottom left plot in Panel A), amplifying the substitution effect, further lowering labor force participation. Lower labor productivity further gets reflected in fewer vacancy postings and a higher unemployment rate.

The overall impact of these forces in equilibrium is manifested in the large increase in the tax rate. For example, for the 10% UBI program the tax rate on the person with average earnings in the economy goes up by 26 percentage points. Furthermore, for the 10% UBI program, capital declines by 28% and labor force participation drops by 14%, or about 12 percentage points. While unemployment rate goes up by about 2%, this amounts to a negligible 0.13 percentage points increase. Therefore, the labor force participation margin is the key margin in the context of labor inputs.

4.1.1. The role of distortionary taxation

To isolate the role of distortionary taxation, we solve again the model assuming that the UBI expenses do *not* need to be financed. This is similar to a policy in which an external windfall of funds is available, much in the spirit of the Alaska fund. In what follows we refer to this as the "Alaska Experiment."

The dashed red line in Figure 1 depicts the results for this exercise. Notably, the decline in GDP is dramatically attenuated - for a 10% UBI, the decline in GDP is 5.5% - only about a third of the fall in the first experiment that featured an increase in distortionary taxation. Similar ratios are observed for aggregate capital and labor force participation. Thus, this result emphasizes the first-order importance of distortionary taxation when considering UBI programs; we return to this point in section 4.1.4 below.

4.1.2. Insurance vs. Income Effect

The Alaska experiment allows us to further decompose the decline in capital. Without the distortionary taxation effect, the decline in capital is driven by two channels. First, it stems from a reduction in savings demand from households. The second arises from the complementarity between capital and labor force participation; as UBI's income effects lead to a decrease in labor force participation among marginal labor force participants, this subsequently results in a decline in capital.

To evaluate the extent to which each channel contributes to decline in capital, recall that given the Cobb-Douglas production function, the labor force participation rate does not by itself affect the capital per worker ratio. As such, in the Alaska Experiment, where the distortionary taxation channel is absent, any changes to capital per worker *must* reflect changes in the demand for savings.[15] Appendix Figure A1 details both the aggregate capital and the capital per worker in the Alaska Experiment for different UBI cases: for the 10% UBI case the change in aggregate capital amounts to about 10%, while the decline in capital per worker is only 7%. The implication is that absent an increase in distortionary taxation, demand for savings explains about two-thirds of the decline in capital, with the remaining third due to income effects. The fact that there is a meaningful effect of UBI on demand for savings is not surprising given that UBI of 10% amounts to about 21% of median before-tax wage in the pre-UBI economy. As such, this effect implies a reduction in the measure of precautionary wealth from 17% in our benchmark no-UBI economy to about 12% in this experiment.

Taking stock, comparing our results when allowing for a rise in distortionary taxation versus when holding it constant, we show that the majority (two-thirds) of the decline in capital and labor is driven by distor-

[15] There is potentially a change in the employment rate within the labor force that could affect the ratio of capital per worker; however, as seen in Figure 1, the change in this rate is negligible.

tionary taxation. Of the remaining effect (one-third), the demand for savings plays a more important role in explaining the decline in capital than the income effect.

4.1.3. Welfare

What are the potential benefits of the UBI program? Consumption inequality results from the decision to participate in the labor force, and idiosyncratic shocks and the saving decisions they imply. Hence, since UBI acts as a provision of public insurance it reduces consumption inequality. The leftmost plot in Panel B in Figure 1 demonstrates the decline in consumption inequality as manifested in the Gini coefficient for consumption. For a 10% UBI, the Gini coefficient falls by about 17%.

How is the decline in inequality related to consumption gains and losses across the economy? Since UBI is added to welfare payments, then those outside the labor force increase their consumption. With respect to those within the labor force, the middle plot in Panel B shows consumption over the different UBI policies for five levels of productivity. It demonstrates that, even within the labor force, those at the bottom of the productivity distribution gain from UBI.

Our welfare measure, applying a utilitarian-based consumption equivalence measure is depicted in the right plot of Panel B.[16] The large costs of UBI imply welfare drops for almost all UBI experiments we consider. Only for small interventions of around 1% is there a small (0.3% in consumption equivalence) rise in welfare.

4.1.4. Mitigating the distortionary effect of UBI

The results from the previous section highlight the effect of distortionary taxation on labor force participation. One potential way to mitigate this effect is to change how UBI is *financed* by changing the progressivity of the tax system, which increases labor income for labor force entrants. We explore this in Appendix A.5 and the main takeaway is that increasing progressivity does not alter UBI's welfare impact. A second potential solution, which we explore below, is to change how UBI is *distributed* by calibrating UBI as a partial substitute for social assistance ($\overline{UBI} > 0$). Relative to the benchmark exercise, this implies stronger incentives for labor force participation, and a lower increase in the tax burden.

4.2. The impact of UBI: substituting social assistance with UBI ($\overline{UBI} > 0$)

Thus far, we considered cases where social assistance remained intact alongside UBI. We now explore the alternative scenario where UBI is a relevant substitute for some social assistance programs but not

[16] See Appendix A.3 for details.

others. For the calibration of $\overline{UBI}$ we assume that Supplemental Security Income, welfare income, and the market value of food stamps could be replaced by UBI. These amount to roughly one-third of the overall benefits discussed in footnote 11. Appendix Figure A2 demonstrates how consumption outside the labor force changes for different magnitudes of the UBI program.

The dash-dot purple line in Figure 1 summarizes this exercise results. The first row of Panel A exhibits two distinct patterns: for UBI up to $\overline{UBI}$ (about 4.5%), and then levels above it. While the trends for high levels of UBI are similar to what we have seen before, the social assistance phase-out area is distinctly different, showing an increase in GDP. In what follows we focus on this region.

4.2.1. The impact on labor force

As is clear from the first row of Panel A in Figure 1, the increase in GDP per capita stems solely from the rise in labor force participation. The labor force rises because in the region where social assistance is replaced with UBI dollar for dollar, the total government transfer for a person outside the labor force does not change but, in contrast, it does increase for an individual in the labor force. This mechanism naturally incentivizes labor force participation (at least in a partial equilibrium sense, holding taxes and prices constant).

The rise in the labor force raises the tax base and reduces the number of individuals eligible for transfers. Furthermore, compared to the baseline exercise, the phasing out of social assistance directly reduces the resources required for funding UBI. Taken together, the tax increase required for financing UBI is smaller (second row, middle plot). By itself, this mitigates the negative effect of the financing cost of UBI on labor force participation.

4.2.2. The impact on capital

In contrast, aggregate capital is almost constant below $\overline{UBI}$ due to two counteracting effects. On one hand, UBI offers enhanced insurance for individuals in the labor force. Consequently, similar to our previous findings, this leads to a reduced demand for savings, resulting in a decrease in capital per worker. On the other hand, in the region where labor force participation increases, labor-capital complementarity implies an increase in demand for capital.[17] Quantitatively, the two effects roughly cancel each other, hence aggregate capital in the economy remains approximately constant. As in the baseline exercise, the decline in capital per worker implies a decline in labor productivity and hence in demand for labor and pre-tax wages (middle

[17] Luduvice (2019) highlights that the removal of the asset-test when UBI is introduced incentivizes savings. This channel is captured here – in our model there are no savings outside the labor force, hence the transition into it implies an increase in personal savings.

row, left plot). Importantly, this decline in demand for labor is small compared to the increase in labor supply, hence the observed increase in labor force participation as discussed above.

4.2.3. The impact on welfare: steady state comparisons

As the leftmost plot in Figure 1 Panel B reveals, introducing UBI while phasing out social assistance decreases inequality faster up to the threshold. As shown in the middle plot of this panel, within the labor force, and compared to the benchmark policy, there is a smaller decline in consumption at higher productivity levels, consistent with the smaller increase in the tax burden. As the right plot of Figure 1 Panel B reveals, overall welfare increases with UBI until reaching the cap ($\overline{UBI}$). This is consistent with the rise in overall resources in the economy (GDP per capita goes up) as well as in insurance (left two plots of Panel B).

To conclude, the specific design of UBI suggested above, is one that can increase in the long run both resources and welfare. This is because its design increases the incentives to participate in the labor force.

4.2.4. The impact on welfare: transition dynamics

Our analysis so far compares allocations and welfare across steady-state equilibria. While there is value in exploring full transition dynamics, doing so for the universe of policy experiments which we consider, is computationally infeasible. Hence, we discuss the full transition dynamics for a specific case where UBI provides the highest steady-state welfare.[18]

Figure A3 summarizes the results for the transition dynamics when UBI equals 5.3% of baseline GDP per capita (roughly $340 monthly per capita, using 2022 GDP). We choose this case, which is slightly above $\overline{UBI}$, as it maximizes welfare using steady-state comparisons. [19]

As seen in the top row of Appendix Figure A3, while the adjustment of labor force to the new steady state occurs relatively fast, aggregate capital and GDP take considerably longer to converge to their new levels. This difference is due to the slow convergence of average productivity to the ergodic distribution, which is unchanged by the reform. The slow convergence arises from new labor force entrants joining at lower productivity levels and the high-persistence of the productivity process. The temporary decline in productivity is reflected in temporary declines in capital per-worker and the marginal product of labor (depicted in Panel B), as well as in temporary lower wages. Compared to the steady state analysis, in the transition, the matching friction plays a more important role – it implies that new entrants take time to find

[18] We thank the editor and the referee for suggesting this approach and some simplifying assumptions, discuss in Appendix A.4.

[19] As robustness, we verify that the maximizing UBI level is not sensitive to changes in the level of progressivity.

jobs, slowing down the employment increase. Moreover, sluggish recovery of labor productivity weakens hiring incentives. Since the full transition takes into account the periods during which unemployment is higher, and the distribution of productivity is lower than in the steady state, the welfare gain associated with the full transition is 7%, compared with 12% in the steady-state comparison.

Finally, we use the transition to delve into the distributional welfare implications of the policy focusing on the generation that experienced the introduction of UBI. Two groups unambiguously gain from the policy: those who are outside the labor force both pre-and post-policy implementation see a slight increase in consumption due to UBI level slightly above zero, hence gain. By revealed preferences, those who transition into the labor force gain as well. Appendix Figure A4 zooms in on a third group – those who are in the labor force before and after the policy implementation.[20] The figure shows the percent change in consumption equivalent welfare between the no-UBI steady state and the first period of UBI implementation for each point on the state-space, that is for each of the five productivity levels, and over the wealth distribution.[21] As expected, conditional on assets level, lower productivity (and income) workers gain more from UBI. Even though total resources in the economy increase, within the group of highest productivity workers, those with low wealth lose – this group bears the tax consequences of the policy, but gains relatively little from the increase in the interest rate.

5. Conclusions

We consider the aggregate and distributional impact of UBI programs. The key channel is distortionary taxation. Keeping intact existing social assistance programs, the higher taxes required to fund UBI induce a substitution effect that reduces labor force participation. UBI also provides public insurance reducing the demand for self insurance resulting in aggregate capital falling. Finally, the third, and quantitatively least important, channel is the positive income effect of UBI on labor force participation. We then study a UBI implementation which partially substitutes social assistance. This substitution incentivizes labor force participation, leading to an increase in output and average welfare.

Our framework is useful for identifying the key channels through which UBI operates, and sufficiently flexible to study different UBI implementations.

[20]The monotonic increase in labor force participation following policy implementation implies there is no mass of workers who transition out of the labor force.

[21]We focus on the employed, however the results for the unemployed are very similar.

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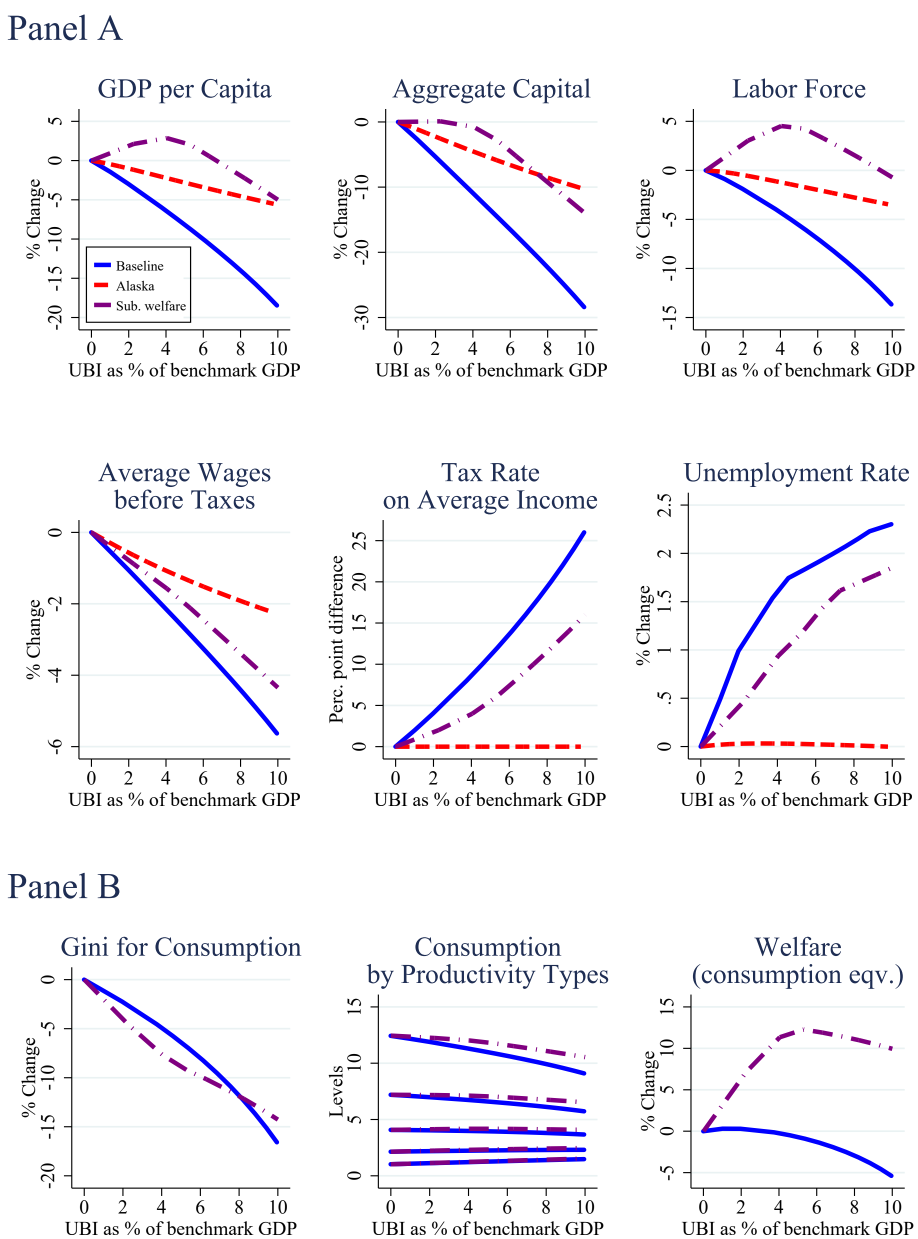
Figure 1: The impact of UBI on allocations and welfare



Notes: Steady state responses of macro aggregates to changes in UBI. UBI expressed as % of benchmark GDP. All measures are expressed in % deviations from their benchmark steady state level other than Tax Rate on Average Income (p.p difference) and Consumption by Productivity Types (in levels). Blue solid lines represent responses in the baseline model; red dashed lines represent the Alaska model (section 4.1.1); purple dash-dot lines represent substituting welfare with UBI (section 4.2).

A. Online Appendix

A.1. Equilibrium and Solution Algorithm

In this appendix we describe the stationary equilibrium of the economy. For ease of notation and consistency with the computational method we describe a discrete state space. We use the notations $Pr(p'|p)$ as the transition probability of individual productivity, and $Pr(p)$ as the unconditional probability for individual productivity draws. A stationary equilibrium consists of:

1. A set of value functions $\{W(a,p), U(a,p), J(a,p), V^{NLF}, V\}$
2. Consumption $c^e(a,p)$ and $c^u(a,p)$ for employed and unemployed workers, respectively, as well as asset accumulation policy functions $g^e(a,p)$ and $g^u(a,p)$
3. A disutility cutoff Γ^*
4. Prices $\{r, w(a,p), \pi\}$
5. Vacancy level v and demand for capital per worker $k(p)$
6. Tightness ratio θ and implied probabilities λ^w and λ^f
7. A government policy consists of: tax on labor income $t_l(y_l)$ and a flat tax on financial income t_a; transfers b^{NLF} for individuals out of the labor force; lump sum transfers UBI; A government expenditure G; a UI policy of replacement rate h and a ceiling on benefits κ
8. Dividends d
9. Distributions over employment status (either e or u), assets a and individual productivity p, denoted by $\mu^e(a,p)$ and $\mu^u(a,p)$, as well as a measure of individuals outside the labor market μ^{NLF}

such that:

1. Given the job finding probability λ^w, the wage function, and prices $\{r, \pi\}$, the worker's choices of c and a' solve the optimization problem for each individual. This results in the value functions $W(a,p)$, and $U(a,p)$.
2. Given the value of staying outside of the labor force, and the value of entering the labor force U(0,$\underline{p}$), Γ^* is the threshold utility cost of joining the labor force.

3. Given the wage functions, prices, the distribution $\mu^e(a,p)$, and the workers asset accumulation decisions, each firm solves the optimal choice of $k(p)$. This results in $J(a,p)$.

4. Given the wage functions, prices, the distribution $\mu^u(a,p)$, the unemployed workers asset accumulation decisions, and the job filling probability λ^f, firms compute the value V. With free entry, $V=0$.

5. The asset market clears, and the aggregate demand for capital equals supply.

6. The wage functions $w(a,p)$ are determined by Nash bargaining.

7. The government has a balanced budget.

$$\begin{aligned}
&\sum_a\sum_p\left[\mu^e(a,p)\left(w(a,p)t_l\left(w(a,p)\right)+at_a(1-q)\right)+\mu^u(a,p)\left(b(p)t_l\left(b(p)\right)+at_a(1-q)\right)\right]\\
&=\sum_a\sum_p\left[\mu^u(a,p)b(p)\right]+G+\mu^{NLF}\left[b^{NLF}+max(UBI-\overline{UBI},0)\right]+(1-\mu^{NLF})UBI
\end{aligned}\tag{7}$$

8. The dividend paid to equity owners every period is the sum of flow profits from all matches, net of the expenditure on vacancies.[22]

$$d=\sum_a\sum_p\left[\left(pf(k(p))-rk(p)-w(a,p)\right)\mu^e(a,p)\right]-\xi v \tag{8}$$

9. The distributions $\mu^e(a,p)$ and $\mu^u(a,p)$ are invariant and generated by $\{\lambda^w,s,\phi\}$, the law of motion for individual productivity and the asset accumulation policy functions as follows:

$$\begin{aligned}
\mu^e(a',p') &= (1-\phi)\{(1-s)\sum_a\sum_p\mu^e(a,p)\times Pr(p'|p)\times 1\{g^e(a,p)=a'\}\\
&\quad +\lambda^w\sum_a\sum_p\mu^u(a,p)\times Pr(p'|p)\times 1\{g^u(a,p)=a'\}\}\\
\mu^u(a',p') &= (1-\phi)\{s\sum_a\mu^e(a,p')\times 1\{g^e(a,p')=a'\}\\
&\quad +(1-\lambda^w)\sum_a\mu^u(a,p')\times 1\{g^u(a,p')=a'\}\}+\phi\times Pr(p)\times 1\{a'=0\}\\
1 &= \sum_a\sum_p\left(\mu^e(a,p)+\mu^u(a,p)\right)+\mu^{NLF}
\end{aligned}$$

[22] As flow profits depend on asset holdings of individual workers, this distribution is taken into account.

A.2. Wealth Moments

The table below presents the share of aggregate wealth owned by quintiles of the wealth distribution both for the data (data source: Table 1 of Krueger, Mitman and Perri (2017)) and our model economy. Further more, it reports the Gini coefficient of the wealth distribution.

Table A1: Wealth moments

	Data	Model
% share owned by		
Q1	-0.2	<0.05
Q2	1.2	1.7
Q3	4.6	7.3
Q4	11.9	21.5
Q5	82.5	69.6
Gini	0.78	0.68

A.3. Detailed Welfare Measure

In what follows we provide a detailed definition of our utilitarian welfare measure applied when comparing welfare across steady states. For each policy experiment we follow the protocol below:

1. Calculate the expectation of the discounted value from consumption over the entire (discretized) state-space.

2. Compute the stock of disutility due to the participation cost.

3. Add (1) and (2).

4. Derive the consumption equivalence measure.

In each of the calculations in (1) and (2), we appropriately account for discounted values of both consumption and participation costs of future (unborn) generations.

Finally, we compare the consumption equivalent measures across steady states, and report them in terms of percent change compared to the benchmark model.

A.4. Transition Dynamics

When calculating transition dynamics in Section 4.2.4, we make a few simplifying assumptions, namely, shifting to annual frequency, and assuming one wage per productivity level. These assumptions reduce dramatically the computational burden, making the calculation of transition dynamics feasible.

We verify that these assumptions do not change our steady state results, by comparing the impact of UBI for the specification for which we calculate transitions (UBI equals 5.3%) with and without imposing these assumptions. In particular, the change in steady states values of GDP per capita is 2.0% using the benchmark economy assumptions and 2.1% when applying the simplifying assumptions. Similarly, consumption equivalent welfare changes by 12.3% in the benchmark and 12.0% in the alternative economy.

A.5. Financing UBI with progressive taxation - a detailed discussion

The results from Section 4 and specifically the Alaska experiment, highlight the importance of distortionary taxation and labor force participation. The analysis in Section 4.2, demonstrates that partially replacing existing social assistance payments with UBI can mitigate the adverse effect of distortionary taxation. Here, we study another approach to potentially mitigate this effect – considering changes in the progressivity of the tax schedule while keeping the government budget balanced.

The effect of increased progressivity on the economy is qualitatively ambiguous. On the one hand, a more progressive tax schedule could raise incentives to participate in the labor force and thereby limit the negative distortionary effect of the UBI financing burden. On the other hand, because increased progressivity reduces incentives to self insure, it lowers the demand for capital in the economy. This latter channel could further depress the demand for capital already induced by the insurance effect of UBI.

In the spirit of Holter, Krueger and Stepanchuk (2019) for the tax function that we use, changing τ_l is akin to changing the progressivity of the tax function. Figure A5 depicts the results for the baseline $\tau_l = 0.15$, along with a more progressive tax scheme ($\tau_l = 0.25$) and a less progressive one ($\tau_l = 0.05$).[23]

As the upper left plot of Figure A5 shows, as in the baseline case, UBI reduces GDP for all progressivity levels. However, for a given amount of UBI, GDP increases with progressivity.

Moreover, consider the case of a rise in progressivity over the benchmark value (from $\tau_l = 0.15$ to 0.25). Figure A5 suggests that, in this case, the higher the UBI level is, the larger the impact of progressivity on

[23] To keep the budget balanced, whenever we change τ_l, we adjust λ_l (the tax on average income). Note that increasing τ_l would mechanically increase the EITC level. To avoid very large EITC driving our results, we bound its value at the maximum level obtained in the baseline calibration with $\tau_l = 0.15$.

output is. To understand these patterns, we need to consider separately the effect of progressivity on capital and labor.

A.5.1. The impact on labor force

As the second and third plots in the first row of Appendix Figure A5 suggest, the effect of progressivity on output is mostly through labor force participation and not through capital. To understand this recall that, in the model, entry into the labor market occurs at low-productivity jobs. Therefore, workers put extra weight on wages in these entry-level jobs when making the decision whether to take them.

The increase in progressivity boosts after-tax wages in entry jobs, an effect illustrated in the left plot in the second row of Appendix Figure A5. This panel shows large gains in after-tax wages at entry. Moreover, for most UBI levels, after-tax wages are higher even for the average-productivity person.

A.5.2. The impact on capital

The rise in labor force participation due to progressivity (conditional on UBI level) would suggest a similar increase occurring in capital due to complementarity. Yet, as seen in the figure, the relation between capital and progressivity conditional on UBI level is not monotonic, and overall, capital seems less sensitive to progressivity. This is explained by the presence of a counteracting force, where high progressivity reduces the demand for savings and, thus, capital due to the public insurance provided by this high progressivity.

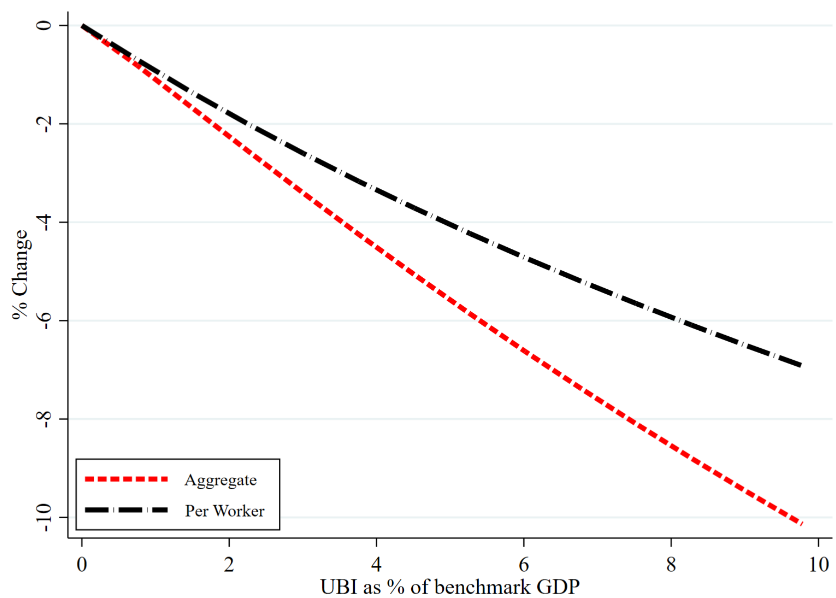
Following our strategy from Section 4.1, we turn to look at the change in capital per worker to isolate this demand for savings channel. As Appendix Figure A6 shows, for low levels of UBI, progressivity depresses the demand for savings, reducing capital per worker. But as UBI increases, the marginal value for progressive taxation as an insurance mechanism falls, as reflected in the shrinking difference between capital per worker for low and high progressivity schemes. This decline in the importance of the insurance channel for higher UBI levels, along with the relatively constant effect of progressivity on labor force participation, explain the non-monotonic relation between aggregate capital and progressivity over different UBI levels.

A.5.3. Welfare

Finally, in terms of welfare, as is clear from Panel B of Figure A5, progressivity reduces consumption inequality (left plot) and increases welfare (middle plot) for each level of UBI. Moreover, the optimal UBI level (the one that maximizes welfare) varies with progressivity. Intuitively, with less progressivity, UBI plays a more important role, by providing insurance. The rightmost plot of Panel B shows an index of consumption-equivalent welfare, with each line normalized to 1 for the case of zero UBI.

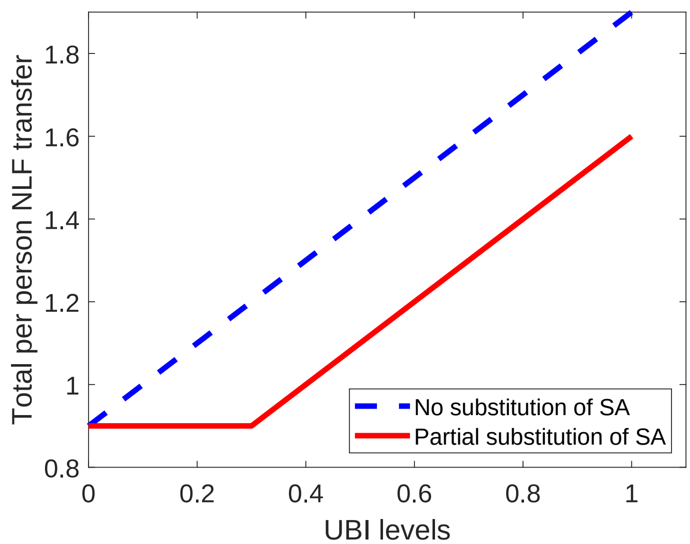
A.6. Appendix Figures

Figure A1: Aggregate Capital vs Capital per Worker - the Demand for Savings Channel



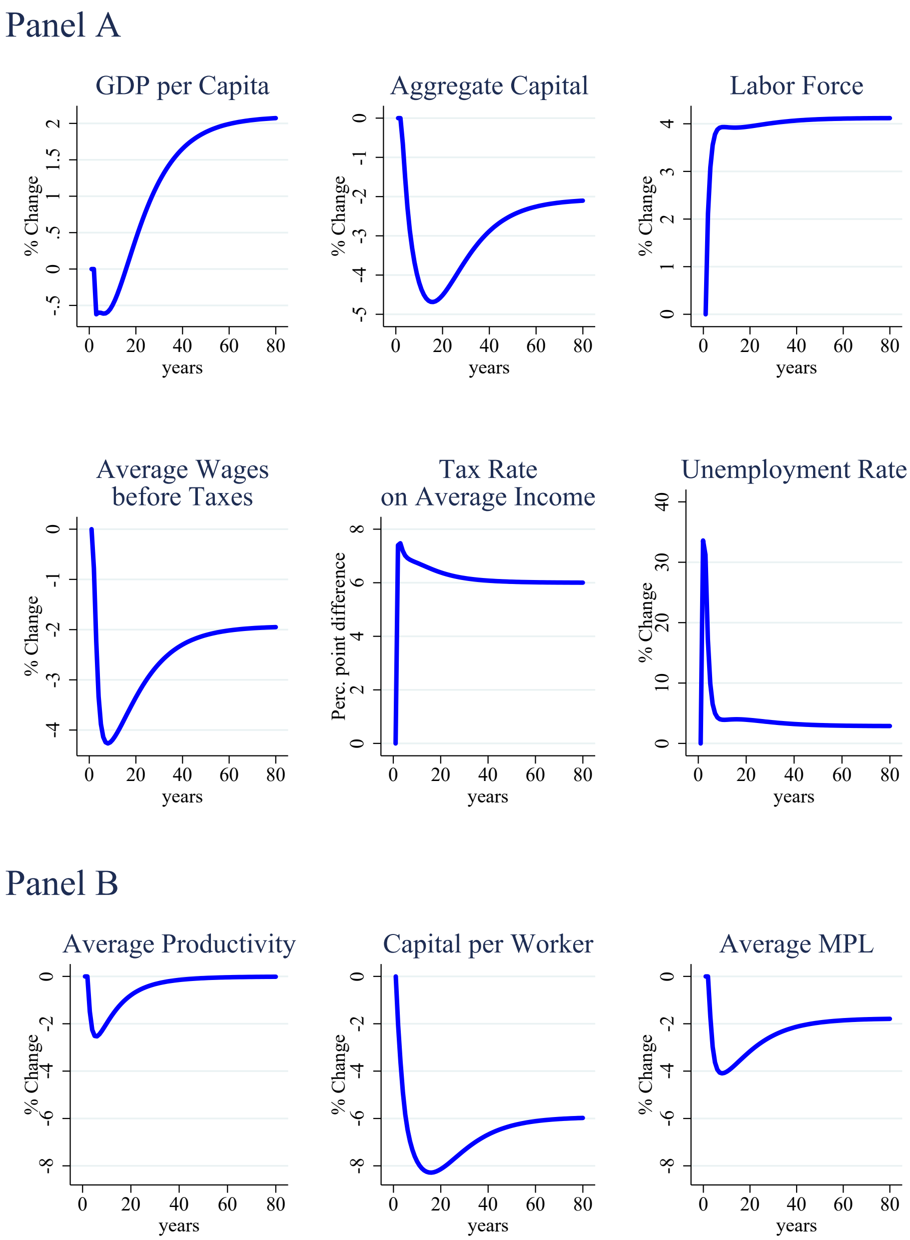
Notes: Steady state responses of aggregate capital (dashed red) and of capital per-worker (dash-dot black) to changes in UBI in the Alaska experiment. UBI is expressed as % of benchmark GDP. Capital is expressed in % difference from its benchmark steady state level.

Figure A2: UBI substitutes for welfare: Consumption outside the labor force



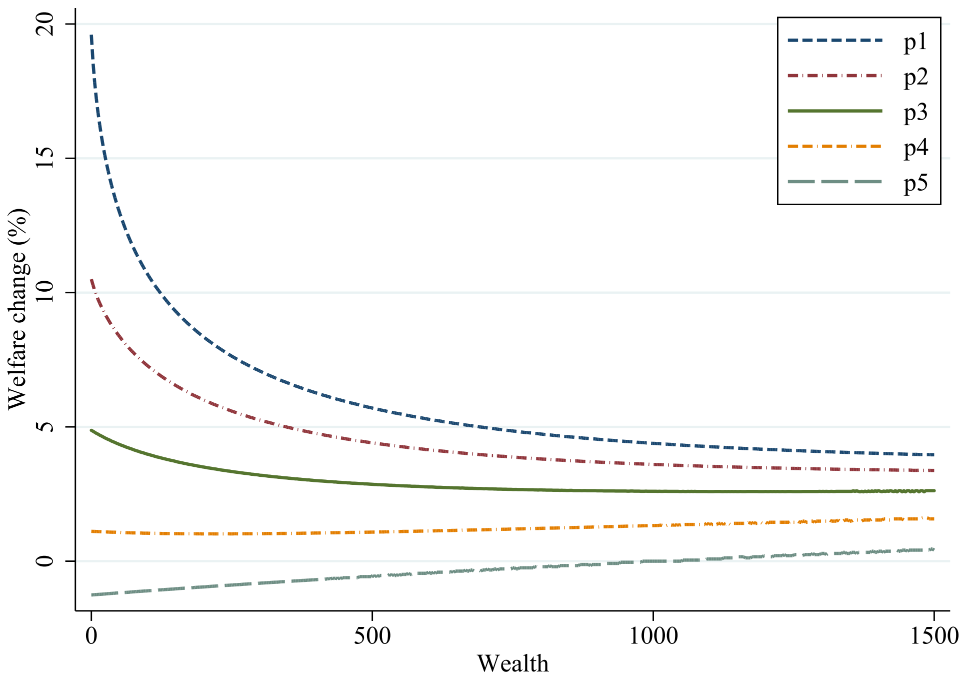
Notes: Consumption outside the labor force implied by the policy whereby UBI substitutes for welfare payments up to a threshold.

Figure A3: UBI substitutes for welfare: Transition Dynamics



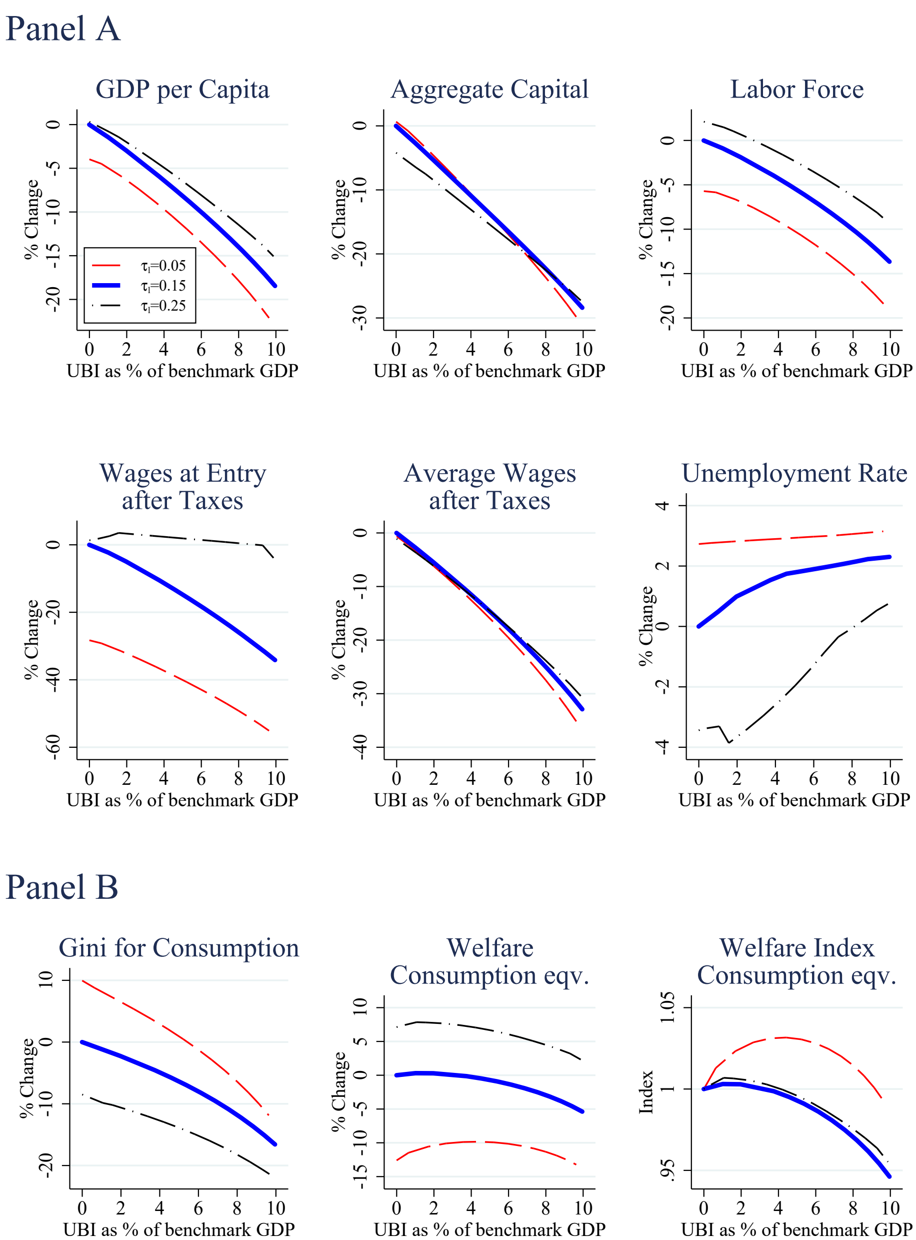
Notes: Transition dynamics of macro aggregates to changes in UBI. The end-point is the steady state with UBI level of 5.3% of baseline GDP per capita. All measures are expressed in % deviations from their initial steady-state level other than Tax Rate on Average Income (p.p difference).

Figure A4: UBI substitutes for welfare: Winners and Losers



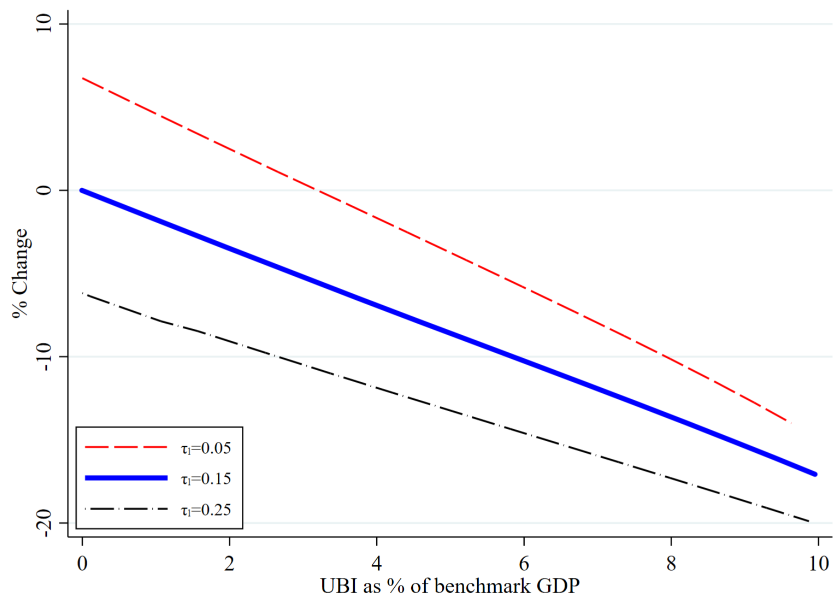
Notes: Welfare gains (consumption equivalent) of employed by wealth over the five levels of productivity. Calculated in the first period of the transition relative to the pre-UBI steady state. We show the results up to wealth level of 1,500 which includes over 98% of employed in the model.

Figure A5: Tax progressivity and the impact of UBI



Notes: Steady state responses of macro aggregates to changes in UBI. UBI expressed as % of benchmark GDP. All measures are expressed in % deviations from their benchmark steady state level other than Welfare Index Consumption equivalent (Indexed to 1 for the no UBI case for each level of progressivity). Blue solid lines represent responses in the baseline model (medium progressivity); High (low) progressivity is represented by the dash-dot black (dashed red) lines.

Figure A6: Capital per Worker - different levels of progressivity



Notes: Steady state responses of capital per-worker to changes in UBI in the baseline model (blue), high (dash-dot black), and low (dash red) progressivity. UBI is expressed as % of benchmark GDP. Capital is expressed in % difference from its benchmark steady state level.