Welfare Costs and Benefits of Deficit-Financed Fiscal Policy

Raman S. Chhina   Calvin He*

March 21, 2025

Updated Frequently. Please click here for the latest version.

Abstract

Deficit-financed fiscal policy plays a crucial role in short-run business cycle stabilization. However, with rising public debt, its benefits must be weighed against the costs of future taxation and redistribution required to service the debt. In this paper, we make progress on the analysis of this welfare trade-off by decomposing and quantifying the channels through which fiscal policy impacts aggregate welfare within a Heterogeneous Agent New Keynesian (HANK) model. Our decomposition shows that, beyond macroeconomic stabilization and redistribution, deficit financing generates welfare benefits through two key mechanisms: i) substantial self-financing of the initial policy cost and ii) direct effects from the stock of public debt. The latter mechanism impacts household liquidity and is summarized by the equilibrium difference between the discount rate and the real interest rate. We also apply our decomposition to create policy ranking measures such as the Benefits-to-Cost Ratio and the Marginal Value of Public Funds within the HANK model. Using these measures, we compare and rank various fiscal policies—including targeted transfers, mortgage principal relief, moratoriums, and unemployment insurance—based on their overall welfare benefits and their "bang for the buck."

Keywords: welfare decomposition, fiscal policy.

JEL codes: D61, E62

*Chhina: Department of Economics, University of Chicago (email:rschhina@uchicago.edu), He: Department of Economics, Stanford University (email:calvinhe@stanford.edu). We would like to thank Greg Kaplan, Adrien Auclert, Fernando Alvarez, Adrien Bilal, Guido Lorenzoni, Mike Golosov and participants at Macro Lunch Seminars at UChicago and Stanford for helpful comments and discussions.

1 Introduction

What fiscal policies provide the greatest welfare benefits relative to their financing costs? This question has become increasingly relevant, particularly as U.S. public debt has steadily risen over the past two decades[1]. From a macro-stabilization perspective, deficit-financed fiscal policy serves as a crucial tool for stimulating demand during recessions. However, these benefits must be weighed against the redistribution and future tax burden required to service and repay the debt. From a different perspective, which Blanchard (2023) calls the *pure public finance approach*, the level of public debt itself has welfare benefits as it can help provide liquidity or even generate pareto improvements by redistributing across generations (Blanchard, 2019; Aiyagari and McGrattan, 1998). These benefits, again, need to be traded-off against redistribution and incentive effects of implied taxes.

While these two channels are closely connected, as they both depend on the level of deficits and public debt, the interaction between them and their relative contribution has been relatively unexplored. To paraphrase Blanchard (2023), "the macro-stabilization approach focuses on the size of the multipliers. The pure public finance approach focuses on the marginal benefits of spending and the marginal costs of taxation and of debt. How should the two be integrated?"

In this paper, we make progress by analyzing the welfare impacts of fiscal policy in a Heterogeneous Agent New Keynesian (HANK) model. We decompose and quantify the main channels through which fiscal policy impacts welfare—and show that, in this model, the macro-stabilization and *pure public finance* effects are closely connected. The presence of nominal rigidities, incomplete insurance markets and non-ricardian households imply that deficit-financed fiscal policy can provide welfare benefits by boosting aggregate demand when output is below its steady-state level. However, running deficits leads to higher future taxes which comes at a welfare cost. The presence of idiosyncratic risk and borrowing constraints also open up the door for public debt to improve welfare by providing liquidity and/or by correcting for the pecuniary externality (Davila et al., 2012). The latter effect crucially depends on the level of public debt in the economy and is summarised by the difference in the discount rate and the real interest rate. The first contribution of this paper is to provide a decomposition that analytically characterizes these welfare benefits and costs— and their relationship to deficits and public debt.

To derive our decomposition results, we augment the HANK model with wage rigidities (Auclert, Rognlie, and Straub, 2018) to account for any arbitrary labor allocation rule, particularly one in which household is on their optimal consumption and labor choices in the steady state. In this model, we provide three analytical results that precisely characterize the channels through which deficit-financed or balanced-budget fiscal policies impact household welfare. Our first

[1]"Fiscal policy in the rich world is mind-bogglingly reckless" (The Economist, June 14, 2023). Boccia and Lett (2024): "It's time for Congress to rein in emergency spending and its abuse" (Cato Institute). . "Deficit spending is often used to respond to short-term financial 'emergency' needs such as wars or recessions. If our national debt grows higher, the federal government may even have difficulty [...] effectively responding.": Simpson-Bowles Commission.

result shows that aggregate utilitarian welfare is driven by three effects: (i) benefits from direct transfers of numeraire resulting from the policy, (ii) the aggregate labor demand channel, and (iii) the net welfare cost from additional taxation required to finance the policy.

The modified labor allocation rule ensures that, in the steady state, Marginal Rate of Transformation (MRT) and Marginal Rate of Substitution (MRS) between consumption and labor are equated for each household, i.e, the aggregate labor wedge is zero. As each household is at their optimal labor and consumption choices, fiscal policy has no first-order effects corresponding to the aggregate labor demand channel in the steady state. However, when the output is below the steady-state level, the presence of nominal wage rigidities and labor rationing by the unions imply that there is a misallocation of resources. Fiscal policy can, hence, correct for this misallocation by stimulating aggregate demand and closing the labor wedge, leading to welfare gains. This channel aligns directly with the Representative Agent New Keynesian (RANK) economy result of Woodford (2011). That is, fiscal policy is ineffective at changing welfare in the steady state since the marginal rate of transformation and the marginal rate of substitution are equalized. However, it does have an effect when a wedge exists between the two—i.e., outside the steady state.

In a RANK economy, fiscal stabilization impacts aggregate welfare solely through the labor demand channel. In contrast, fiscal policy has additional welfare effects in a HANK economy. Specifically, we demonstrate that the remaining two effects: direct transfer + tax channel are non-zero even when output is at its steady-state level. Intuitively, in an economy with heterogeneous agents, a fiscal stimulus—even with uniform transfers—redistributes wealth among individuals because the tax changes used to finance the policy are not uniformly distributed. This leads to a shift in utilitarian welfare, as some households are more affected than others. Additionally, the presence of uninsured income risk means that tax changes (levied on idiosyncratic income) also affect the distribution of risk both across individuals and within individuals over time and states. More subtly, fiscal policy also impacts welfare due to two externalities: a pecuniary externality and a fiscal externality, which leads to the self-financing of part of the policy costs.

The fiscal externality arises because labor unions, which determine households' labor supply, do not internalize that increasing aggregate labor supply also raises total tax revenue by boosting hours worked per household. This leads to the self-financing of a portion of the initial policy cost. The extent of self-financing depends on general equilibrium output response, which rises with larger deficit financing in our baseline model. Thus, greater deficit financing results in higher self-financing of the policy and, consequently, a lower welfare cost from additional tax rate adjustments needed to fund the policy.

The pecuniary externality effect, on the other hand, is determined by the level of public debt in the steady state. We show that the welfare benefit directly depends on the difference between the household discount rate ρ and the real rate of return on liquid savings r, which in turn is pinned down by the level of public debt in the economy. The presence of idiosyncratic risk and incomplete markets forces the households to accumulate precautionary savings and for the asset market to clear, given the quantity of public debt, the rate of return in the economy falls below ρ. A deficit financed fiscal policy can, however, increase welfare as the government faces no uncertainty and thus can boost current consumption. Moreover, deficits also increase the level of debt in the economy which provides larger liquidity to households. Lastly, the pecuniary effect of Davila et al. (2012) also operates as agents don't internalize the impact of their savings behavior on the other agents in the economy.

The quantitative contribution of these channels, however, varies substantially. While the aggregate labor demand channel is zero to the first order around the steady state, its magnitude remains low even under a large recessionary shock. The tax and transfer effect, while small under a balanced budget policy, rises sharply with larger amounts of deficit financing. Our quantitative exercises, highlight that this is driven completely by the net aggregate deficits effect governed by the two externalities which go in opposite direction for large amounts of deficit financing. The self financing effect increases welfare when government holds deficits for longer while the $\rho - r$ channel reduces welfare.

In the second part of the paper, we come back to our main question: Which policies provide the greatest welfare benefits relative to their financing costs? We enrich our environment to incorporate short-term debt, long-term mortgages, and unemployment risk to analyze and rank the impact of a broader range of fiscal policies, such as mortgage principal relief, payment moratoriums, and unemployment insurance extensions. To rank these policies in terms of their welfare benefits relative to their costs, we introduce two widely used metrics from empirical public finance: the Benefits-to-Cost Ratio (BCR) and the Marginal Value of Public Funds (MVPF). These ratio measures quantify the "bang for the buck" of each policy—i.e., the total value of the net benefits provided, including stabilization, direct transfers, and pecuniary externality correction, relative to the welfare cost of excess taxation required to fund the policy, adjusted for self-financing.

Our decompositions allows us to define popular policy evaluation criteria from public finance in the context of our HANK economy. Specifically, we extend our analysis by defining an Aggregate Efficiency Social Welfare Function from Dávila and Schaab (2022*b*). This SWF defines the total gains from a policy as aggregate Kaldor-Hicks efficiency change (Kaldor, 1939; Hicks, 1939) or the net Willingness-to-Pay of all individuals for the policy in terms of a common numeraire. Using our decomposition with this SWF, we then define the Benefits-to-Cost Ratio as the ratio of aggregate WTP for direct and labor demand benefits of the policy to the WTP for the rise in tax rates. The Marginal Value of Public Funds (Hendren and Sprung-Keyser, 2020) divides the same numerator by net cost of the policy in terms of the numeraire — accounting for the self financing of the policy. Closing the government budget also allows us to define the relationship between MVPF and BCR in our economy.

In the last section of the paper, we extend the model in multiple dimensions. We allow the households to have two types of assets, short-term savings/debt and long-term mortgages. We also add unemployment risk i.e. the households get an exogenous unemployment shock and stay out of the labor force before finding employment again. This setting allows us to compare and rank different fiscal policies commonly used during recessions including spending, targeted transfers, mortgage relief, mortgage moratorium, and unemployment insurance extensions.[2] We compare these policies by computing the net total welfare effects and their “bang for buck" as given by the two measures.

Our results complement the empirical public finance literature by demonstrating that policies like moratoriums can deliver a high "bang for the buck." A moratorium provides liquidity to borrowing-constrained households in exchange for higher future payments. This can generate significant consumption and stabilization effects while imposing minimal fiscal costs, as it primarily redistributes resources across time for the same individual. However, we show that relying solely on measures like the Benefits-to-Cost Ratio (BCR) and the Marginal Value of Public Funds (MVPF) can lead to misleading policy conclusions. The net aggregate welfare benefits of a moratorium scale highly non-linearly. Intuitively, moratorium-like policies primarily benefit a subset of households—those with access to home equity but constrained by fixed costs. As a result, such policies can "empty their chamber" relatively quickly, limiting their net aggregate welfare impact compared to alternatives like principal reductions.

Literature Over the past decade, a substantial body of literature has examined the aggregate and distributional impacts of fiscal and monetary policies in models with incomplete markets, idiosyncratic risk, and nominal rigidities (Kaplan, Moll, and Violante, 2018; Auclert, 2019; Auclert, Rognlie, and Straub, 2018; Hagedorn, Manovskii, and Mitman, 2019; McKay and Reis, 2016)[3]. However, much of this research has primarily focused on the consumption effects of fiscal policies, with less attention given to their welfare implications. Bartal and Becard (2024) and Carroll et al. (2023) are two recent papers that quantitatively study welfare effects of government spending and transfers under a utilitarian social welfare function in HANK models[4].

Relative to their work, we contribute in multiple dimensions. First, our decomposition provides an analytical characterization of the key channels through which fiscal policy affects welfare in HANK economies, while also quantifying the role of each channel. Second, we explicitly highlight the role of deficits and public debt in shaping welfare outcomes. Traditionally, one strand of literature, which Blanchard (2023) refers to as *pure public finance*, focuses on the long term welfare effects of public debt and studies fiscal policy as a tool to alter the quantity of debt to desired levels (Aiyagari, 1995; Aiyagari and McGrattan, 1998; Davila et al., 2012; Blanchard, 2019)[5] . The other strand, which Blanchard (2023) terms *pure functional finance*, focuses on the role of fiscal policy as a tool of aggregate demand management and studies the relationship between

[2]We provide a background on some of these policies in Appendix D.1

[3]See Violante (2021) and Auclert, Rognlie, and Straub (2024) for a review.

[4]Bhandari et al. (2017); Dávila and Schaab (2022*a*); Auclert et al. (2024); LeGrand and Ragot (2023) study optimal policy in heterogeneous environments

[5]with dynamic efficiency playing a central role (Samuelson, 1958; Diamond, 1965; Abel et al., 1989)

output multipliers and deficits (Auclert, Rognlie, and Straub, 2018; Hagedorn, Manovskii, and Mitman, 2019; Angeletos, Lian, and Wolf, 2024). Our paper shows that, in a HANK framework, the two roles of fiscal policy are closely interconnected. While fiscal policy enhances welfare by "filling the gap" during recessions, it also interacts with pecuniary externalities and dynamic inefficiency—two key mechanisms in the *pure public finance* approach. The impact of the latter channels depends on the equilibrium difference between the discount rate and endogenous real interest rate, which we describe in Section 3.4.

Third, we incorporate tools from empirical public finance literature and a burgeoning literature studying welfare assessments with heterogeneous agents (Saez and Stantcheva, 2016; Dávila and Schaab, 2022*b*; Bhandari et al., 2023) to provide a welfare ranking of fiscal policies in a HANK environment. Specifically, we apply the efficiency planner formulation from Dávila and Schaab (2022*b*) to quantify the aggregate willingness-to-pay for a fiscal policy shock. We then construct the counterparts of standard public finance evaluation criteria, such as the Benefits-to-Cost Ratio and the Marginal Value of Public Funds in the HANK economy (Hendren and Sprung-Keyser, 2020, 2022; García and Heckman, 2022; Bergstrom, Dodds, and Rios, 2024). This provides a unified criterion for comparing the welfare effects of different policies. However, we also emphasize the limitations of these ratio approaches.

Lastly, our main application contributes to the literature on evaluating the impacts of various debt relief policies implemented during recessions[6] (Bolton and Rosenthal, 2002; Cherry et al., 2021; Ganong and Noel, 2020; Noel, 2021; Dinerstein, Yannelis, and Chen, 2023; Agarwal et al., 2017; Scharlemann and Shore, 2016). While Noel (2021); Dinerstein, Yannelis, and Chen (2023); Laibson, Maxted, and Moll (2021) advocate for payment pauses and moratoriums as cost-effective policies that deliver a larger "bang for the buck," other policymakers and economists argue for permanent debt relief[7]. Empirical studies typically assess the consumption effects of such policies on affected households relative to their fiscal cost. In contrast, we complement this approach by evaluating welfare effects, incorporating both direct and general equilibrium benefits while accounting for the welfare loss from the policy's fiscal cost. For instance, while moratoriums often exhibit a high Marginal Value of Public Funds (MVPF), their aggregate welfare effects scale in a highly nonlinear manner.

Layout The paper is organized as follows: We lay out the baseline model in Section 2. In Section 3 we provide the analytical results from our main decomposition exercise and quantify different channels under a standard calibration in Section 4. Lastly, we layout an extended version of our baseline model, define policy ranking criteria and rank different fiscal policies in Section 5

[6]Examples from the United States include the Farm Mortgage Pauses during the Great Depression, the Home Affordable Mortgage Program (HAMP) following the 2008 Financial Crisis, and Debt Moratoriums during the COVID-19 crisis.

[7]Piskorski and Seru: "If You Want a Quick Recovery, Forgive Debts" (Barron's, April 15, 2020).

2 Model: HANK with Wage Rigidities

This section lays out a standard heterogeneous agent framework with wage rigidities to study the welfare effects of fiscal policies. Time is continuous in the model and the structure follows directly from (Auclert, Rognlie, and Straub, 2018). However, we differ from them by introducing a general labor allocation rule in the union problem which we fully describe in Section 2.2.

2.1 Households

There is a unit mass of households denoted by $i \in [0, 1]$. Each households is infinitely lived and discounts the future at rate ρ. It gets a flow utility u from consumption c_t and a dis-utility flow from working $n_t \in [0, 1]$, where n_t denote the hours worked as a fraction of the unit time endowment. Their preferences are time separable and they maximize the following objective

$$V_0^i(\cdot) = \mathbb{E}_0 \int e^{-\rho t} u(c_{it}, n_{it}) dt \tag{1}$$

subject to a budget constraint. The expectation is taken over the idiosyncratic productivity shocks, the households have perfect foresight over aggregate shocks. Their state at time is given by (a_{it}, e_{it}) where a_{it} is the amount of liquid assets and e_{it} is the idiosyncratic productivity. They can use the liquid asset to save and borrow, up to an exogenous borrowing limit $\underline{a}$, at a real interest rate r_t. Given the current state, household's asset holdings evolve as follows

$$\dot{a}_{it} = r_t a_{it} - c_{it} + \Gamma_t(a_{it}, e_{it}) + (1 - \tau_t)\left(e_{it} n_{it} \frac{W_t}{P_t}\right) \tag{2}$$

$$a_{it} \geq \underline{a} \tag{3}$$

Households income stream consists of interest payments, government transfers $\Gamma(a_{it}, e_{it})$, and after tax income which is determined the tax rates τ_t, effective labor supply $e_{it} n_{it}$ and real wage $\frac{W_t}{P_t}$. The savings/borrowing are hence determined by flow income net of consumption.

Households maximize 1 subject to 2-3 by choosing a path of consumption $\{c_{it}\}_{i,t\geq 0}$. The household labor supply is determined by the labor unions[8]. Hence, they take as given the path of labor supply, interest rates, wages, prices, transfers and tax rates $\{n_{it}\}_{i,t\geq 0}, \{r_t, W_t, P_t, \Gamma_t, \tau_t\}_{t\geq 0}$. In the steady state a recursive formulation of the problem gives optimal consumption policies $c(a, e, \Theta)$ with $\Theta := \{r, W, P, \Gamma, \tau\}$ along with optimal labor supply $n(a, e)$ chosen by the unions. Optimal drift of liquid assets implied by these decision rules along with the idiosyncratic productivity process imply a stationary distribution $g(da, de)$. Outside the steady state each object is time-varying and depend on $\Theta_t := \{r_t, W_t, P_t, \Gamma_t, \tau_t\}$ and $n_t(a, e)$ which we define next.

[8] This is due to labor market frictions, see Auclert and Rognlie (2017)

2.2 Labor Market

The labor hours n_{it} of an individual i are determined by a union (Erceg, Henderson, and Levin, 2000; Schmitt-Grohé and Uribe, 2005; Auclert, Rognlie, and Straub, 2018). The labor market structure consists of an aggregate labor packer who combines differentiated labor tasks supplied by a continuum of unions. Each union chooses the optimal amount of tasks to maximise the utility of all its members subject to Rotemberg adjustment costs (Rotemberg, 1982) and final demand from the labor packer. Specifically,

Final Labor Packer — There is a final competitive labor packer that packages tasks produced by different labor unions (indexed by $k \in [0,1]$) into aggregate employment services using a CES technology.

$$N_t = \left(\int_0^1 n_{k,t}^{\frac{\epsilon-1}{\epsilon}} dk \right)^{\frac{\epsilon}{\epsilon-1}} \tag{4}$$

where $\epsilon > 0$ is the elasticity of substitution across tasks. Cost minimization implies that the demand tasks from union k is

$$n_{k,t}(w_{k,t}) = \left(\frac{w_{k,t}}{W_t} \right)^{-\epsilon} N_t \qquad\qquad \text{where } W_t = \left(\int_0^1 w_{k,t}^{1-\epsilon} dk \right)^{\frac{1}{1-\epsilon}} \tag{5}$$

Unions.— Unions hire a representative sample of the population as its members. Each union $k \in [0,1]$ then rations labor to its members based on an allocation rule $n_{kt}(a_t, e_t)$[9]. The union k then aggregates efficient units of work into a union-specific task, $n_{k,t}$

$$n_{k,t} = \int_0^1 e_{it} n_{kt}(a_t, e_t) g_t(da_t, de_t) \tag{6}$$

Union's Problem.—The union seeks to maximise the utility of all its members subject to a quadratic adjustment cost by choosing wages $\{w_{k,t}\}_{t>0}$ to maximise

$$\max_{\{w_{k,t}\}_{t\geq 0}} \left\{ \int_0^\infty e^{-\int_0^t \rho_s ds} \left(\left\{ \int \int u \left(c_t(a_t, e_t), \int n_{k,t}(a_t, e_t) dk \right) g_t(da_t, de_t) \right\} - \frac{\Psi}{2} \left(\frac{\dot{w}_{k,t}}{W_t} \right) \right) dt \right\} \tag{7}$$

given the demand curve (Equation 5) for its task. Here $g_t(da, de)$ is the distribution of $\{a_t, e_t\}$ at time t.

Labor Allocation Rule Each union is infinitesimal and therefore only takes into account its marginal effect on every household's consumption and labor supply. Moreover, by symmetry

[9]We allow labor allocation rules do depend on individual state (a_t, e_t). This differs from Auclert and Rognlie (2017) who use an allocation rule where labor is rationed equally to all households irrespective of their state. Auclert and Rognlie (2017) can be written as a special case of our allocation rule.

each union sets the same wage $W_{kt} = W_t$ and all of them use the same labor allocation rule which we assume is of the following form

$$n(a_t, e_t) = \frac{\gamma(a_t, e_t)}{\mathbb{E}\gamma(a_t, e_t)} N_t$$

where N_t is the aggregate labor demand in the economy and $\mathbb{E}\gamma(a_t, e_t) = \int \gamma(a_t, e_t) g_t(da, de)$ i.e. the unions use a function $\gamma(a_t, e_t)$ to determine the labor supply of a households with state (a_t, e_t) as a fraction of the total labor demand in the economy. When $\gamma(a_t, e_t) = 1 \quad \forall (a_t, e_t)$ all workers work the same number of hours and corresponds to the model in Auclert, Rognlie, and Straub (2018). We also consider a special alternate allocation rule where in steady state $\gamma(a_t, e_t) = \bar{\gamma}(a_t, e_t)$ is such that:

$$v'\left(\frac{\bar{\gamma}(a,e)}{\mathbb{E}_{ss}\bar{\gamma}(a,e)} N_{ss}\right) = u'(c_{ss}(a,e))\left((1-\tau_{ss})\frac{W_{ss}}{P_{ss}}\frac{\bar{\gamma}(a,e)}{\mathbb{E}_{ss}\bar{\gamma}(a,e)} N_{ss}\right) \tag{8}$$

This labor allocation rule ensures that households are at their optimal consumption and labor choices in the steady state. Outside of the steady state, the rationed labor is determined by function $\bar{\gamma}(a, e)$ which solves the Eq 8.

Finally, this labor market setup yields aggregate wage inflation that evolves according to the following New Keynesian Wage Phillips Curve (derived in Appendix A.2) -

$$\rho\pi_w = \frac{\epsilon}{\Psi} N_t \int \left[\gamma_{i,t} v'(n_{it}) - (1-\tau^s)\frac{\epsilon - 1}{\epsilon}(1-\tau_t) e_{it} w_t u'(c_{it})\right] di + \dot{\pi}_w \tag{9}$$

According to Eq. 9, conditional on future nominal wage inflation, the unions set a higher wage if the marginal rate of substitution between labor hours and consumption $v'(n_{it})/u'(c_{it})$ exceeds the marginal rate of transformation. We set the subsidy τ_s such that $(1-\tau^s)\frac{\epsilon-1}{\epsilon}$ ensuring that our labor allocation rule implies zero inflation in the steady state.

2.3 Production

Production is linear in aggregate labor i.e. the aggregate output in the economy is given by

$$Y_t = X_t N_t$$

where X_t is aggregate productivity. There is perfect competition and prices are fully flexible. This implies that the firm earns zero profits $P_t X_t N_t - W_t N_t = 0$, thus

$$P_t X_t = W_t$$

This implies a simple relationship between wage and price inflation: $\pi_t = \pi_t^w - \frac{\dot{X}_t}{X_t}$. Hence, when there are no shocks to aggregate TFP, price and wage inflation are equalized.

2.4 Consolidated Monetary-Fiscal Authority

Government sets an exogenous plan for spending $\{G_t\}$, taxes $\{T_t\}$ and transfers $\Gamma_t(\cdot)$ taking the initial level of government debt as given. It alters the total tax revenue raised by changing the rate of taxation τ_t. This yields the following law of motion for government debt

$$\dot{B}_t = rB_t + G_t + \Gamma_t - T_t$$

where T_t and Γ_t are calculated as follows

$$\int \tau_t \left(\frac{W_t}{P_t} e_{it} n_{it} \right) dg_t(da_t, de_t) = T_t \tag{10}$$

$$\int \Gamma(a_{it}, e_{it}) dg_t(da_t, de_t) = \Gamma_t \tag{11}$$

To pin down the evolution of government debt and taxes outside the steady state, we assume that the government follows the following rule to adjust its primary surpluses $s(t) := T_t - G_t - \Gamma_t$.

$$s(t) = s^* + \phi(B(t) - B^*).$$

Where s^* is the steady state level of surpluses and the parameter ϕ governs the level of deficit financing for a policy. A large value of ϕ implies that the debt is repaid quickly, and $\phi \to \infty$ is equivalent to balanced-budget policy where aggregate debt fixed. On the other hand, $\phi \to r$ implies that the government runs the deficit to perpetuity.

Monetary Authority.— sets the nominal interest rate on the liquid asset by following a Taylor rule with coefficient ϕ_π i.e. $i_t = \bar{r} + \phi_\pi \pi_t + \epsilon_t$. For our main results we assume that $\phi_\pi = 1$. This implies that the real interest rate, given by the Fisher equation $r_t = i_t - \pi_t$, is constant. We consider the case of active monetary policy i.e. a Taylor rule with $\phi_\pi > 1$ in Section 4.6.1.

2.5 Equilibrium

Definition 1. *Competitive Equilibrium: Given an initial distribution of household assets and idiosyncratic productivities $g_0(da, de)$, and a sequence of taxes, transfers, and government spending $\{T_t, \gamma_t, G_t\}_t$, exogenous shocks $\{X_t, \rho_t, \epsilon_t\}$, a competitive equilibrium is given by prices $\{P_t, W_t, \pi_t, \pi_t^w, r_t, w_t\}$, aggregate quantities $\{Y_t, N_t, C_t, B_t, T_t, \Gamma_t, G_t\}$ and individual policies $\{a_t, c_t, n_t\}$ such that the households optimize, unions optimize, firms optimize, monetary and fiscal policy follow their rules, and the goods, asset, and* *labor markets clears, and the government balances its budget*

$$\begin{aligned}
Y_t &= C_t + G_t \\
A_t &= B_t \\
N_t &= \int n_t(a_t, e_t) dg_t \\
\dot{B}_t &= rB_t + G_t - T_t + \Gamma_t
\end{aligned}$$

3 Welfare Effects of Fiscal Policies

In this section, we provide our main theoretical results. First, we present a decomposition that separates the first-order welfare effects of any policy in the HANK model into three components: (1) direct benefits from individual transfers provided by the policy, (2) general equilibrium effects (multiplier), and (3) welfare losses associated with financing the policy through additional taxes. We provide analytical expressions for each of these components and show that, in addition to the aggregate stabilization channels active in a RANK economy, the HANK economy features four additional sources of welfare effects for fiscal policy shocks: redistribution across households, intertemporal risk transfer, suboptimality of the level of liquid savings in the steady state, and self-financing.

3.1 Social Welfare Function

For the results in Section 3 and Section 4 we evaluate the welfare effects of different policies by using a utilitarian welfare function i.e. with pareto weights $\alpha(a,e) = 1 \quad \forall a, e$. This implies that after any policy perturbation governed by the scalar parameter θ, the aggregate welfare change conditional on the initial state distribution is given by

$$\frac{dW}{d\theta} := \int \int \alpha(a_0, e_0) \frac{dV(a_0, e_0)}{d\theta} g(a_0, e_0) dade. \tag{12}$$

While we present our main results using a utilitarian social welfare function (SWF), Appendix 5.1 generalizes our results to arbitrary SWFs.

3.2 Welfare Decomposition

In the HANK model defined in Section 2, the only time-varying prices and quantities that matter for agent i's consumption and welfare at time t are exogenous individual-specific transfers, $\{\Gamma_s(a_s, e_s)\}_{s\geq t}$, tax rates, $\{\tau_s\}_{s\geq t}$, and aggregate labor demand, $\{N_s\}_{s\geq t}$.[10] Hence, from the goods market clearing condition and the government budget condition, we can see that these three

[10]Given $Z_t = (1-\tau_t)N_t$, agent i's income in period t is given by $z_{it} = Z_t \frac{e_{it}^{1-\lambda}}{\int e_{it}^{1-\lambda} di}$. And because of the constant real rate rule for monetary policy, changes in the nominal interest rate and inflation do not affect household utility.

sequences are also sufficient to describe the equilibrium of the economy. Thus, starting from the steady-state distribution, household instantaneous utilities are entirely determined by these three aggregate sequences and can be expressed as a function of the form —

$$V(a_0, e_o) = \mathcal{V}(\{\Gamma_s(a_s, e_s)\}, \{N_s\}, \{\tau_s\} | a_0, e_0) \tag{13}$$

Given any set of weights defined in Section 3.1, the aggregate normalized welfare can thus also be expressed entirely as a function of these aggregates (relative to the steady-state values).

$$W = \mathcal{W}(\{\Gamma_s\}, \{\tau_s\}, \{N_s\}) \tag{14}$$

Here, Γ_s are the aggregate transfers, τ_s the tax rate and N_s the aggregate labor demand. Hence, up to first order we can decompose the aggregate welfare in the economy as

Proposition 1 (Welfare Decomposition)**.** *Aggregate welfare gains from a policy perturbation can be decomposed into three effects (to first-order)*

$$dW = \mathbf{\Omega}^{\mathbf{\Gamma}} d\mathbf{\Gamma} + \mathbf{\Omega}^N d\mathbf{N} + \mathbf{\Omega}^\tau d\boldsymbol{\tau}$$

where $\mathbf{\Omega}^{\mathbf{\Gamma}} d\mathbf{\Gamma} = \int_{s=0}^{\infty} \frac{\partial W}{\partial \Gamma(s)} d\Gamma(s) ds$, $\mathbf{\Omega}^N d\mathbf{N} = \int_{s=0}^{\infty} \frac{\partial W}{\partial N(s)} dN(s) ds$ *and* $\mathbf{\Omega}^\tau d\boldsymbol{\tau} = \int_{s=0}^{\infty} \frac{\partial W}{\partial \tau(s)} d\tau(s) ds$. *See Appendix B.1 for analytical expressions of* $\mathbf{\Omega}^{\mathbf{\Gamma}}, \mathbf{\Omega}^N$ *and* $\mathbf{\Omega}^\tau$

First, there is a *direct transfer* effect on welfare, $\mathbf{\Omega}^{\mathbf{\Gamma}} d\mathbf{\Gamma}$. This effect reflects the increase in income for households receiving a government transfer, which, holding all else equal, leads to a gain in utility. Second, there is the *labor demand* effect of the transfer policy, which operates through general equilibrium changes in output, labor supply, and labor income. This effect, given by $\mathbf{\Omega}^N d\mathbf{N}$, can either enhance or reduce welfare depending on the sign of $\mathbf{\Omega}^N$, a point we discuss in detail in Sec. 3.3. Lastly, financing a policy requires the government to adjust *tax rates* over time. Higher taxes reduce welfare by lowering households' disposable income for consumption and spending. Thus, Proposition 1 highlights the trade-offs in the welfare impact of a transfer policy financed by raising taxes — either contemporaneously or in the future. While transfers can increase aggregate welfare, they must be weighed against the potential welfare losses from future tax increases. Additionally, the labor demand effects of a policy may be either positive or negative, depending on the sign of $\mathbf{\Omega}^N$.

In the next two sections, we examine each of these effects separately. First, we analyze the general equilibrium welfare effect, followed by an analysis of the direct and financing welfare effects, which we refer to as the "tax and transfer" effects.

3.3 Aggregate Labor Demand Channel

Proposition 2 provides an analytical expression for the aggregate labor demand effect in terms of the steady-state values of the household Marginal Rate of Substitution (MRS) and Marginal Rate of Transformation (MRT). Specifically, $\Omega^N(s)$, the marginal effect of a unit increase in aggregate labor supply on aggregate welfare, is determined by the expected aggregate labor wedge. This wedge arises due to labor rationing by unions, which prevents households from choosing their optimal labor supply. Furthermore, since household MRT and MRS differ, this effect can either enhance or reduce welfare.

Proposition 2. *Denote the period s state of an agent who starts with (a_0, e_0) as $x_s = (a_s, e_s)$. The labor demand effect is*

$$
\begin{aligned}
\boldsymbol{\Omega}^N \boldsymbol{dN} &= \int_0^\infty e^{-\rho s}\Omega^N(s)dN(s)ds \\
&= \int_{s=0}^\infty e^{-\rho s}\left[\int_{a_0,e_0}\mathbb{E}_0^i\Big[\underbrace{(1-\tau)we_s u'(c^{ss}(x_s)) - v'(n^{ss}(x_s))}_{\text{Individual labor Wedge}}\Big]\gamma_0(\cdot)dg_0(\cdot)\right]dN_s ds
\end{aligned}
$$

This effect also arises in a RANK economy with wage rigidities (Woodford, 2011). Since there is a representative agent, the labor wedge is simply given by $(1-\tau)Wu'(C) - v'(N)$ i.e. the difference between the MRT and MRS of the representative agent. In the steady state, this effect is zero, as households are at their optimal labor and consumption choices. However, during recessions, the wedge becomes positive because rigid wages prevent the representative household from supplying enough labor. Conversely, during booms, the wedge turns negative, as households cannot immediately increase their labor supply due to wage rigidities. Thus, a government spending policy[11] can improve welfare outside the steady state by stimulating labor supply during recessions and reducing it during booms. However, to a first-order approximation, it has no effect on welfare in the steady state.

In contrast, in the HANK model of Auclert, Rognlie, and Straub (2018), the welfare effects of stimulating aggregate labor supply are nonzero even in the steady state. This arises due to the equal rationing rule imposed by labor unions and the calibration targeting of a zero wedge in the Wage New Keynesian Phillips Curve, which incorporates markups. As a result, while the wedge in the Phillips Curve is zero, the welfare-relevant labor wedge may still be positive or negative, even in the steady state[12]. Thus, to have a direct comparison with the RANK economy, we adopt the allocation rule specified in equation 8, which ensures that all individual labor wedges are closed in the steady state.

This labor allocation rule ensures that the labor demand welfare effects are zero to a first-order approximation for any social welfare function and any fiscal policy. Intuitively, this rule guaran-

[11]Deficit-financed transfers have no effect since the household is Ricardian.

[12]This ensures that welfare relevant wedge is zero for all planners with different pareto weights

tees that for *every* household, the additional benefit from working more is exactly offset by the disutility of increased labor, eliminating any welfare gain from adjusting labor supply. Corollary 1 formalizes this insight.

Corollary 1. *With the γ^* allocation rule , the labor demand effect for small shocks around steady state is zero.* $\boldsymbol{\Omega}^N \boldsymbol{dN} = 0$ *as*

$$\mathbb{E}_0^i \Big[\underbrace{(1-\tau) w e_s u'(c^{ss}(a_s, e_s | a_0, e_0)) - v'(\gamma^*(a_s, e_s | a_0, e_0) N^{ss})}_{\textit{Labor Wedge}} \Big] = 0 \quad \forall a_0, e_0$$

Proof. See Appendix B.3 □

With this labor allocation rule, the aggregate labor demand effect on welfare aligns directly with the RANK economy result of Woodford (2011). That is, fiscal policy is ineffective at changing welfare in the steady state since the marginal rate of transformation and the marginal rate of substitution are equalized. However, it does have an effect when a wedge exists between the two—i.e., outside the steady state. For example, under a large exogenous contractionary shock, where $\Omega^N > 0$, fiscal policy would have a first-order general equilibrium effect of improving welfare. In Section 4.5, we numerically demonstrate that $\Omega^N > 0$ when a positive real rate shock induces a recession. Consequently, policies that stimulate output (e.g., transfers or government spending) generate positive labor demand welfare effects during a recession, and vice versa.

3.4 Tax and Transfer Channel

In a RANK economy, fiscal stabilization impacts aggregate welfare solely by closing the wedge identified in the previous section—that is, through the aggregate labor demand channel—during periods when output falls below its flexible-wage level. In contrast, fiscal policy has additional welfare effects in a HANK economy. Specifically, we demonstrate that the terms $\boldsymbol{\Omega}^{\boldsymbol{\Gamma}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{\tau} d\boldsymbol{\tau}$ are non-zero even when output is at its steady-state level. These terms also serve as additional factors influencing welfare when fiscal policy is employed as a tool for aggregate demand management — on top of the "filling the output gap" effect.

Intuitively, in an economy with heterogeneous agents, a fiscal stimulus—even with uniform transfers—redistributes wealth among individuals because the tax changes resulting from financing the policy are not uniformly distributed. This leads to a shift in utilitarian welfare, as some households are more affected than others. Additionally, the presence of uninsured income risk means that tax changes (levied on idiosyncratic income) also affect the distribution of risk both across individuals and within individuals over time. More subtly, fiscal policy also impacts welfare due to two externalities: a pecuniary externality[13] and a fiscal externality, which leads to the self-financing of part of the policy costs.

[13] Because of the un-insurable idiosyncratic income risk, households save too much in the steady state. However, as there is no aggregate uncertainty, the government can increase welfare by running deficits.

Proposition 3 formalizes this intuition by combining the Ω^{Γ} and Ω^{τ} terms to decompose the tax and transfer effects into three components: a net "static" aggregate deficits term, a term that captures the incidence of these aggregate deficits across individuals, and finally, a term that captures changes in individual risk while keeping the deficits fixed.

Proposition 3. *For a uniform transfer shock $d\Gamma_s(a,e) = d\Gamma_s$ in period s, the effects of deficit financing on welfare are given by the following terms*

$$\boldsymbol{\Omega}^{\boldsymbol{\Gamma}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{\tau} d\boldsymbol{\tau} =$$
$$\int_0^{\infty} e^{-\rho s} \Bigg[\underbrace{\mathcal{U}_s'[d\Gamma_s - Y_{ss} d\tau_s]}_{\text{Net Aggregate Deficits}} + \underbrace{\mathbb{C}ov_{a,e}\Big(\mathbb{E}_0^i\left[u'(c^{ss}(x_s))\right], \mathbb{E}_0^i[d\Gamma_s - we_s n^{ss}(x_s) d\tau_s]\Big)}_{\text{Deficit Incidence}}$$
$$+ \underbrace{\mathbb{E}_{a,e}\Big(\mathbb{C}ov^i\left(u'(c^{ss}(x_s)), d\Gamma_s - we_s n^{ss}(x_s) d\tau_s\right)\Big)}_{\text{Aggregate Insurance Effect}} \Bigg] ds$$

where $\mathcal{U}_s' := \int u'(c_s(a,e)) g_0(a_0,e_0) da de = \mathbb{E}_{a,e}[u'(c_s)]$ and $dT_s = d(Y_s \tau_s)$

Proof. See Appendix B.4 □

In the Net Aggregate Deficits term, $[d\Gamma_s - Y_{ss} d\tau_s]$ represents the net aggregate static deficits in period s, i.e., the cost of the policy minus the tax raised, with output held at the steady-state level. When multiplied by an "average" utility and discounted at rate ρ, this term captures the total welfare, which depends solely on the *aggregate* deficits. The second term depends on the distribution of these net deficits. While transfers are uniform, taxes are based on each household's idiosyncratic productivity and labor supply, leading to a heterogeneous impact across households. The covariance term summarizes the total effect: it is welfare-improving if households with higher expected marginal utility receive higher net transfers. Similarly, the covariance in the final term is positive if households receive transfers during high marginal utility states and repay during low marginal utility states. We next discuss each term in detail.

Net Aggregate Deficits The term isolates the effect of aggregate deficits on aggregate welfare for a fiscal stimulus that provides uniform transfers to all households. First, note that this term is zero under a balanced budget policy, i.e., if $d\Gamma_s = Y_{ss} d\tau_s$. However, the term becomes positive if the uniform transfers are financed by deficits and the net transfers are valued according to the average (normalized) marginal utility, which is independent of the time period. These welfare impacts arise due to two externalities: a pecuniary externality resulting from over-saving by households, and a fiscal externality, as labor unions do not internalize that changes in labor supply also affect income tax revenue and, consequently, future tax rates.

Formally, we can combine this term with the intertemporal government budget constraint,

$\left(\int_0^\infty e^{-rs}(d\Gamma_s - d(\tau_s Y_s)ds\right) = 0$, to split the net aggregate deficits term into two components

$$\begin{aligned}
&\bar{\mathcal{U}}' \int_0^\infty e^{-\rho s}[d\Gamma_s - Y_{ss} d\tau_s] \\
&= \underbrace{\bar{\mathcal{U}}' \int e^{-rs}\tau_{ss} dY_s ds}_{\text{Self-financing}} + \underbrace{\bar{\mathcal{U}}' \int_0^\infty \left[e^{-\rho s} - e^{-rs}\right] [d\Gamma_s - Y_{ss} d\tau_s]}_{\text{Pecuniary Externality}}
\end{aligned} \tag{15}$$

Equation 15 illustrates that fiscal policy has two externalities that drive welfare changes in the HANK economy. The first term represents the net present value, discounted by the real rate r, of the self-financing effect that fiscal policy has in equilibrium. A stimulative policy, like uniform transfers, results in a welfare gain as part of the policy is self-financed. This occurs because: 1) the uniform transfers increase household consumption, as households are non-Ricardian, which decreases marginal utility and opens up the household labor wedge. This induces labor unions to increase labor demand[14], and 2) unions do not internalize that by increasing labor supply, they also increase total tax revenues. The combination of the two results in a welfare change given by $\bar{\mathcal{U}}' \int e^{-rs}\tau_{ss} dY_s ds$.

The second welfare effect arises from the "pecuniary externality" (Davila et al., 2012; Aiyagari, 1995)[15]. Since markets are incomplete, there is a precautionary motive for accumulating savings. In addition, the possibility of being borrowing-constrained in future periods motivates agents to accumulate even more savings. These two factors lead to an increase in savings, thereby lowering the real rate below the discount rate, i.e., $\rho > r$. However, as there is no aggregate uncertainty, a deficit-financed fiscal policy can increase welfare by boosting present consumption. The countervailing effect of increased savings, due to the rise in the real rate, is effectively neutralized by the monetary authority's adherence to a constant real rate rule.

Fiscal policy as a tool for aggregate demand management also affects welfare in HANK economies by redistributing across individuals, which we discuss next. However, to summarize, these two externalities imply that the welfare effects of fiscal policies may be amplified in the presence of heterogeneous agents. In addition to the aggregate labor demand channel, fiscal policies also influence welfare by self-financing a part of the initial policy cost, and by interacting with the over- or under-accumulation of savings in the steady state compared to optimal levels. The first effect, which depends on the amount of self-financing, is fully determined by the steady-state iMPCs of the model. The second effect depends on the amount of steady-state savings and government debt, which determine the difference between ρ and r.

[14] To the first order, this does not affect welfare through the aggregate labor demand channel, as the marginal rate of transformation (MRT) and marginal rate of substitution (MRS) were equated in the steady state.

[15] i.e., "the incomplete market structure itself induces outcomes that could be improved upon, in the Pareto sense, if consumers merely acted differently—if they used the same set of markets but departed from purely self-interested optimization" — Davila et al. (2012).

Deficit Incidence Even with a fiscal policy that uses transfers that are uniformly distributed, the net income effects on households are distributed heterogeneously. This is because income taxes, which finance the policy, depend on individual idiosyncratic productivity and labor supply. The total impact of the redistribution, thus, depends on how the net transfers are distributed across individuals with different marginal utilities. For example, if the fiscal policy redistributes towards individuals with high marginal utility, it would lead to a welfare increase from the perspective of a utilitarian planner.

$$\mathbb{C}ov_{a,e}\Big(\mathbb{E}_0^i\left[u'(c^{ss}(x_s))\right], \mathbb{E}_0^i[d\Gamma_s - we_s n^{ss}(x_s)d\tau_s]\Big) \tag{16}$$

As a special case, this term is exactly zero if labor unions follow a constant labor allocation rule, i.e., $n(x_s) = N$, and if idiosyncratic productivity follows a process such that $\mathbb{E}[e_s] = \bar{e}$. In this case, all households pay the same expected taxes and receive equal transfers, meaning the policy does not redistribute resources across households with different marginal utilities. As a result, this term vanishes.

Aggregate Insurance Due to the presence of idiosyncratic income risk, individuals experience different marginal utilities in different states over their lifetimes. Since income taxes depend on idiosyncratic productivity states, uniform transfers financed by income taxes may effectively redistribute income across different states for the same household. The overall impact of this redistribution depends on the joint distribution of net transfers and households' marginal utilities across states. This impact is captured by the covariance term in Eq. 17 for each individual, and the total welfare change is given by the cross-sectional average of all these covariances.

$$\int_0^\infty e^{-\rho s}\mathbb{E}_{a,e}\Big(Cov^i\left(u'(c^{ss}(x_s)), d\Gamma_s - we_s n^{ss}(x_s)d\tau_s\right)\Big)ds \tag{17}$$

Similar to the Deficit Incidence term, this term vanishes under a special case where labor allocation is constant and taxes are levied only on the non-idiosyncratic component of household income. In this case, fiscal policy does not redistribute income across different states, and its effects operate solely through aggregate deficits.

4 Quantitative Welfare Impact in Simple HANK

In this section, we illustrate and quantify our decompositions by comparing a uniform transfer shock under different levels of deficit financing in the one-account HANK model from Section 2. The shocks occur in the first period ($t = 0$), after which government transfers revert to steady-state levels. Agents do not anticipate the shocks and have perfect foresight.

4.1 Calibration

Table 1: Calibration of Model Parameters

Parameter	Value	Description
Y^{ss}	1	Steady-state quarterly output
r	0.005	Quarterly real rate
ρ	0.019	Discount rate
γ	1	IES
ϕ	0.5	Frisch Elasticity
φ	-	Labor disutility
$\underline{a}$	0	Borrowing constraint
G	0.2	Govt. spending
B	0.25	Liquid bonds
(ρ_e, σ_e)	(0.967, 0.017)	Productivity persistence and Std. Dev.
Statistics		
% on borrowing constraint	0.268	

Household preferences follow a separable constant elasticity utility function specification: $u(c_t, n_t) = \frac{c^{1+\gamma}}{1+\gamma} - \varphi\frac{n_t^{1+\phi}}{1+\phi}$. In our baseline calibration, we set $\gamma = 1$, implying a log utility over consumption, and set the Frisch elasticity to be 2, i.e., $\phi = 0.5$. We impose a hard borrowing constraint by setting $\underline{a} = 0$, and we set the interest rate to $r = 0.005$ per quarter (equivalent to 2% per year).

Household preferences follow a separable constant elasticity utility function specification: $u(c_t, n_t) = \frac{c^{1+\gamma}}{1+\gamma} - \varphi\frac{n_t^{1+\phi}}{1+\phi}$. In our baseline calibration, we set $\gamma = 1$, implying a log utility over consumption, and set the Frisch elasticity to be 2, i.e., $\phi = 0.5$. We impose a hard borrowing constraint by setting $\underline{a} = 0$, and we set the interest rate to $r = 0.005$ per quarter (equivalent to 2% per year).

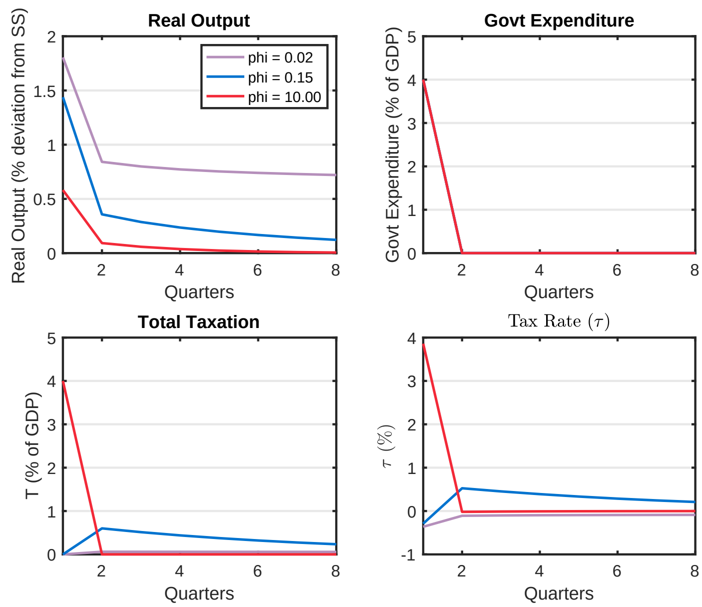
The income process follows Guerrieri and Lorenzoni (2017), who use an AR(1) process at a quarterly frequency. We convert the AR(1) process to a continuous-time Ornstein-Uhlenbeck (OU) process and then discretize the OU process using an eleven-state Poisson process (Laibson, Maxted, and Moll, 2021). Finally, we calibrate the level of government debt in the model to match the micro-evidence on MPCs (Kaplan and Violante, 2022; Auclert, Rognlie, and Straub, 2018). We target a quarterly MPC of 0.25 and an annual MPC of 0.5. To achieve the MPC target, the model requires a low level of government debt/net savings in the steady state, approximately one-quarter of GDP.

4.2 Aggregate Consumption and Output Impact of Fiscal Stimulus

Figure 1 plots the impact of a period-zero uniform transfer shock, of size 1% of annual GDP, on various macroeconomic aggregates over different levels of deficit financing. As the first panel shows, the fiscal stimulus leads to an increase in output for all levels of deficit financing, but the multiplier depends on the level of deficit financing. For a balanced-budget uniform transfer, i.e., $\phi \to \infty$, the output multiplier is the smallest and increases as the level of deficit financing rises.

A higher multiplier implies that, while the initial government expenditure remains the same across all levels of deficit financing (Panel B), the total tax rate required to finance the policy vary significantly with different values of ϕ. Specifically, as ϕ increases, the larger rise in output implies that a larger portion of the initial cost of the policy is self-financed. Hence, the tax rates do not need to rise as much.

Figure 1: Impact of Period 0 Uniform Transfer Fiscal Stimulus



While a fiscal stimulus necessarily leads to an increase in output, its welfare impact is not as straightforward. In our baseline model with nominal wage rigidities, a fiscal stimulus starting from the steady state can, in principle, be welfare-reducing. This occurs because labor rationing and wage rigidity prevent worker hours from immediately adjusting to their efficient levels, potentially leading to a welfare loss. The magnitude of this effect depends on the size of the wedge in the labor optimality condition and all the other effects discussed in Section 3. In the next two sections, we quantify the relative size of these effects under our baseline calibration.

4.3 Aggregate Welfare Change and Decomposition

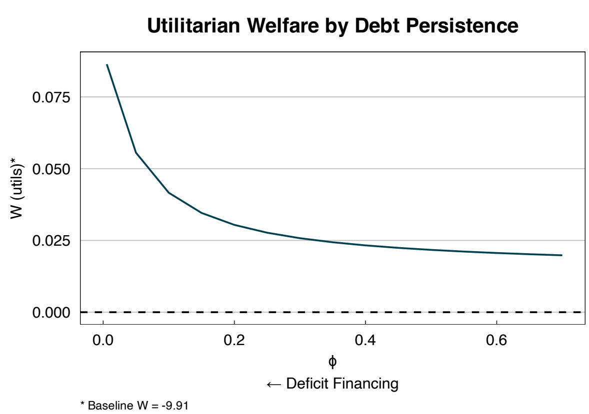
Figure 2a shows that the utilitarian welfare change, dW (defined in Eq.12) in response to a period 0 uniform transfer stimulus is positive for all levels of deficit financing under our baseline calibration. Moreover, the welfare impact increases monotonically with the amount of deficit financing, i.e., as $\phi \to r$. The welfare change, dW, in Fig. 2a reflects all the different effects discussed in

Section 3. To quantify the relative contribution of each term, we apply our decompositions in Proposition 1, 2 and 3 to the aggregate welfare change response.

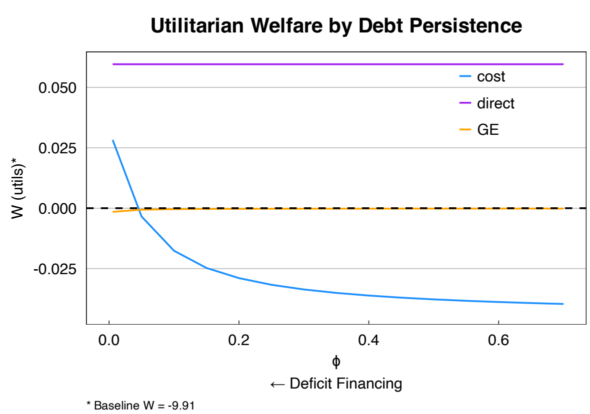
Proposition 1 decomposed the net aggregate welfare change into three terms: $\mathbf{\Omega}^{\mathbf{\Gamma}} d\mathbf{\Gamma}, \mathbf{\Omega}^{N} d\mathbf{N}$ and $\mathbf{\Omega}^{\tau} d\boldsymbol{\tau}$. Fig. 2b illustrates the relative quantitative contribution of these three terms. First, note that the contribution of the aggregate labor demand channel, $\mathbf{\Omega}^{N} d\mathbf{N}$, is zero up to the first order. This follows directly from Corollary 1 which states that under the γ^* allocation rule, all households are at the their optimal labor choices in the steady state. By the envelope condition, thus, a change in aggregate labor supply has no first-order welfare effect.

Second, the contribution of the uniform transfers, $\mathbf{\Omega}^{\mathbf{\Gamma}} d\mathbf{\Gamma}$, remains constant across all levels of deficit financing. Intuitively, since the transfers occur only at period 0 and are unanticipated, the level of deficit financing does not influence the isolated welfare change due to transfers. Lastly, and most interestingly, the welfare effects from tax rate changes vary substantially with the level of deficit financing and largely shape the aggregate response. For low levels of deficit financing, $\mathbf{\Omega}^{\tau} d\boldsymbol{\tau}$, is negative, meaning that the tax rate increase required to finance the policy results in a welfare loss for households. However, as deficit financing increases, the necessary rise in tax rates declines because a larger portion of the initial cost is self-financed. At sufficiently high levels of deficit financing, the welfare contribution of this effect reaches zero when the rise in output fully offsets the initial policy cost thus leading to no welfare loss from tax rate rises. Beyond this point, the effect turns positive as self-financing exceeds the initial cost.

Figure 2: Welfare change from uniform transfer for different deficit financing in HANK



(a) Welfare Change (utils)



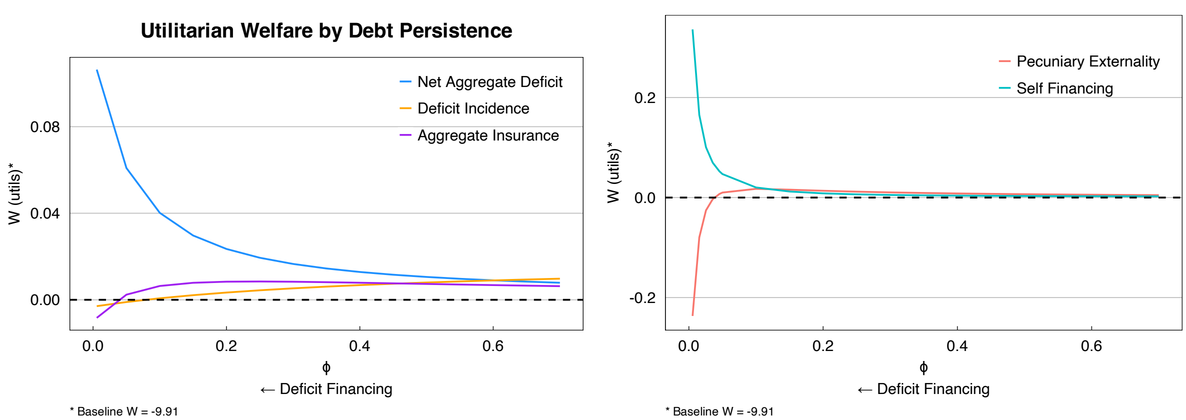
(b) Welfare Breakdown

4.4 Tax and Transfer Effect

We further apply the results from Proposition 3 to the $\mathbf{\Omega}^{\mathbf{\Gamma}} d\mathbf{\Gamma} + \mathbf{\Omega}^{\tau} d\boldsymbol{\tau}$ terms in our calibrated model and quantify the role of aggregate deficits and their distribution in shaping the aggregate welfare response. Figure 3a illustrates the contribution of three effects: net aggregate deficits, deficit incidence, and aggregate insurance terms defined in Proposition 3 for different levels of deficit financing. First, note that all three terms vary with the level of deficit financing. The level of deficits, by definition, impacts the "net aggregate deficits" term, but as the required tax rate change varies with different levels of deficit financing, it also impacts the incidence and insurance terms by interacting with heterogeneity in idiosyncratic productivity and labor supply across individuals. This means that as the level of deficit financing changes, it influences not only the overall welfare impact but also how the policy affects different households differently based on their individual states.

Second, while the "deficit incidence" and the "aggregate insurance" components decrease with deficit financing, eventually becoming negative, the "net aggregate deficit" term is increasing and always positive. At high levels of deficit financing, the "net aggregate deficits" terms is also quantitatively significantly larger than the remaining two terms. This implies that, as deficit financing increases, the policy's welfare gains primarily stem from the self-financing driven by larger multiplier and and pecuniary externality benefits, outweighing the welfare losses from redistribution towards lower marginal utility individuals and income/asset states.

Figure 3: Welfare Decomposition



(a) Welfare Change (utils)

(b) Decomposition of Deficits Term. REPLACE

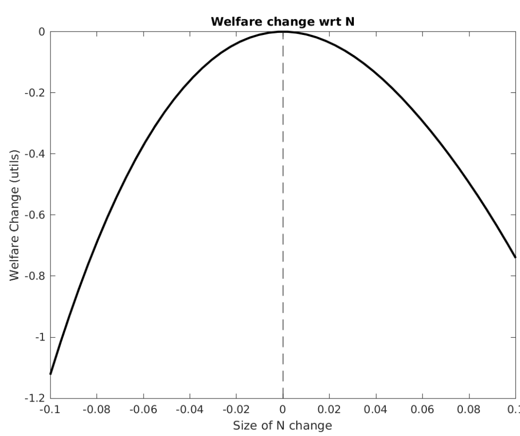
Further breaking down the aggregate deficit term, we plot the two components of the aggregate deficits term, i.e., $\bar{\mathcal{U}}' \int e^{-rs}\tau_{ss} dY_s ds$ (self-financing) and $\bar{\mathcal{U}}' \int_0^\infty \left[e^{-\rho s} - e^{-rs}\right]\left[d\Gamma_s - Y_{ss} d\tau_s\right]$ (pecuniary externality) in Fig. 3b.The two components initially have the same sign for small levels of deficit financing. However, as deficit financing increases, the direction of the pecuniary effect reverses. The magnitude and sign of the self-financing effect depend on the output multiplier, which increases monotonically with larger deficits, whereas the second effect is tied to changes in the level of public debt, which may rise or fall. If the output multiplier is low, the stock of debt increases to finance the policy, providing liquidity benefits to households. However, as the output multiplier grows larger, the policy begins to more than finance itself, leading to tax cuts and a subsequent decline in the level of public debt. This reduction in debt, in turn, lowers liquidity benefits and ultimately results in a welfare loss.

4.5 Fiscal Stabilization with Output Gaps

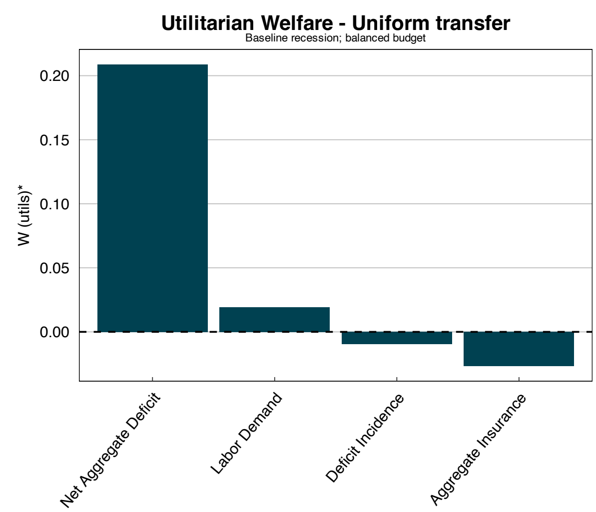
In the previous section, the welfare effects from the labor demand channel were zero because households were already on their optimal labor choices in the steady state. As a result, the welfare effects of fiscal policy were entirely due to redistribution across individuals or individual states, along with the presence of two externalities. However, outside of the steady state, such as during a recession when output is below the steady state level, fiscal policy can improve welfare by correcting the misallocation of resources caused by wage rigidities.

To illustrate this channel, Figure 4a plots the welfare change from a permanent change in N_t, while holding τ and Y at their steady-state levels. As households are already on their optimal labor choices at the steady state, welfare is maximized at steady-state values (with the γ^* allocation rule closing all individual labor wedges). However, with fixed wages/output, both an increase or decrease in labor demand results in welfare reduction, as it leads to a misallocation of resources. The welfare changes are asymmetric, though, as increasing labor demand brings a positive income effect, while a reduction in labor demand leads to both a decrease in income and a wedge in the optimality condition. This implies that fiscal policy can improve welfare by closing the wedge when the economy is outside the steady state.

Figure 4: Welfare Decomposition



(a) Welfare Change from different policies and deficit financing in HANK



(b) Welfare Change of balanced-budget uniform transfer with a baseline recession

To quantify the magnitude of this effect, we study the same period-0 uniform transfer but relative to a baseline where the economy is under a contractionary real rate shock. Specifically, we begin with a baseline featuring a large positive real rate shock of 2% with a quarterly decay rate of 0.2, and evaluate the welfare change resulting from a balanced-budget one-time uniform transfer fiscal stimulus.[16] Fig. 4b plots the welfare components of the experiment described

[16]We use a balanced-budget parametrization because the real rate shock interacts with the government budget

above. The labor demand effect now contributes positively to the welfare change of the policy, highlighting how the labor rationing rule generates individual labor wedges outside of steady state. Stabilization policy improves welfare by addressing these wedges. However, the magnitude of the labor demand effect is small relative to the net aggregate deficit channel. This channel dominates the welfare effect, as the baseline recession also increases the average marginal utility, thereby amplifying the net aggregate deficit channel.

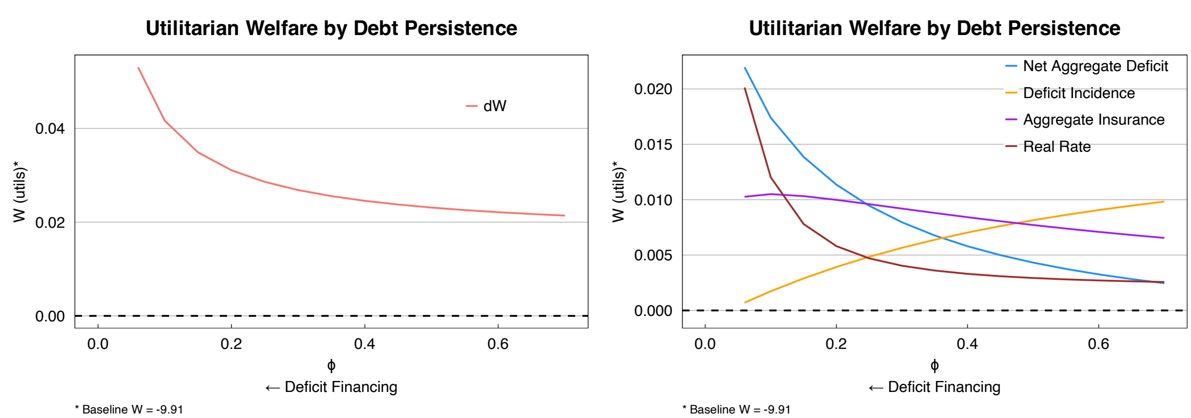
4.6 Extensions

Our baseline model makes several simplifying assumptions to illustrate the key channels through which fiscal stabilization policies impact aggregate welfare. Next, we relax these assumptions and quantify their impact under our baseline calibration.

4.6.1 Active Monetary Policy

In the baseline model, the monetary authority follows a constant real rate rule. Thus, the changes in the wage inflation caused by fiscal stimulus are not passed on the households as the monetary authority increases nominal rates in tandem, keeping the real rate constant. However, with an active monetary policy, the inflationary effect of fiscal stimulus policy might lead to a welfare loss to the households as the real rates also increase[17]. Figures 5a and 5b plot the aggregate welfare change and the Proposition 1 decomposition for a one-time uniform transfer fiscal stimulus and active monetary policy, i.e., $\phi_\pi = 1.5$. The aggregate welfare gain is lower when monetary policy is active relative to the constant real-rate rule.

Figure 5: Welfare change



(a) Welfare Change (utils)

(b) Welfare Breakdown

The decomposition in Fig. 5b provides insight into the dampened response. First, the role of net

constraint, requiring tax rate changes to cover both the initial cost of the policy and the increased cost of deficits.

[17] There are no borrowers in our baseline economy so the welfare loss comes from increased cost of running deficits

aggregate deficits is significantly smaller than before, though still positive. This reduction occurs because active monetary policy dampens the output multiplier, limiting the extent to which self-financing generates net income gains for households. Meanwhile, the deficit incidence and insurance terms remain relatively minor and do little to offset the decline in the net aggregate deficit component.

Additionally, changes in the real interest rate now directly impact welfare. Specifically, real rates increase in response to higher output, raising returns for saver households at any given level of asset holdings. This effect dominates the countervailing mechanism, where higher real rates increase the cost of running deficits and, consequently, the required tax rates. Overall, the introduction of active monetary policy mutes the welfare effects of expansionary fiscal policy by dampening the output multiplier and, in turn, limiting the degree of policy self-financing.

4.6.2 Uniform Labor Rationing Rule and Persistent Fiscal Policy Shocks

Our baseline results use the allocation rule in equation 8, creating zero labor demand effects from fiscal policy around the steady state. We explore how a constant labor rationing rule, which is commonly used in the literature, changes the welfare consequences of fiscal policy.Despite labor wedges not being closed for every individual, so long as the labor unions receive a labor subsidy that corrects the monopoly distortion, the first-order labor demand welfare effects are still 0. This occurs because the average individual labor wedge being zero is sufficient for the labor demand effect, $\mathbf{\Omega}^n d\mathbf{N}$, to be zero. We calibrate the model with the same parameters but solve the household block without a labor choice, resulting in individual labor wedges in the steady state. The results are in Appendix C.1 and show that the welfare consequences of the uniform transfer shock as very similar if using a constant allocation rule (correcting for the monopoly distortion).

The uniform transfer shock explored in Section 4 was a one-quarter shock. Our decompositions can be applied to any arbitrary sequence of shocks and in Appendix C.2 we show the same results for a uniform transfer shock that decays over a year. The results are qualitatively unchanged.

4.7 Alternate Social Welfare Functions

We extend our analysis to consider welfare assessments from the perspective of an Kaldor-Hicks (Kaldor, 1939; Hicks, 1939) Efficiency Planner (Dávila and Schaab, 2022*b*). For an given Social Welfare Function $W = \int \int \alpha(a,e)V(a,e)dade$ with Pareto weights $\alpha(a,e)$ defined on the initial state (a,e) of the household, a normalized welfare (Dávila and Schaab, 2022*b*) change resulting from a policy perturbation $d\theta$ is defined as

$$\frac{dW^{\lambda}}{d\theta} = \underbrace{\frac{1}{\int \int \alpha(a,e)\Lambda(a,e)g(a,e)dade}}_{\text{Normalization}} \underbrace{\left(\int \int \alpha(a,e)\frac{dV(a,e)}{d\theta}g(a,e)dade \right)}_{\text{Social Welfare Function}}$$

where the second part of the expression is the change in the social welfare function and the first part is a normalization to convert the change from utils to the units of the numeraire. The function $\Lambda(a,e)$ denotes the marginal value of receiving the numeraire good for a household with initial state (a,e).

We provide our results for two common numeraires used in the literature: 1) A unit of consumption good in period zero (Fagereng et al., 2024; Del Canto et al., 2023), 2) A unit of consumption good in every future time and state of the world (Dávila and Schaab, 2022*b*). In the first case, $\Lambda(a,e)$ is simply equal to $V_a(a,e) = u'(c(a,e))$ i.e. the marginal utility of getting an additional consumption unit in period zero. In the second case, $\Lambda(a,e) = \int e^{\int_0^t \rho_s ds}\mathbb{E}[u'(c_t(a,e))]dt$, where the expectation is with respect to all future individual states. While our results are qualitatively similar with both normalizations, the second normalizations helps us in further decomposing the efficiency changes into aggregate efficiency, inter-temporal sharing and risk sharing components from Dávila and Schaab (2022*b*).

Given the normalized welfare, aggregate efficiency change after a perturbation $d\theta$ is given by the first term in the right-hand side of the following equation.

$$\frac{dW^{\lambda}}{d\theta} = \underbrace{\int\int \mathrm{WTP}(a,e)g(a,e)dade}_{\text{Efficiency, } \frac{dW^E}{d\theta}} + \underbrace{\mathbb{C}ov\left(\omega(a,e), \mathrm{WTP}(a,e)\right)}_{\text{Redistribution, } \frac{dW^{RD}}{d\theta}} \tag{18}$$

where the willingness-to-pay and the weights $\omega(a,e)$ are defined as follows

$$\mathrm{WTP}(a,e) = \frac{\frac{dV(a,e)}{d\theta}}{\Lambda(a,e)} \qquad\qquad \omega(a,e) = \frac{\alpha(a,e)\Lambda(a,e)}{\sum \alpha(a,e)\Lambda(a,e)g(a,e)dade}$$

The efficiency component of normalized welfare i.e. $\frac{dW^{AE}}{d\theta}$ denotes the sum total of each agent's willingness-to-pay (WTP) for the policy perturbation in units of the numeraire.[18]. The results with the efficiency planner are presented in Appendix C.3.

5 Welfare Ranking of Fiscal Policies

Sections 3 and 4 addressed the first key question of the paper: What are the main channels through which fiscal stabilization policies impact aggregate welfare, and what are their quantitative significance? In this section, take our insights from the previous sections to address our

[18]Thus $\frac{dW^{AE}}{d\theta} > 0$ implies that the policy perturbation is Kaldor-Hicks efficient (Kaldor 1939, Hicks 1939, Hicks 1940) i.e. net total gains to the *winners* from the policy are larger than the total losses to the *losers* from the policy and the planner can hypothetically turn the perturbation into a pareto improvement by compensating the *losers* if transfers were costless.

$$\frac{dW^E}{d\theta} = \int\int \mathrm{WTP}(a,e)g(a,e)dade$$

second question: Which business cycle fiscal stabilization policies provide the largest welfare benefits relative to their financing costs?

We begin by applying the decomposition in Proposition 1 and the Aggregate Efficiency Planner framework outlined in Section 4.7 to define two widely used policy evaluation criteria from the empirical public finance literature: the Benefit-to-Cost Ratio (BCR) and the Marginal Value of Public Funds (MVPF) (García and Heckman, 2022; Hendren and Sprung-Keyser, 2020; Finkelstein and Hendren, 2020). We then extend our baseline HANK model from Section 2 to incorporate unemployment risk and long-term mortgages. Using these evaluation criteria, we rank six prominent business cycle stabilization policies—uniform transfers, targeted transfers, government spending, mortgage moratoriums, mortgage principal relief, and extensions of unemployment insurance benefits—based on their effectiveness in delivering welfare gains relative to their fiscal costs.

5.1 Alternative Social Welfare Functions

5.2 Policy Ranking Criteria

Similar to Proposition 1 we can decompose the Aggregate Willingness-to-Pay for the policy shock into three components i.e. $dW^E = \boldsymbol{\Omega}^{\boldsymbol{\Gamma},\boldsymbol{E}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{N,E} d\mathbf{N} + \boldsymbol{\Omega}^{\tau,E} d\boldsymbol{\tau}$ where E denotes Kaldor-Hicks Efficiency. Using this decomposition, we define our two criteria BCR and MVPF as follows:

Definition 2. *In the HANK model of Section 2 i.e. with wage rigidities and a constant real rate rule the Benefits-to-Cost Ratio (BCR) and Marginal value of Public Funds (MVPF) for a fiscal policy shock are defined as*

$$BCR := \frac{\boldsymbol{\Omega}^{\Gamma,E} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{N,E} d\mathbf{N}}{\boldsymbol{\Omega}^{\tau,N} d\boldsymbol{\tau}}$$

$$MVPF := \frac{\Omega^{\Gamma,E} d\Gamma + \boldsymbol{\Omega}^{N,E} d\mathbf{N}}{\left[e^{(\phi-r)s}\left(\int_0^s e^{-(\phi-r)s}\phi d\Gamma(s)\, ds\right) - \tau_{ss} dY(s)\right]}$$

The numerator in equation 2 for both BCR and MVPF captures the net aggregate Willingness-to-Pay (WTP) of all individuals in the economy for the policy shock. This includes the welfare benefits derived from fiscal transfers as well as the general equilibrium benefits of 'filling the gap'. The denominator in the BCR represents the WTP for the welfare loss generated by the higher tax rates required to finance the policy, whereas in the MVPF, it reflects the 'net fiscal cost,' which is the initial cost of the policy minus the self-financing effects.

The Benefits to Cost Ratio in Definition 2 measures the welfare gain from a policy perturbation relative to the social cost of financing the policy. In the terminology of the empirical public finance literature, it measures the "bang for the buck" of a policy, i.e., welfare benefits per dollar of the welfare cost of financing the policy. So, a larger BCR implies that the policy provides higher net social benefits for a given social cost of financing the policy. The MVPF, on the other hand, has the same numerator i.e. the social benefits as in the BCR but it follows Hendren and Sprung-Keyser (2020) to define the cost of the policy as the net expenditure of the government in terms of period 0 dollars, i.e., it ignores the social welfare cost of raising the funds for the policy[19]. However, it does account for the "fiscal externality" of the policy and the net cost is determined by adjusting the the discounted sum of the expenditure on the policy by the self financing of the policy.[20]

5.3 Environment: HANK with Mortgages and Unemployment Risk

5.3.1 Households

There is a unit mass of households denoted by $i \in [0,1]$. Each households is infinitely lived and discounts the future at rate ρ. It gets a flow utility u from consumption c_{it} and a dis-utility flow from working $n_{it} \in [0,1]$, where n_{it} denote the hours worked as a fraction of the unit time endowment. Their preferences are time separable and they maximize the following objective

$$V_0^i(\cdot) = \mathbb{E}_0 \int e^{-\rho t} u(c_{it}, n_{it}) dt \tag{19}$$

Households can save and borrow in a liquid asset a. Savings in the liquid asset yield a real interest rate r_t^a, while borrowing—up to an exogenous borrowing limit $\underline{a}$—is subject to a borrowing wedge ω^{cc} on the interest rate. All households in the economy are endowed with a house of fixed size $\bar{K}$, which they can finance using long-term mortgages m_t. Mortgage principal is repaid at a rate ζ_t and accrues interest at a rate r_t^m. The evolution of household asset holdings is governed by the following equations:

$$\dot{a}_{it} = r_t^a a_{it} + \omega^{cc} a_{it}^- - c_{it} - (r_t^m + \zeta_t) m_t + T^a(a_t, m_t) + y_{it} + r_t^a \bar{K} + \Pi_t \tag{20}$$

$$\dot{m}_t = -\zeta_t m_t - T^m(a_t, m_t) \tag{21}$$

$$a_{it} \geq \underline{a} \tag{22}$$

where y_{it} is income receipt from labor income or unemployment insurance benefits as described in section 5.3.2. Households also receive government transfers $T^a(a_t, m_t)$ and $T^m(a_t, m_t)$ which are paid in their liquid account and mortgage account, respectively. Their immovable assets (housing, $\bar{K}$) generates rental income $r^a \bar{K}$, and Π_t is profits from banks.

[19] Using period 0 dollars as a numeraire ensures that the units o of the numerator and the denominator are the same

[20] Benefits to Cost Ratio of a policy and MVPF are related as follows

$$\text{BCR}^j = \frac{\text{MVPF}^j}{\text{MCPF}^j} \qquad \text{where, MCPF} = \frac{\mathbf{\Omega}^{\tau,E}}{\left[e^{(\phi - r)s}\left(\int_0^s e^{-(\phi - r)s} \phi d\Gamma(s)\, ds\right) - \tau_{ss} dY(s)\right]}$$

Households must pay a fixed cost to adjust the composition of their mortgage debt and liquid balances. That is, a household with a balance sheet composition of (a, m) can change its debts to (a', m') subject to a fixed cost (and a utility cost specified in Section 5.6.2). This fixed cost varies depending on whether the household prepays its mortgage, i.e., if the household pre-pays, it is subject to the following constraint

$$a' + m' = a_t + m_t - \kappa^{pre}, \text{ such that } m' \in [0, m_t), \ \& \ a' \leq a_t \tag{23}$$

and if they extract equity from their house, then they are subject to the following constraint

$$a' + m' = a_t + m_t - \kappa^{adj} + \tau^m, \text{ such that } m' \in [m_t, \underline{m}), \ \& \ a' \geq a_t \tag{24}$$

The constraints differ in terms of the fixed costs. We assume that $\kappa^{adj} >> \kappa^{pre}$, following the fact that it is much less costly to pre-pay a mortgage as compared to re-financing or extracting equity from a home (Laibson, Maxted, and Moll, 2021). We also assume that the government can use a subsidy τ^m to directly reduce the cost of drawing equity.[21] [22] Reducing the cost works as a moratorium, as the household can increase its present consumption by drawing on equity but is required to make higher payments in the future.

5.3.2 Employment Status and Idiosyncratic Income

In addition to the idiosyncratic productivity shocks, the household now also faces unemployment risk. We define the household labor market status by $e \in \{e^E, e^U, e^N\}$, where E denotes employed, U denotes unemployed, and N denotes not in the labor force. We assume that e follows a Poisson jump process, with the Poisson arrival rate of moving from state e^i to e^j given by $\lambda^{i \to j}$. Further, we assume that when $e = e^E$, the household's idiosyncratic productivity z_t evolves according to a continuous-time Ornstein-Uhlenbeck (OU) process:

$$dz_t = -\kappa(z_t - \bar{z})dt + \sigma dW_t,$$

where W_t is a standard Brownian motion.

When the employment state is $e = e^U$, the household is unemployed and receives unemployment insurance (UI) benefits given by $\omega^{UI} w_{ss}$, which are phased out at an arrival rate of $\lambda^{U \to N}$. Hence, $\lambda^{U \to N}$ is a policy parameter that governs the length of time households receive benefits after losing their job. Once UI benefits are phased out, the household receives a subsistence income $\bar{y}$.

[21]In practice, Covid moratoriums also worked by reducing the cost of drawing equity. Cherry et al. (2021), for instance, document that "CARES Act guarantees individuals with federally backed mortgages the right to pause their mortgage payments, it does not automatically place their mortgages in forbearance. Borrowers must contact their loan servicer to put their payments on hold, though the forbearance process is straightforward – *borrowers simply need to claim they have a pandemic related hardship and do not need to submit any documentation*

[22]Schneider and Moran (2024) document a similar policy, early access to retirement savings, by directly reducing the cost of drawing from the illiquid pension accounts

For employed households, real income is subject to progressive taxation a la Benabou (2000) and Heathcote, Storesletten, and Violante (2017). Progressivity of the income taxes is governed by λ, and the level of taxes is determined by τ_t. Thus, the household income evolution is summarized as follows

$$y_{it} = \begin{cases} (1-\tau_t)(w_t z_{it} n_{it})^{1-\lambda} & \text{if } e \in e^E \\ \omega^{UI} w_{ss} & \text{if } e = e^U \\ \bar{y} & \text{if } e = e^N \end{cases} \tag{25}$$

where z_{it} follows a continuous-time Ornstein-Uhlenbeck (OU) process.[23]

Households take the path of interest rates, wages, prices, transfers, moratorium subsidies, and taxation $\{r_t^a, r_t^m, W_t, P_t, T^a(a_t, m_t)^a, T^m(a_t, m_t), \tau_t^m, \tau_t\}_{t\geq 0}$ as well as the hours supplied $\{n_t\}_{t\geq 0}$ as given.[24] The decision rules of the household imply a stationary distribution $\mu(da, dm, de; \Theta)$ with $\Theta := \{r, W, P, T^a(a,m)^a, T^m(a,m), \tau^m, \tau\}$. Outside the steady state, the optimal policies of the household depend on the time path of prices and government policies $\Theta_{t\geq 0}$.

5.4 Labor Market and Production

Similar to the baseline model, households are represented by labor unions which decide household labor supply according an allocation rule γ. However, as there are both employed and un-employed agents the economy, the unions only represent the mass of individuals who are employed. With an appropriate labor subsidy, we show in Appendix E that aggregate wage inflation evolves according to the following New Keynesian Wage Philips Curve—

$$\rho \pi_w = \frac{\epsilon}{\Psi} N_t \int_i \Big[\gamma_{i,t} v'(n_{it}) - (1-\tau_t)(1-\lambda)(w_t e_{it})^{1-\lambda} n_{it})^{-\lambda} u'(c_{it}) \Big] \mathbb{1}[e \in e^E] di + \dot{\pi}_w \tag{26}$$

Production is identical to the baseline model in Section 2.3 i.e. output is linear in aggregate labor.

$$Y_t = X_t N_t$$

where X_t is aggregate productivity. There is perfect competition and prices are fully flexible. This implies that the representative firm earns zero profits $P_t X_t N_t - W_t N_t = 0$, thus

$$P_t X_t = W_t$$

[23]To solve the model, we discretize y_{it} to be on a grid $\{y_i\}_i$ with $\lambda^{i \to i'} \forall i, i'$ or $\mathbf{A}^y$ governing the of transition between the income states.

[24]This is due to labor market frictions, see Auclert and Rognlie (2017). This implies that they take their total income as given.

Further, the price and wage inflation are related as follows

$$\pi_t = \pi_t^w - \frac{\dot{X}_t}{X_t}$$

In absence of shocks to aggregate TFP, the price and wage inflation are always equal.

5.5 Banks

A representative bank engages in maturity transformation between long-term mortgages and liquid assets. The profits of the bank are given by the total amount of mortgage debt in the economy and the difference between the interest rate on mortgages and liquid savings. It also generates profits from the difference between the real rate on savings and the interest rate on short term borrowing. Hence, profits are given by

$$\Pi_t = (r^m - r^b)M_t + \omega^{cc} A_t^-$$

where M_t is the total amount of mortgage debt and A_t^- is the total amount of short term debt. These profits are rebated uniformly to all the households in the economy.

5.6 Consolidated Monetary-Fiscal Authority

Monetary Authority.— sets the nominal interest rate on the liquid asset by following a Taylor rule with coefficient ϕ_π i.e. $i_t = \bar{r} + \phi_\pi \pi_t + \epsilon_t$.

Fiscal Authority.- The government sets an exogenous plan for expenditures (discussed below) $\{E_t\}$ and taxes $\{T_t\}$ taking the initial level of government debt as given. This implies that debt evolves as

$$\dot{B}_t^g = rB_t^g + E_t + -T_t$$

where the total tax revenue is governed by changing τ_t

$$T_t := \int \left(\frac{W_t}{P_t} e_{it} n_{it} - \tau_t \left(\frac{W_t}{P_t} e_{it} n_{it} \right)^{1-\lambda} \right) d\mu_t. \tag{27}$$

Total expenditures by the government (E_t) can be expressed as

$$E_t = G_t + UI_t + T^a(a_t, m_t) + T^m(a_t, m_t) + \chi\tau^m \int d^{eq}(a, m, e, t) d\mu_t \tag{28}$$

where denotes the mass of individuals who use the moratorium option.

5.6.1 Equilibrium

Definition 3. *Competitive Equilibrium: Given an initial distribution of household assets, mortgage balances and idiosyncratic income* $g_0(da, dm, dy)$*, and a sequence of interest rates, wages, prices, transfers, moratorium subsidies, and taxation* $\{r_t^a, r_t^m, W_t, P_t, T^a(a_t, m_t)^a, T^m(a_t, m_t), \tau_t^m, \tau_t\}_{t\geq 0}$ *as well as the hours supplied* $\{n_t\}_{t\geq 0}$ *as given., exogenous shocks* $\{X_t, \rho_t, \nu_t\}$*, a competitive equilibrium is given by prices* $\{r, W, P, T^a(a,m)^a, T^m(a,m), \tau^m, \tau\}$*, aggregate quantities* $\{Y_t, N_t, C_t, A_t, M_t T_t, G_t, UI_t\}$ *and individual policies* $\{a_t, m_t, c_t, n_t\}$ *such that the households optimise, unions optimize, firms optimize, monetary and fiscal policy follow their rules, and the goods, asset markets clears, and the government balances its budget*

$$
\begin{aligned}
Y_t &= C_t + G_t + \omega^{cc} \int \min\{b_t, 0\} d\mu_t + \lambda \kappa^{adj} \int d^{adj}(b, m, e, t) d\mu_t \\
B_t &= \bar{H} + A_t - M_t \\
\dot{B}_t &= r B_t + G_t + \Gamma_t + UI_t + \chi \tau^m \int d^{eq}(a, m, e, t) d\mu_t - T_t
\end{aligned}
$$

5.6.2 Household Value Functions

The state variables are liquid assets (a), long-term mortgage debt (m), idiosyncratic income state ($\tilde{e} = (e, z)$), and time t. Let $V^n(a, m, e, t)$ denote the value function of the household with the corresponding state variables.

Value of mortgage adjustment:— The value of drawing equity from the mortgage is given by

$$
V^{eq}(a + m, \tilde{e}) = \max_{a', m'} V^n(a', m', \tilde{e})
$$

$$
\text{subject to}
$$

$$
a' + m' = a + m - \kappa^{adj} + \tau^m, \text{ given } a' > a, m' > m
$$

and the value of prepaying the mortgage is

$$
V^{pre}(a + m, \tilde{e}) = \max_{a', m'} V^n(a', m', \tilde{e})
$$

$$
\text{subject to}
$$

$$
a' + m' = a + m - \kappa^{pre}, \text{ given } a' < b, m' < m
$$

Using these two value functions, the adjustment value function is

$$
V^{adj} = \max\{V^{eq}(a, m, \tilde{e}), V^{pre}(a, m, \tilde{e})\}
$$

The household value function:— The final household value function is given by the HJB equation in Equation 29. The first three lines of the equation represent the value that the household gets from optimal consumption and savings decisions without adjusting their short- and long-term asset positions. The last line represents the value of portfolio rebalancing. The households get the opportunity to rebalance at the rate χ and, given the opportunity to adjust, choose whether to draw equity or prepay their mortgage. Their decision is summarized the optimal policy function $d(a,m,e,t)$ given in Equation. 30.

$$\begin{aligned}\rho V^n(a,m,\tilde{e},t) = \max_c u(c) &+ V_a\left[r_t a + \omega^{cc} a^- - c - (r_t^m + \zeta)m + T_t^a(a,m) + y_t(\tilde{e})\right] \\ &+ V_m\left[-\zeta m - T_t^m(a,m)\right] \\ &+ \sum_{\tilde{e}'\neq\tilde{e}} \lambda^{\tilde{e}\to\tilde{e}'}\left[V^n(;\tilde{e}') - V^n(;\tilde{e})\right] \\ &+ \chi d(b,m,\tilde{e},t)\left[V^{adj}(a+m,\tilde{e},t) - V^n(b,m,\tilde{e},t) - \Psi\right]\end{aligned} \tag{29}$$

where Ψ is the utility cost of adjusting and

$$d(a,m,\tilde{e},t) = \begin{cases} 1 & \text{if } V^{adj}(a+m,\tilde{e},t) > V^n(a,m,\tilde{e},t) \\ 0 & \text{otherwise.} \end{cases} \tag{30}$$

5.7 Calibration

Table. 2 shows the main parameters of the model. We calibrate the model to a quarterly frequency. As in the simple model, household preferences follow a separable constant elasticity utility function specification: $u(c_t,n_t) = \frac{c^{1+\gamma}}{1+\gamma} - \varphi\frac{n_t^{1+\phi}}{1+\phi}$. We set $\gamma = 2$ and $\phi = 2$. We follow Heathcote, Storesletten, and Violante (2017) and set the labor tax progressivity to 0.181. The income process is the same as in the simple model. Moreover we calibrate the Poisson jumps across labor force status to match empirical job-finding and separation rates detailed in Appendix **??**.

As in the simple model, monetary policy follows a real-rate rule. However, we calibrate the steady-state level of government bonds to be more realistic at 3.1 times quarterly output. The two-asset structure of the economy allows us to get a reasonable level of aggregate wealth while still having high MPCs. We set UI generosity to be half of the average income earned by employed households, and the baseline government support ($\bar{y}$) is half of UI benefits. Lastly, we set the average length of UI to be 2 quarters as it is in most states in the US.

The mortgage repayment rate, and the fixed cost for refinancing are externally calibrated and closely align with the values in Laibson, Maxted, and Moll (2021). The three internally calibrated parameters in the model are the discount rate (ρ), labor disutility (φ), and the interest rate on mortgages (r^m). They are calibrated to target three key moments highlighted in the table.

Table 2: Calibration

Parameter	Description	Value	Target
Preferences			
γ	Risk aversion	1.2	
σ	Frisch elasticity	0.5	
ψ	Labor disutility	0.8951	$\pi^{ss} = 0$
ρ	Discount rate	0.0123	Mean Net Assets ($3.1 \times Y$)
Government			
ϕ^m	Taylor-rule coefficient	1	Constant real-rate rule
G	Government spending	0.2	20% of output
B	Government bonds	3.1	310% of quarterly output
τ	Tax level	0.2334	
$\bar{\omega}$	UI generosity	0.5	50% of average SS income
$\bar{y}$	Baseline support	$0.5\bar{\omega}$	Half of UI
$\lambda^{u\to n}$	Loss of UI	0.5	Average 2 quarters of UI
T^a, T^m, τ^m	Transfers and moratorium subsidy	0, 0, 0	
Equilibrium			
r^a	Real rate on liquid assets	0.5%	2% annual
Y	Steady-state quarterly output	1	
Mortgages			
r^m	Real Rate on Mortgages	0.73%	Average mortgage size of 1.5 quarterly output
ζ	Mortgage Repayment Rate	0.88%	20 year half-life
χ	Rebalancing Opportunity	3	Once per month
$\kappa^{pre}, \kappa^{eq}$	Fixed Cost	0.002, 0.04	
H	Home value	3	
Income Process			
(ρ_e, σ_e)	Employed productivity persistence and Std. Dev.	(0.967, 0.017)	Guerrieri and Lorenzoni (2017)
λ	Tax progressivity	0.181	Heathcote, Storesletten, and Violante (2017)
$\boldsymbol{\lambda}$	Poisson jumps across employment states	See Appendix **??**	
Phillips Curve			
κ	Slope of Phillips curve	0.03	Auclert, Rognlie, and Straub (2018)

5.8 Policy Options

The fiscal authority in the model can choose between a number of different policies summarized in Table 3. Specifically, we allow for government spending, uniform and targeted transfers, mortgage principal reductions, mortgage moratoriums, UI benefit increases and UI extensions. These policies represent a set of main tools that are often used by macro-stabilisation. They vary both in their size and in their targeting of different populations. While the benefits of targeting crucial depend on the pareto weights in the social welfare functions, given their distributional intentions, policies can still be ranked in terms of their benefits to cost ratio. Specifically, we use our policy ranking criteria from Sec 5.2 to rank these policies in the next section.

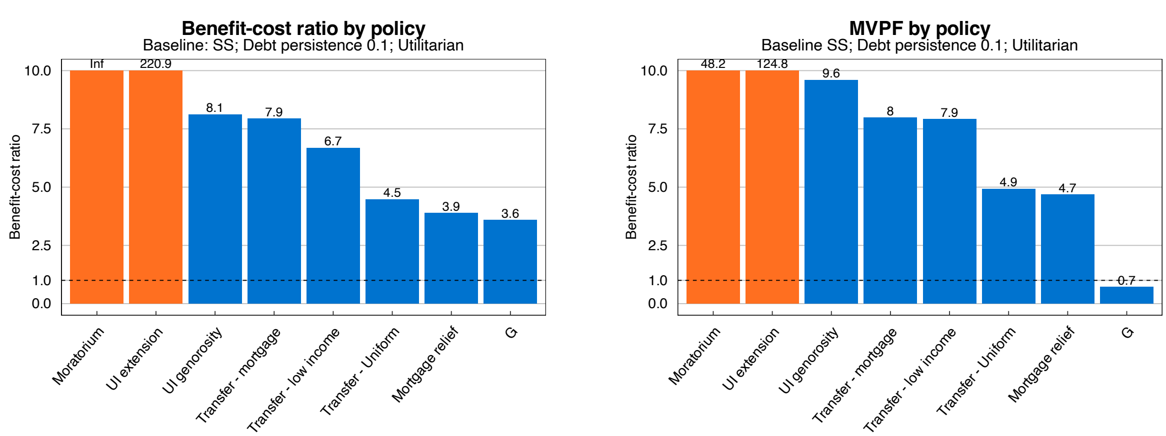
Table 3: Policy Menu

Policy	Change	Description
Government spending	G	1% of GDP
Transfer - Uniform	T^a	1% of GDP
Transfer - Low income	$T^a(e < \underline{e})$	1% of GDP
Transfer - Mortgage holders	$T^a(m > 0)$	1% of GDP
Mortgage Principal Reduction	$T^m(m > 0)$	1% of GDP
Mortgage moratorium	τ^m to κ^{eq}	Reduces cost of drawing equity by 50%
UI increase	$\uparrow \omega^{UI}$	Pr(keeping UI) increases from 0.25 to 0.4
UI extension	$\downarrow \lambda^{u \to n}$	Increase UI generosity by 25%

5.9 Results

Fig 6 and Table 4 provide the main results from our quantitative exercise. Fig. 6 ranks policies based on the Benefits-to-Cost Ratio (BCR) and the Marginal Value of Public Funds (MVPF) when the deficit financing parameter is set to 0.1. A BCR greater than one indicates that the policy generates benefits exceeding its costs. As shown in the figure, at this level of deficit financing, all policies yield net positive benefits—even completely wasteful government spending. However, there is significant variation in the BCR across different policies. Government spending exhibits the lowest BCR, followed by mortgage relief and uniform transfers. In contrast, under our calibration, moratoriums and unemployment insurance (UI) extensions result in an infinite BCR. The variation in BCR stems from differences in how policies affect output and consumption. Uniform transfers generate a low output response due to poor targeting, while mortgage principal relief faces similar limitations because the funds are deposited into illiquid accounts, limiting their impact on household consumption. A moratorium, on the other hand, leads to small fiscal costs but it is able to stimulate consumption by targeting the liquidity constarined households.

Figure 6: BCR and MVPF of different policies



However, the net aggregate welfare benefit ranking of each policy differs significantly from the BCR. The last column of Table 4 reports the total welfare change when the policy cost is fixed at 1% of total GDP. While transfer and mortgage relief policies can be scaled up to this threshold to generate substantial aggregate welfare gains, moratoriums and UI extensions "empty the chamber" quickly, meaning their welfare benefits plateau at relatively lower levels of spending. This happens as moratoriums, target only the set of people who wanted to adjust their mortgages but could not because of the fixed costs.

For instance, the individuals in the economy can be partitioned into three sets depending on their states (b, m, e, t) and how they react to an option of taking up a moratorium on their long term debt

$$\begin{aligned} \text{Type A, Adjust by paying the cost:} \quad & V^{adj}(b,m,e,t;\kappa^{adj}) \geq V^{n}(b,m,e,t) \\ \text{Type B, Adjust only with the moratorium option:} \quad & V^{mora}(b,m,e,t) \geq V^{n}(b,m,e,t) \geq V^{adj}(b,m,e,t;\kappa^{adj}) \\ \text{Type C, Don't want to adjust:} \quad & V^{n}(b,m,e,t) \geq V^{mora}(b,m,e,t) \end{aligned}$$

The Type A individuals have enough liquid assets to pay for the fixed cost to adjustment and hence they adjust even without the moratorium provision. The Type C, individuals are already at their optimal portfolio composition and hence are not affected by the moratorium option. The moratorium policy essentially then targets the Type B individuals who would like to increase their consumption by adjusting but are liquidity constrained. By reducing the cost of adjustment from κ^{eq} to $\kappa^{mora} = \kappa^{eq} - \tau^{m}$, the policy is able to increase consumption by specifically targeting these individuals. Thus the total effect of the policy is limited by the fraction of people are Type B.

Table 4: BCR, MVPF and Net Welfare for each policy

Policy	BCR	MVPF	Cumulative Y (%)	100*dW (utils)
Moratorium	Inf	48.20	0.27	0.27
UI extension	220.85	124.75	0.02	1.51
UI generosity	8.11	9.60	0.07	2.15
Transfer - mortgage	7.93	7.98	1.15	9.95
Transfer - low income	6.68	7.91	0.40	10.98
Transfer - Uniform	4.47	4.92	0.65	5.96
Mortgage relief	3.89	4.68	0.03	6.03
G	3.59	0.72	2.76	0.50

6 Conclusion

In this paper, we analyze the welfare effects of fiscal policy in a Heterogeneous Agent New Keynesian (HANK) model. Beyond macroeconomic stabilization and redistribution, our analysis shows that deficit-financed fiscal policy generates welfare benefits through two key mechanisms: (i) substantial self-financing of the initial policy cost and (ii) direct effects on the stock of public debt. Our decomposition highlights and quantifies each of these channels. Finally, we use these insights to rank various business cycle policies based on their Benefits-to-Cost Ratio (BCR) and discuss important caveats regarding the limitations of such ratio measures.

References

Abel, Andrew B, N Gregory Mankiw, Lawrence H Summers, and Richard J Zeckhauser. 1989. "Assessing dynamic efficiency: Theory and evidence." *The Review of Economic Studies*, 56(1): 1–19.

Agarwal, Sumit, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, Tomasz Piskorski, and Amit Seru. 2017. "Policy intervention in debt renegotiation: Evidence from the home affordable modification program." *Journal of Political Economy*, 125(3): 654–712.

Aiyagari, S Rao. 1995. "Optimal capital income taxation with incomplete markets, borrowing constraints, and constant discounting." *Journal of political Economy*, 103(6): 1158–1175.

Aiyagari, S Rao, and Ellen R McGrattan. 1998. "The optimum quantity of debt." *Journal of Monetary Economics*, 42(3): 447–469.

Angeletos, George-Marios, Chen Lian, and Christian K Wolf. 2024. "Can Deficits Finance Themselves?" *Econometrica*, 92(5): 1351–1390.

Auclert, Adrien. 2019. "Monetary policy and the redistribution channel." *American Economic Review*, 109(6): 2333–2367.

Auclert, Adrien, and Matthew Rognlie. 2017. "Aggregate demand and the top 1 percent." *American Economic Review*, 107(5): 588–592.

Auclert, Adrien, Matthew Rognlie, and Ludwig Straub. 2018. "The intertemporal keynesian cross." National Bureau of Economic Research.

Auclert, Adrien, Matthew Rognlie, and Ludwig Straub. 2024. "Fiscal and monetary policy with heterogeneous agents." National Bureau of Economic Research.

Auclert, Adrien, Michael Cai, Matthew Rognlie, and Ludwig Straub. 2024. "Optimal long-run fiscal policy with heterogeneous agents."

Bartal, Mehdi, and Yvan Becard. 2024. "Welfare Multipliers."

Benabou, Roland. 2000. "Unequal societies: Income distribution and the social contract." *American Economic Review*, 91(1): 96–129.

Bergstrom, Katy, William Dodds, and Juan Rios. 2024. "Optimal Policy Reforms."

Bhandari, Anmol, David Evans, Mikhail Golosov, and Thomas Sargent. 2017. "Optimal Fiscal-Monetary Policy with Redistribution." *Princeton University*.

Bhandari, Anmol, David Evans, Mikhail Golosov, and Thomas Sargent. 2023. "E ciency, Insurance, and Redistribution E ects of Government Policies."

Blanchard, Olivier. 2019. "Public debt and low interest rates." *American Economic Review*, 109(4): 1197–1229.

Blanchard, Olivier. 2023. *Fiscal policy under low interest rates.* MIT press.

Boccia, Romina, and Dominik Lett. 2024. *Curbing Federal Emergency Spending: Government Spending Grows with Excessive and Wasteful Emergency Designations.* Cato Institute.

Bolton, Patrick, and Howard Rosenthal. 2002. "Political intervention in debt contracts." *Journal of Political Economy*, 110(5): 1103–1134.

Carroll, Christopher, Edmund Crawley, Ivan Frankovic, and Håkon Tretvoll. 2023. "Welfare and Spending Effects of Consumption Stimulus Policies."

Cherry, Susan F, Erica Xuewei Jiang, Gregor Matvos, Tomasz Piskorski, and Amit Seru. 2021. "Government and private household debt relief during COVID-19." National Bureau of Economic Research.

Dávila, Eduardo, and Andreas Schaab. 2022*a*. "Optimal monetary policy with heterogeneous agents: A timeless ramsey approach." *Available at SSRN 4102028*.

Dávila, Eduardo, and Andreas Schaab. 2022*b*. "Welfare assessments with heterogeneous individuals." National Bureau of Economic Research.

Davila, Julio, Jay H Hong, Per Krusell, and José-Víctor Ríos-Rull. 2012. "Constrained efficiency in the neoclassical growth model with uninsurable idiosyncratic shocks." *Econometrica*, 80(6): 2431–2467.

Del Canto, Felipe N, John R Grigsby, Eric Qian, and Conor Walsh. 2023. "Are inflationary shocks regressive? A feasible set approach." National Bureau of Economic Research.

Diamond, Peter A. 1965. "The evaluation of infinite utility streams." *Econometrica: Journal of the Econometric Society*, 170–177.

Dinerstein, Michael, Constantine Yannelis, and Ching-Tse Chen. 2023. "Debt moratoria: Evidence from student loan forbearance." National Bureau of Economic Research.

Erceg, Christopher J, Dale W Henderson, and Andrew T Levin. 2000. "Optimal monetary policy with staggered wage and price contracts." *Journal of monetary Economics*, 46(2): 281–313.

Fagereng, Andreas, Matthieu Gomez, Emilien Gouin-Bonenfant, Martin Holm, Benjamin Moll, and Gisle Natvik. 2024. "Asset-price redistribution."

Finkelstein, Amy, and Nathaniel Hendren. 2020. "Welfare analysis meets causal inference." *Journal of Economic Perspectives*, 34(4): 146–167.

Ganong, Peter, and Pascal Noel. 2020. "Liquidity versus wealth in household debt obligations: Evidence from housing policy in the great recession." *American Economic Review*, 110(10): 3100–3138.

García, Jorge Luis, and James Joseph Heckman. 2022. "Three criteria for evaluating social programs." *Journal of Benefit-Cost Analysis*, 13(3): 281–286.

Guerrieri, Veronica, and Guido Lorenzoni. 2017. "Credit crises, precautionary savings, and the liquidity trap." *The Quarterly Journal of Economics*, 132(3): 1427–1467.

Hagedorn, Marcus, Iourii Manovskii, and Kurt Mitman. 2019. "The fiscal multiplier." National Bureau of Economic Research.

Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L Violante. 2017. "Optimal tax progressivity: An analytical framework." *The Quarterly Journal of Economics*, 132(4): 1693–1754.

Hendren, Nathaniel, and Ben Sprung-Keyser. 2020. "A unified welfare analysis of government policies." *The Quarterly Journal of Economics*, 135(3): 1209–1318.

Hendren, Nathaniel, and Ben Sprung-Keyser. 2022. "The Case for Using the MVPF in Empirical Welfare Analysis." National Bureau of Economic Research Working Paper 30029.

Hicks, John R. 1939. "The foundations of welfare economics." *The economic journal*, 49(196): 696–712.

Hicks, John R. 1940. "The valuation of the social income." *Economica*, 7(26): 105–124.

Kaldor, Nicholas. 1939. "Welfare propositions of economics and interpersonal comparisons of utility." *The economic journal*, 49(195): 549–552.

Kaplan, Greg, and Giovanni L Violante. 2022. "The marginal propensity to consume in heterogeneous agent models." *Annual Review of Economics*, 14: 747–775.

Kaplan, Greg, Benjamin Moll, and Giovanni L Violante. 2018. "Monetary policy according to HANK." *American Economic Review*, 108(3): 697–743.

Kroszner, Randy, et al. 1999. *Is it better to forgive than to receive?: Repudiation of the gold indexation clause in long-term debt during the great depression.* Citeseer.

Laibson, David, Peter Maxted, and Benjamin Moll. 2021. "Present bias amplifies the household balance-sheet channels of macroeconomic policy." National Bureau of Economic Research.

LeGrand, François, and Xavier Ragot. 2023. "Optimal Fiscal Policy with Heterogeneous Agents and Capital: Should We Increase or Decrease Public Debt and Capital Taxes?" Working Paper, SciencesPo.

McKay, Alisdair, and Ricardo Reis. 2016. "The role of automatic stabilizers in the US business cycle." *Econometrica*, 84(1): 141–194.

Noel, Pascal. 2021. "Comments on "Government and Private Household Debt Relief during COVID-19" by Cherry, Jiang, Matvos, Piskorski, and Seru."

Rose, Jonathan. 2013. "A primer on farm mortgage debt relief programs during the 1930s."

Rotemberg, Julio J. 1982. "Sticky prices in the United States." *Journal of political economy*, 90(6): 1187–1211.

Saez, Emmanuel, and Stefanie Stantcheva. 2016. "Generalized social marginal welfare weights for optimal tax theory." *American Economic Review*, 106(01): 24–45.

Samuelson, Paul A. 1958. "An exact consumption-loan model of interest with or without the social contrivance of money." *Journal of political economy*, 66(6): 467–482.

Scharlemann, Therese C, and Stephen H Shore. 2016. "The effect of negative equity on mortgage default: Evidence from hamp's principal reduction alternative." *The Review of Financial Studies*, 29(10): 2850–2883.

Schmitt-Grohé, Stephanie, and Martin Uribe. 2005. "Optimal fiscal and monetary policy in a medium-scale macroeconomic model." *NBER Macroeconomics Annual*, 20: 383–425.

Schneider, Patrick, and Patrick Moran. 2024. "Household liquidity policy."

Violante, Gianluca. 2021. "What have we learned from HANK models, thus far?" *Beyond the pandemic: the future of monetary policy*, 267.

Wheelock, David C, et al. 2008. "Changing the rules: State mortgage foreclosure moratoria during the Great Depression." *Federal Reserve Bank of St. Louis Review*, 90(6): 569–570.

Woodford, Michael. 2011. "Simple analytics of the government expenditure multiplier." *American Economic Journal: Macroeconomics*, 3(1): 1–35.

A Wage Philips Curve Derivation

Final Labor Packer — There is a final competitive labor packer which that packages the tasks produced by different labor unions into aggregate employment services using the constant-elasticity-of-substitution technology.

$$N_t = \left(\int_0^1 n_{k,t}^{\frac{\epsilon-1}{\epsilon}} dk \right)^{\frac{\epsilon}{\epsilon-1}}$$

where $\epsilon > 0$ is the elasticity of substitution across tasks. Cost minimization implies that the demand for task k is

$$n_{k,t}(w_{k,t}) = \left(\frac{w_{k,t}}{w_t} \right)^{-\epsilon} N_t \qquad \text{where } w_t = \left(\int_0^1 w_{k,t}^{1-\epsilon} dk \right)^{\frac{1}{1-\epsilon}} \tag{31}$$

Unions.—Each union k aggregates efficient units of work into a union-specific task using an allocation rule $n_{ikt} = \gamma_i n_{kt}$ with $\int \gamma_i di = 1$.

$$\begin{aligned} n_{k,t} &= \int_0^1 e_{it} \gamma_i n_{kt} di \\ &= \int_0^1 e_{it} n_{ikt} di \end{aligned}$$

Given the above demand curve the union seeks to maximise the utility of all its members by choosing wages $\{w_{k,t}\}_{t>0}$ to maximise

$$\int_0^\infty e^{-\rho t} \left(\int \left\{ u(c_t(a,y)) - v\left(\int_0^1 \gamma_i n_{k,t} dk \right) d\mu_t \right\} - \frac{\Psi}{2} \left(\frac{\dot{w}_{k,t}}{w_t} \right) \right) dt \tag{32}$$

μ_t is the distribution of a, y at time t. Each union is infinitesimal and therefore only takes into account its marginal effect on every household's consumption and labor supply.

A.1 Useful Derivatives

By the envelope theorem of the household problem we have:

$$\frac{\partial c_{it}(a,e;w_{k,t})}{\partial w_{k,t}} = \frac{\partial z_{it}}{\partial w_{k,t}}$$

where z_{it} is the post-tax income of the household.

$$z_{it} = (1-\tau_t)\left(\frac{w_{kt}}{P_t}\underbrace{e_{it}\gamma_i n_{kt}}_{n_{it}}\right)^{1-\theta} \tag{33}$$

$$= (1-\tau_t)\left(\frac{w_{kt}}{P_t}e_{it}\gamma_i \frac{w_{kt}}{w_t}^{-\epsilon} N_t\right)^{1-\theta} \tag{34}$$

$$= (1-\tau_t)\left(\frac{e_{it}\gamma_i}{P_t}w_{kt}^{1-\epsilon}w_t^{\epsilon}N_t\right)^{1-\theta} \tag{35}$$

$$\frac{\partial z_{it}}{\partial w_{kt}} = (1-\tau_t)(1-\theta)\left(\frac{e_{it}\gamma_i}{P_t}w_{kt}^{1-\epsilon}w_t^{\epsilon}N_t\right)^{-\theta}\left((1-\epsilon)\frac{e_{it}\gamma_i}{P_t}w_{kt}^{-\epsilon}w_t^{\epsilon}N_t\right) \tag{36}$$

Change aggregate terms into union-specific terms using labor demand function

$$= (1-\tau_t)(1-\theta)\left(\frac{e_{it}\gamma_i}{P_t}w_{kt}n_{kt}\right)^{-\theta}\left((1-\epsilon)\frac{e_{it}\gamma_i}{P_t}n_{kt}\right) \tag{37}$$

$$= \left(1-\underbrace{\left(1-(1-\theta)(1-\tau_t)\left(\frac{e_{it}\gamma_i}{P_t}w_{kt}n_{kt}\right)^{-\theta}\right)}_{MTR_{it}}\right)\frac{e_{it}\gamma_i}{P_t}n_{kt}(1-\epsilon) \tag{38}$$

$$= (1-MTR_{it})\frac{e_{it}\gamma_i}{P_t}n_{kt}(1-\epsilon) \tag{39}$$

Household i's total hours worked are

$$\begin{aligned} n_{it} &= \int_0^1 \gamma_i n_{k,t} dk \\ &= \gamma_i \int_0^1 \left(\frac{W_{k,t}}{w_t}\right)^{-\epsilon} N_t dk \end{aligned}$$

Differentiating w.r.t $W_{k,t}$

$$\frac{\partial n_{it}}{\partial w_{kt}} = -\gamma_i \epsilon \frac{n_{kt}}{w_{kt}}$$

Simplifying PC term:

1. First we show we can write this as a function of $\frac{\partial c_{it}}{\partial n_{it}}$. Then we will re-express $\frac{\partial c_{it}}{\partial n_{it}}$ to be a

function of only z_{it}, γ, N

$$
\begin{aligned}
\frac{\partial z_{it}}{\partial n_{it}} &= \frac{\partial}{\partial n_{it}}(1-\tau_t)\left(\frac{e_{it}\gamma_i}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon} N_t\right)^{1-\theta} && (40)\\
&= \frac{\partial}{\partial n_{it}}(1-\tau_t)\left(\frac{e_{it}\gamma_i N_t}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon}\right)^{1-\theta} && (41)\\
&= (1-\tau_t)(1-\theta)\left(\frac{e_{it}\gamma_i N_t}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon}\right)^{-\theta}\left(\frac{e_{it}}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon}\right) && (42)\\
&= (1-\tau_t)(1-\theta)\left(\frac{e_{it}\gamma_i}{P_t} w_{kt} n_{kt}\right)^{-\theta}\left(\frac{e_{it}}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon}\right) && (43)\\
&(w_{kt} = w_t)\\
&= (1-MTR_{it})\frac{e_{it} w_t}{P_t} && (44)
\end{aligned}
$$

2. Another expression for $\frac{\partial z_{it}}{\partial n_{it}}$:

$$
\begin{aligned}
\frac{\partial z_{it}}{\partial n_{it}} &= \frac{\partial}{\partial n_{it}}(1-\tau_t)\left(\frac{w_{kt}}{P_t} e_{it}\gamma_i n_{kt}\right)^{1-\theta} && (45)\\
&= (1-\tau_t)(1-\theta)\left(\frac{w_t}{P_t} e_{it} n_{it}\right)^{-\theta}\frac{w_t}{P_t} e_{it} && (46)\\
&= (1-\tau_t)(1-\theta)\left(\frac{w_t}{P_t}\right)^{1-\theta} e_{it}^{1-\theta} n_{it}^{-\theta} && (47)\\
&= (1-\tau_t)(1-\theta)\left(\frac{w_t}{P_t}\right)^{1-\theta} e_{it}^{1-\theta} (\gamma_i N_t)^{-\theta} && (48)\\
&= (1-\theta)\underbrace{(1-\tau_t)\left[\frac{w_t}{P_t} e_{it}\gamma_i N_t\right]^{1-\theta}}_{z_{it}}\frac{1}{\gamma_i N_t} && (49)\\
&= (1-\theta)\frac{z_{it}}{\gamma_i N_t} && (50)
\end{aligned}
$$

A.2 Back to the Problem

Drift of state variable

$$
\begin{aligned}
\pi_{k,t} &= \frac{\dot{w}_{k,t}}{w_{k,t}} && (51)\\
dw_{k,t} &= \pi_{k,t} w_{k,t} dt && (52)
\end{aligned}
$$

Re-write the objective in Eq. 32 in recursive form. Let $J(w,t)$ be the value function of the union with wage w

$$\rho J(w,t) = \max_{\pi_w} \underbrace{\int [u(c_{it}) - v(n_{it})]di}_{\text{Total flow of utility of the households}} - \frac{\Psi}{2}\pi_w^2 + J_w(w,t) \underbrace{\pi_w}_{\text{state variable drift}} + J_t(w,t)$$

Each union is infinitesimal so they only account for the the marginal effect of their decisions on each household's utility.

The FOC and the envelope condition of the above problem give

$$\text{FOC: } \Psi\frac{\pi_w}{w} = J_w(w,t)$$
$$\text{Envelope: } (\rho - \pi_w)J_w(w,t) = \int \left[\frac{du(c_{it})}{dw} - \frac{dv(n_{it})}{dw}\right] di + J_{ww}(w,t)w\pi_w + J_{tw}(w,t)$$

From the derivations in Section A.1 re-write the envelope condition as

$$(\rho - \pi_w)J_w(w,t) = \int \gamma_i n_{k,t} \left[(1-\epsilon)\frac{e_{it}}{P_t}u'(c_t)(1-\text{MTR}_{it}) + \frac{\epsilon}{w}v'(n_t)\right] di + J_{ww}(w,t)w\pi_w + J_{tw}(w,t)$$

Now differentiate the FOC wrt time to get

$$J_{ww}(w,t)\dot{w} + J_{wt}(w,t) = \Psi\frac{\dot{\pi}_w}{w} - \Psi\frac{\pi_w}{w^2}\dot{w}$$

Substitute this in the envelope condition to get

$$(\rho - \pi_w)J_w(w,t) = \int \gamma_i n_{k,t} \left[(1-\epsilon)\frac{e_{it}}{P_t}u'(c_{it})(1-\text{MTR}_{it}) + \frac{\epsilon}{w}v'(n_{it})\right] di + \Psi\frac{\dot{\pi}_w}{w} - \Psi\frac{\pi_w}{w^2}\dot{w}$$

Now substitute the FOC (and note that $\frac{\dot{w}}{w} = \pi_w$ and $n_{k,t} = N_t$)

$$(\rho - \pi_w)\Psi\frac{\pi_w}{w} = \int \gamma_i n_t \left[(1-\epsilon)\frac{e_{it}}{P_t}u'(c_{it})(1-\text{MTR}_{it}) + \frac{\epsilon}{w}v'(n_{it})\right] di + \Psi\frac{\dot{\pi}_w}{w} - \Psi\frac{\pi_w^2}{w}$$

Note that $\Psi\frac{\pi_w^2}{w}$ term on both the sides cancels out. And we get

$$\rho\Psi\frac{\pi_w}{w} = \int \gamma_i N_t \left[(1-\epsilon)\frac{e_{it}}{P_t}u'(c_{it})(1-\text{MTR}_{it}) + \frac{\epsilon}{w}v'(n_{it})\right] d\mu_t + \Psi\frac{\dot{\pi}_w}{w}$$

Multiply the above equation by w and note that $\frac{\partial z_{it}}{\partial n_{i,t}} = (1-\text{MTR}_{it})e_{it}\frac{w}{P}$

$$\rho\pi_w = \frac{\epsilon}{\Psi}N_t \int \left[\gamma_i v'(n_{it}) - \frac{\epsilon-1}{\epsilon}\frac{\partial z_{it}}{\partial n_{it}}u'(c_{it})\right] di + \dot{\pi}_w$$

Lastly, use $\frac{\partial z_{it}}{\partial n_{it}} = (1-\theta)\frac{z_{it}}{\gamma_i N_t}$:

$$\rho\pi_w = \frac{\epsilon}{\Psi}N_t \int \left[\gamma_i v'(n_{it}) - \frac{\epsilon-1}{\epsilon}(1-\theta)\frac{z_{it}}{\gamma_i N_t}u'(c_{it})\right] di + \dot{\pi}_w$$

This is the aggregate Philips curve. In case of linear taxation, $\theta = 0$ and adjusting for the monopoly market, by providing a wage subsidy $\tau_t^w = \epsilon^{-1}$ we get

$$\begin{aligned}
\rho\pi_w &= \frac{\epsilon}{\Psi}N_t \int \left[\gamma_i v'(n_{it}) - \frac{\epsilon-1}{\epsilon}(1-\theta)\frac{(1-\tau_t)(1+\tau^w)w_t e_{it}}{\gamma_i N_t}u'(c_{it})\right] di + \dot{\pi}_w \\
\rho\pi_w &= \kappa^w N_t \int \left[\gamma_i v'(n_{it}) - (1-\tau_t)w_t e_{it} u'(c_{it})\right] di + \dot{\pi}_w \\
\text{where } \kappa^w &= \frac{\epsilon}{\Psi}
\end{aligned}$$

B Section 3 Proofs: Welfare Effects of Fiscal Policies

B.1 Proof of Proposition 1

Proof. Let e be the idiosyncratic state, the time dependent HJB is

$$\rho V(a,e,t;l,\tau,\Gamma) = \max_c \left[u(c,e,t) - v(l,e,t) + \partial_a V(a,e,t)((1-\tau)wel + ra - c + \Gamma) + \mathcal{A}_t V(a,e,t) + \partial_t V(a,e,t)\right] \tag{53}$$

Here the households take the prices $\{r,w\}_{t\geq s}$, taxes/transfers quantities $\{\tau,\Gamma\}_{t\geq s}$ and labor supply $\{l\}_{t\geq s}$ as given— made explicit in the LHS. We consider a baseline where a path of prices is exogenously given and remains the same during our perturbation. The First Order Condition of the above problem is

$$u_c(c,e,t) = \partial_a V(a,e,t)$$

Now for an exogenous sequence of shocks $\{dl_s\}_{t\geq s}$, $\{d\tau_s\}_{t\geq s}$ and $\{d\Gamma_s\}_{t\geq s}$ at time t, the welfare effect of individual with state a_t, e_t at time t, up to the first order i.e. $dV(a_t, e_t, t)$ is given by

$$
\begin{aligned}
\rho dV(a,e,t) &= -v_l(l,e,t)dl_t + d\left(\partial_a V(a,e,t)s(a,l)\right) + \partial_a V(a,e,t)[(1-\tau)wedl_t - weld\tau_t + d\Gamma_t] \\
&\quad + \mathcal{A}_t dV(a,e,t) + \partial_t dV(a,e,t) \\
&= \partial_a V(a,e,t)[(1-\tau)wedl_t - weld\tau_t + d\Gamma_t] - v_l(l,e,t)dl_t + \partial_a\left(dV(a,e,t)s(a,l)\right) \\
&\quad + \mathcal{A}_t dV(a,e,t) + \partial_t dV(a,e,t) \\
&= [\partial_a V(a,e,t)(1-\tau)we - v_l(l,e,t)]dl_t - \partial_a V(a,e,t)weld\tau_t + \partial_a V(a,e,t)d\Gamma_t + \partial_a\left(dV(a,e,t)s(a,l)\right) \\
&\quad + \mathcal{A}_t dV(a,e,t) + \partial_t dV(a,e,t)
\end{aligned}
$$

We Differentiated the HJB at an interior point in the state space; and used the envelope theorem to eliminate the derivatives w.r.t c. Applying the Feynman-Kac formula

$$
\begin{aligned}
dV(a,e,t) &= \mathbb{E}_t\left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'}\Big[[\partial_a V(a,e,s)(1-\tau)we - v_l(l,e,s)]dl_s - \partial_a V(a,e,s)we_s l_t d\tau_s + \partial_a V(a,e,s)d\Gamma_s\Big]ds\right) \\
&= \mathbb{E}_t\left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'}\Big[(1-\tau)we_s u'(c_s(a,e)) - v'(\gamma_t(a,e)N_t)\Big]dN(s)ds\right) + \mathbb{E}_t\left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'} u'(c_s(a,e))d\right. \\
&\quad - \mathbb{E}_t\left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'} u'(c_s(a,e))we_s\gamma_t(a,e)N_t d\tau(s)ds\right)
\end{aligned}
$$

Here $T\wedge\tau := \inf\{t \geq 0 | a_t = \underline{a}\}$ is the stopping time at which the wealth reaches the borrowing constraint. The second line in the equation above uses the first order conditions. Let $g_t(a,e)$ be the distribution at time t and let $\Lambda_t(a,e)$ be the marginal value of getting the numeraire for an agent with state a, e at time t, we get

$$
\frac{dW^\lambda}{d\theta} = \int_{s=0}^{\infty}\Big[\Omega^{\Gamma(s)}d\Gamma(s) + \Omega^{Y(s)}dY(s) + \Omega^{\tau(s)}d\tau(s)\Big]ds \tag{54}
$$

$$
\frac{dW^\lambda}{d\theta} = \mathbf{\Omega}^{\mathbf{\Gamma}}d\mathbf{\Gamma} + \mathbf{\Omega}^{Y}d\mathbf{Y} + \mathbf{\Omega}^{\tau}d\boldsymbol{\tau} \tag{55}
$$

where

$$
\begin{aligned}
\int_{s=0}^{\infty}\Omega^{Y(s)}dY(s) &= \int\left[\Lambda_t^{-1}(a,e)\mathbb{E}_t\left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'}\Big[(1-\tau)we_s u'(c_s(a,e)) - v'(\gamma_t(a,e)N_t)\Big]dY(s)ds\right)\right]g_t(a,e)dade \\
\int_{s=0}^{\infty}\Omega^{\Gamma(s)}d\Gamma(s) &= \int\left[\Lambda_t^{-1}(a,e)\mathbb{E}_t\left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'}\Big[u'(c_s(a,e))d\Gamma(s)ds\Big]\right)\right]g_t(a,e)dade \\
\int_{s=0}^{\infty}\Omega^{\tau(s)}d\tau(s) &= \int\left[\Lambda_t^{-1}(a,e)\mathbb{E}_t\left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'}\Big[u'(c_s(a,e))we\gamma_t(a,e)N_t d\tau(s)ds\Big]\right)\right]g_t(a,e)dade
\end{aligned}
$$

□

B.2 Proof of Proposition 2

Proposition. *Denote the period s state of an agent who starts with* (a_0, e_0) *as* $x_s = (a_s, e_s)$*. The labor demand effect is*

$$\boldsymbol{\Omega}^N \boldsymbol{dN} = \int_0^\infty e^{-\rho s} \Omega^N(s) dN(s) ds$$
$$= \int_{s=0}^\infty e^{-\rho s} \left[\int_{a_0, e_0} \mathbb{E}_0^i \Big[\underbrace{(1-\tau) w e_s u'(c^{ss}(x_s)) - v'(n^{ss}(x_s))}_{\textit{Individual labor Wedge}} \Big] \gamma_0(\cdot) dg_0(\cdot) \right] dN_s ds$$

Proof. Follows directly from the result in Sec. B.1 □

B.3 Proof of Corollary 1

Corollary 2. *The welfare effect of the general equilibrium changes, beginning from the labor allocation in the steady state is zero to the first order i.e.*

$$\Omega^{Y(s)} := \mathbb{E}_0 \left(\int_0^{T \wedge \tau} e^{-\int_t^s \rho dt'} \left[(1-\tau) w e u'(c_s(a,e)) \Big|_{ss} - v'(\gamma(a,e) Y(s)) \Big|_{ss} \right] \right) \Bigg] g_0(a,e) da de = 0$$

Proof. Plug the FOC to get the result. □

B.4 Proof of Proposition 3

Proposition. *For a uniform transfer shock* $d\Gamma_s(a,e) = d\Gamma_s$ *in period s, the effects of deficit financing on welfare are given by the following terms*

$$\boldsymbol{\Omega}^\Gamma d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^\tau d\boldsymbol{\tau} =$$
$$\int_0^\infty e^{-\rho s} \Bigg[\underbrace{\mathcal{U}_s' [d\Gamma_s - Y_{ss} d\tau_s]}_{\textit{Net Aggregate Deficits}} + \underbrace{\mathbb{C}ov_{a,e} \Big(\mathbb{E}_0^i \left[u'(c^{ss}(x_s)) \right], \mathbb{E}_0^i [d\Gamma_s - w e_s n^{ss}(x_s) d\tau_s] \Big)}_{\textit{Deficit Incidence}}$$
$$+ \underbrace{\mathbb{E}_{a,e} \Big(\mathbb{C}ov^i \left(u'(c^{ss}(x_s)), d\Gamma_s - w e_s n^{ss}(x_s) d\tau_s \right) \Big)}_{\textit{Aggregate Insurance Effect}} \Bigg] ds$$

where $\mathcal{U}_s' := \int u'(c_s(a,e)) g_0(a_0, e_0) da de = \mathbb{E}_{a,e}[u'(c_s)]$ *and* $dT_s = d(Y_s \tau_s)$

Proof. Combining the last two terms and using that $E[XY] = E[X]E[Y] + \text{Cov}(X,Y)$

$\boldsymbol{\Omega}^{\boldsymbol{\Gamma}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{\tau} d\boldsymbol{\tau}$

$$\int \left[\Lambda_0^{-1}(a_0,e_0) \int_0^\infty e^{-\rho s}\left(\mathbb{E}_0[u'(c_s)]\mathbb{E}_0[d\Gamma_s - we_s n_s d\tau_s] + Cov(u'(c_s), d\Gamma_s - we_s n_s d\tau_s)\right) ds\right] g_0(a,e) dade$$

Take the term $\int \left[\Lambda_0^{-1}(a_0,e_0) \int_0^\infty e^{-\rho s}\left(\mathbb{E}_0[u'(c_s)]\mathbb{E}_0[d\Gamma_s - we_s n_s d\tau_s]\right) ds\right] g_0(a,e) dade$. And interchange the time and cross section integrals

$$\int_0^\infty e^{-\rho s}\left[\int \Lambda_0^{-1}(a_0,e_0)\left(\mathbb{E}_0[u'(c_s)]\mathbb{E}_0[d\Gamma_s - we_s n_s d\tau_s]\right) g_0(a,e) dade\right] ds$$

Again use $E[XY] = E[X]E[Y] + \text{Cov}(X,Y)$ and call $\mathcal{U}'_s := \int u'(c_s(a,e)) g_0(a_0,e_0) dade = \mathbb{E}_{a,e}[u'(c_s)]$ and we can use the fact that

$$\int \mathbb{E}_t[d\Gamma_s(a,e) - we_s n_s d\tau_s] g_t(a,e) dade = \underbrace{\int \mathbb{E}_t[d\Gamma_s(a,e)] g_t(a,e) dade}_{d\Gamma_s} - \underbrace{\int \mathbb{E}_t[we_s n_s d\tau_s] g_t(a,e) dade}_{wN_s d\tau_s}$$

Using this we can re-write $\int \left[\Lambda_t^{-1}(a_0,e_0) \int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'}\left(\mathbb{E}_t[u'(c_s)]\mathbb{E}_t[d\Gamma_s - we_s n_s d\tau_s]\right) ds\right] g_t(a,e) dade$ as

$$= \int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'} \Lambda_t^{-1}(a_0,e_0)\left[\underbrace{\mathbb{E}_t \mathcal{U}'_s[dE_s - wNd\tau_s]}_{\text{Net Aggregate Deficits}} + \underbrace{Cov_{a,e}\left(\mathbb{E}_t[u'(c_s)], \mathbb{E}_t[d\Gamma_s - we_s n_s d\tau_s]\right)}_{\text{Incidence of Deficits}}\right] ds$$

Now take the second term

$$\int \left[\Lambda_t^{-1}(a_0,e_0) \int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'}\left(Cov(u'(c_s), d\Gamma_s - we_s n_s d\tau_s)\right) ds\right] g_t(a,e) dade$$

Interchanging the integrals

$$\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'} \Lambda_t^{-1}(a_0,e_0) \underbrace{\left[\int \left(Cov(u'(c_s), d\Gamma_s - we_s n_s d\tau_s)\right) g_t(a,e) dade\right]}_{\text{Aggregate Insurance Effect}} ds$$

Denote the term in the curly brackets as $\mathbb{E}_{a,e}\left(Cov(u'(c_s), d\Gamma_s - we_s n_s d\tau_s)\right)$. So we can write

$$= \int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'} \Lambda_t^{-1}(a_0, e_0) \Bigg[\underbrace{\mathbb{E}_t \mathcal{U}_s'[dE_s - wNd\tau_s]}_{\text{Net Aggregate Deficits}} + \underbrace{\mathbb{C}ov_{a,e}\left(\mathbb{E}_t[u'(c_s)], \mathbb{E}_t[d\Gamma_s - we_s n_s d\tau_s]\right)}_{\text{Incidence of Deficits}}$$
$$+ \underbrace{\mathbb{E}_{a,e}\left(Cov(u'(c_s), d\Gamma_s - we_s n_s d\tau_s)\right)}_{\text{Aggregate Insurance Effect}} \Bigg] ds$$

$\square$

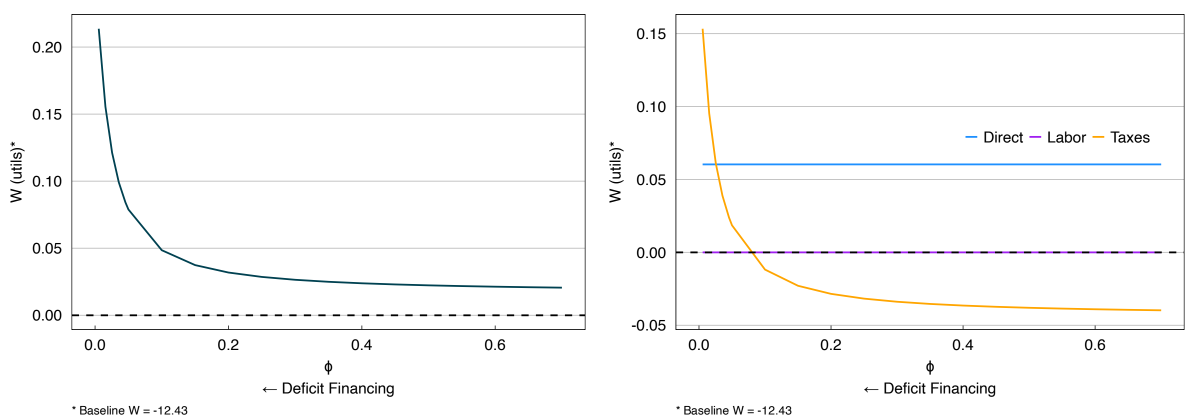
C Baseline Extensions

C.1 Uniform Labor Rationing

We also present the results for the same uniform transfer shock as in Section 4, but for a model where the labor union allocates an equal amount of labor to all households i.e. $\gamma(a,e) = 1$. This allocation rule is commonly used in the literature but, as previously argued, is not necessarily suitable for welfare analysis due to the presence of individual labor wedges.

Figures 7a and 7b show the overall welfare effect and the welfare decomposition to the uniform transfer shock. Three things are worth highlighting. First, The effects are qualitatively the same as the baseline model with optimal steady state labor allocation. That is, higher levels of deficit financing yield larger welfare improvements. Second, the magnitude of the welfare change is larger with the constant allocation rule. Third, the labor demand effect is still zero in this model. This occurs because the utilitarian planner only requires the average individual labor wedge to be zero for the labor demand effects to have no first-order effects. The labor demand effect would be non-zero for other planners.

Figure 7: Welfare change from uniform transfer for different deficit financing in HANK



(a) Welfare Change (utils) (b) Welfare Breakdown

We omit the tax and transfer effect plots for brevity, but we confirm that welfare remains largely driven by the self-financing term.

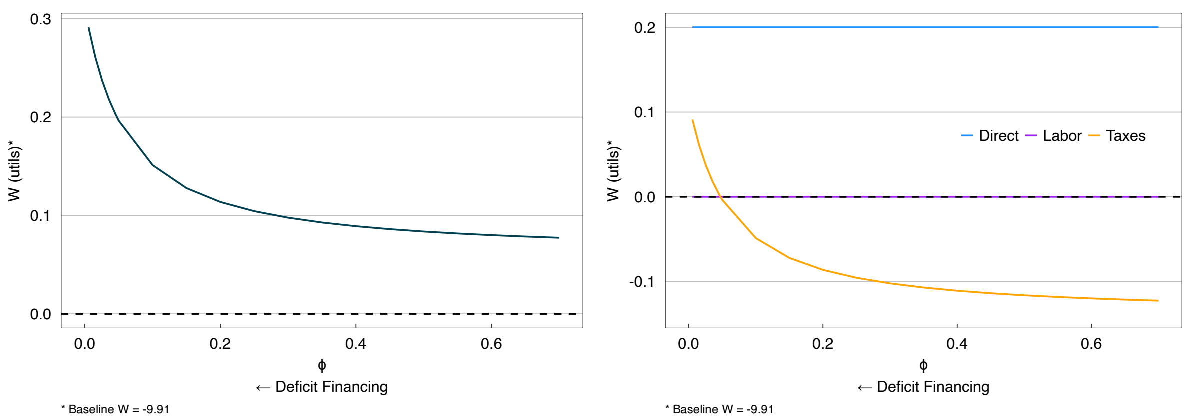
C.2 Persistent Fiscal Policy

Our baseline only considers a one-time uniform transfer shock. Here, we consider a persistent uniform transfer shock of 1% of annual GDP that decays at a quarterly rate of 0.3.

Figures 8a and 8b show the welfare change to the persistent uniform transfer shock and the welfare components. Qualitatively the shape of the responses are similar to the one-time shock.

The primary difference is simply that the magnitude of the responses are larger. As shown in Figures 9a and 9b, the increase in welfare is mostly driven by the net aggregate deficit term, which is buoyed by the higher multiplier associated with the persistent shock.

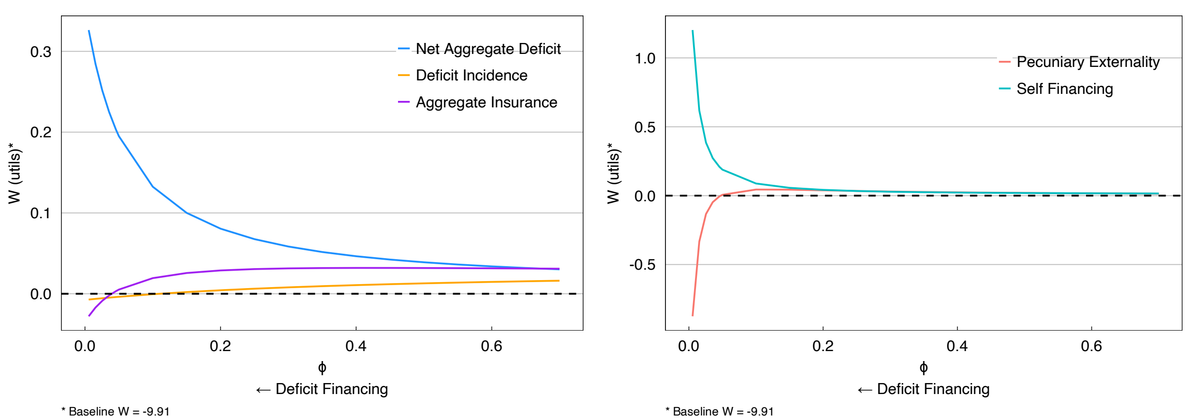
FIGURE 8: WELFARE CHANGE FROM PERSISTENT UNIFORM TRANSFER FOR DIFFERENT DEFICIT FINANCING IN HANK



(A) WELFARE CHANGE (UTIL)

(B) WELFARE BREAKDOWN

FIGURE 9: WELFARE DECOMPOSITION TO PERSISTENT SHOCK



(A) WELFARE CHANGE (UTIL)

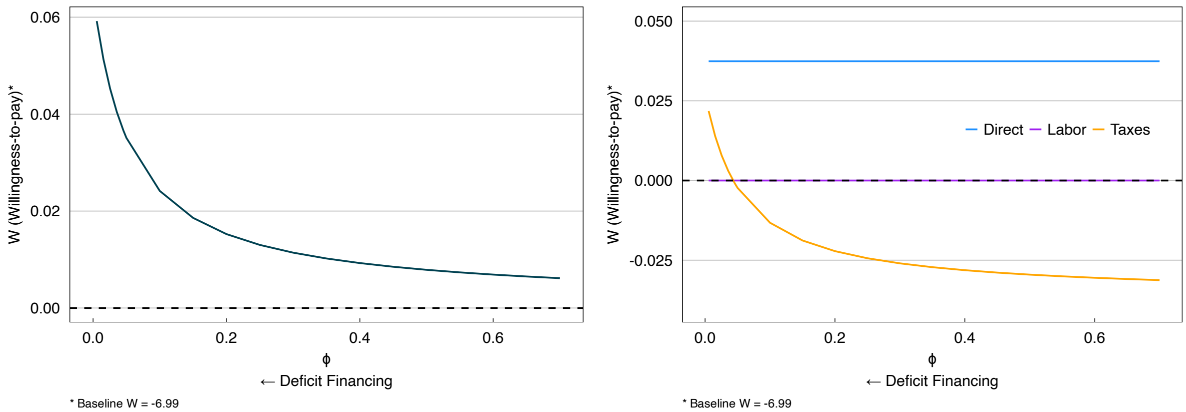
(B) DECOMPOSITION OF DEFICITS TERM.

C.3 Alternative Planners

In this appendix, we present the same results as Section 4 but with an alternative planner numeraire; namely period-0 consumption units. This is equivalent to $\Lambda(a_0, e_0) = u'(c_0(a_0, e_0))$.

Figures 10a and 10b show the welfare decomposition from the one-time uniform transfer shock over various levels of deficit financing. The results are similar to the baseline utilitarian welfare results.

Figure 10: Welfare change in period-0 consumption units from uniform transfer for different deficit financing in HANK

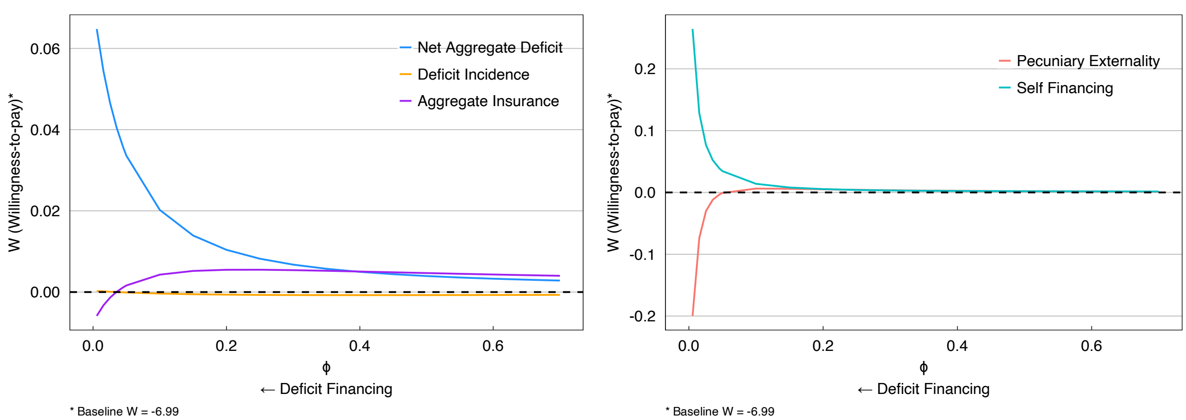


(a) Welfare Change (WTP)

(b) Welfare Breakdown

Figures 11a and 11b show the tax and transfer effects, and the breakdown of the net aggregate deficit term from the policy as viewed by the efficiency planner. The net aggregate deficit term remains the dominate force in driving up welfare as deficit financing increases. The main difference between the utilitarian and efficiency planner comes from the aggregate insurance term playing a larger role for the efficiency planner. This occurs as insurance is now benchmarked to period-0 consumption, which changes the insurance value of future taxes.

Figure 11: Welfare Decomposition in Period-0 consumption units



(a) Welfare Change (WTP)

(b) Decomposition of Deficits Term.

D Debt Relief Model Appendix

D.1 Background on the Debt Relief Policies in the United States

The New Deal Farm Mortgage debt relief programs implemented after the Great Depression in 1930s were the first large scale debt relief programs in the United States history (Rose, 2013). They were implemented in a set of two closely related programs run by Federal Land Banks (FLB) and their regulator, Land Bank Commissioner (LBC), in response to sharply increasing delinquiencies and defaults of farm mortgages. A similar program was run by Home Owners' Loan Corporation (HOLC) to tackle the crisis in residential home mortgages. The relief comprised of a reduction in interest rates, principal repayment pauses and changes in the duration of the loans. In both the cases however— i.e. for for residential and non-residential farm mortgages— no debt was permanently forgiven and rather the objective was to be to provide a temporary relief to help the borrowers go through the downturn without large scale defaults[25]. Even though there was no permanent redistribution, these programs still required funding to provide for the missed payments. It was provided by the Treasury in two forms, capital investment in banks and cash payments, to fund the forbearance and subsidize interest rates respectively.

Along with these federally legislated programs, a number of states also implemented foreclosure moratoriums which prohibited lenders to foreclose on the mortgages of the individuals unable to repay (Wheelock et al., 2008). The losses to the lenders were not financed by the government but rather directly borne by the banks. And lastly, the Great Depression and the New Deal era also saw the abrogation of Gold clauses in the debt contracts post the dollar devaluation which relieved the debtors $69 billion in payments—an amount greater than the GDP (Kroszner et al., 1999). Although indirectly, these programs led to a permanent redistribution from lenders to borrowers.

Post the Great Financial Crisis of 2008, the US government again implemented debt relief polices very similar in vein to the Great Depression. The Housing Affordable Modification Program (HAMP) included interest rate reductions, longer duration for almost 1.8 million borrowers but notably also forgiveness on the original principal amount for nearly 245,000 borrowers.[26]. The Principal Reduction Alternative (PRA) provided an additional $67,000 in principal forgiveness as compared to the standard HAMP and its costs were borne both by the mortgae servicer and the Treasury which provided incentive subsidies ranging from 6% to 21% of the principal reduction.[27]

With the valuable lessons learned from the Great Recession, the outbreak of Covid-19 pandemic saw immediate calls for debt relief policies[28]. The CARES Act of March 2020 granted forbearance

[25]" *temporary* readjustement of amortization, to give sufficient time to farmers to restore to them the hope of ultimate free ownership of their own land" - Roosevelt (Rose, 2013)

[26]See Ganong and Noel (2020), Scharlemann and Shore (2016) and Agarwal et al. (2017) for a discussion of the economic impacts of HAMP

[27]`https://www.irs.gov/newsroom/principal-reduction-alternative-under-the-home-affordable-modification-program`

[28]Amit Seru and Tomasz Piskorski for example wrote as early as April 2020 in a Barron's article that "Vulnerable

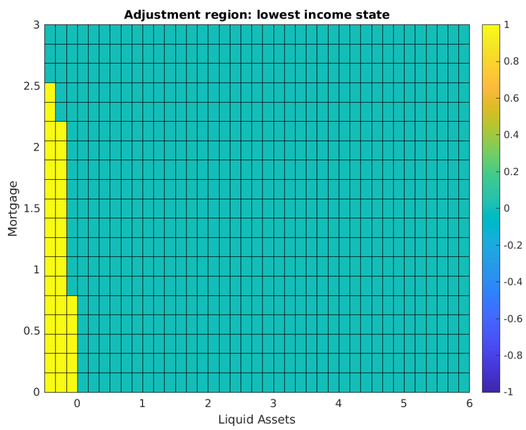
on debt payments for most credit types including residential mortgages, auto, revolving, and student debt. The choice to enter forbearance was optional[29] and once the moratorium period ended the borrowers had the choice to add the missed payments as amortization in their existing schedule or do a one time balloon payment. While these policies acted as social insurance the White House also announced in 2022 the student loan forgiveness provisions of the second fiscal stimulus act called the HEROES Act. While it still hasn't been implemented but most borrowers were scheduled to receive $10,000 for federal student loans and $20,000 for Pell grant loans as a permanent reduction in debt levels.

households need permanent and quick debt relief. Washington can help directly"

[29]Except all federal student loans which were automatically entered to forbearance and their interest rate set to zero percent (Cherry et al., 2021)

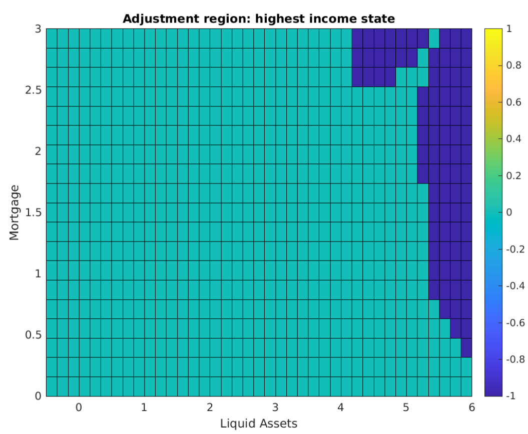
D.2 Steady State of the Model

Figure 12: Adjustment regions for households with different income levels



(a) Adjustment region for low income households

(b) Adjustment region for middle income households

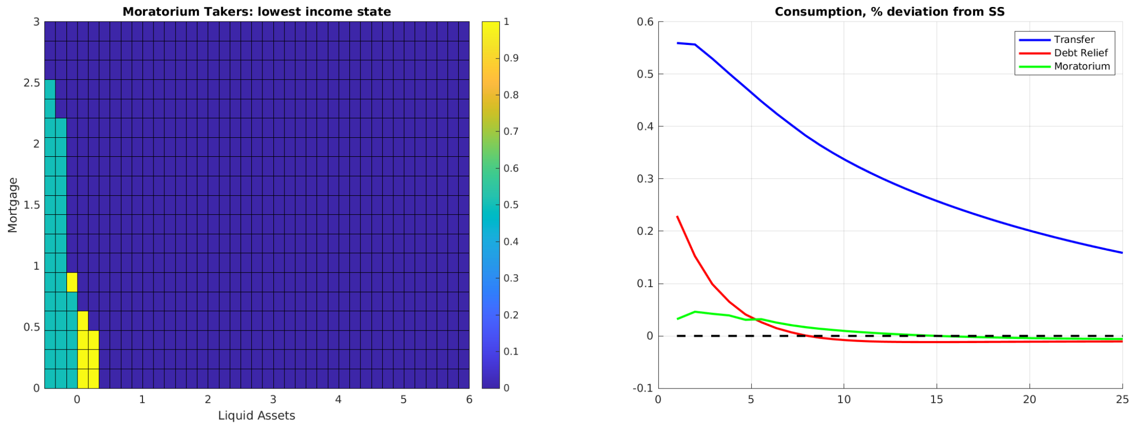


(C) Adjustment region for high income households

Notes: A value of zero (color green) denotes no adjustment. A value of positive one, color yellow, denotes drawing equity and a value of negative one (color blue) denotes pre-paying the long term debt.

D.3 Moratorium

Figure 13: Adjustment regions for households with different income levels



(a) Self-selection of HHs into forbearance

(b) Partial Equilibrium Consumption Response

Notes: A value of zero (color green) denotes no adjustment. A value of positive one, color yellow, denotes drawing equity and a value of negative one (color blue) denotes pre-paying the long term debt.

E Wages Phillips Curve

Our quantitative model features non-linear taxation and a richer set of income states, which includes unemployment and not-in-the-labor force. In this appendix, we show how to account for these features.

Unions.— Face the same problem as in Equation 32, except now they only optimize over the employed population. Recall i represents all state variables, which are now $\{a, m, e\}$, and let i_x represent the x-th entry in the state vector, and let e^E represent a vector of only employed productivity states. This means an agent is employed if $i_3 \in \boldsymbol{e}$. Then union k, subject to the same demand curve in Equation 31, solves the following:

$$\int_0^\infty e^{-\rho t}\left(\int \left\{u(c_t(a,y)) - v\left(\int_0^1 \gamma_i n_{k,t} dk\right) d\mu_t \cdot \mathbb{1}[i_3 \in e^E]\right\} - \frac{\Psi}{2}\left(\frac{\dot{w}_{k,t}}{w_t}\right)\right) dt \tag{56}$$

Wages Phillips Curve.— Following the same steps as above we can derive the following wages New Keynesian Phillips curve

$$\rho\pi_w = \frac{\epsilon}{\Psi} N_t \int \left[\gamma_i v'(n_{it}) - \frac{\epsilon - 1}{\epsilon}(1-\theta)\frac{z_{it}}{\gamma_i N_t} u'(c_{it})\right] \cdot \mathbb{1}[i_3 \in e^E] di + \dot{\pi}_w$$

Monopoly correction.—Lastly, we want to correct for the monopoly distortion by providing a labor subsidy adjusted for progressivity, $(1-\tau^s)^{\frac{1}{1-\theta}}$. Similar to before the optimal labor subsidy requires setting $\tau^w = \epsilon^{-1}$

$$\rho\pi_w = \frac{\epsilon}{\Psi} N_t \int \left[\gamma_i v'(n_{it}) - \frac{\epsilon - 1}{\epsilon}(1-\theta)(1-\tau_t)(1+\tau^s)\frac{(w_{it} e_{it} \gamma_i N_t)^{1-\theta}}{\gamma_i N_t} u'(c_{it})\right] \cdot \mathbb{1}[i_3 \in e^E] di + \dot{\pi}_w$$

applying optimal wage subsidy

$$\rho\pi_w = \frac{\epsilon}{\Psi} N_t \int \left[\gamma_i v'(n_{it}) - (1-\theta)(w_{it} e_{it}(1-\tau_t))^{1-\theta}(\gamma_i N_t)^{-\theta} u'(c_{it})\right] \cdot \mathbb{1}[i_3 \in e^E] di + \dot{\pi}_w$$

The subsidy is by lump-sum taxes. For each employed household the funds from the wage subsidy are offset by the lump-sum taxes, leaving post-tax income as specified in the household problem.