Welfare Costs and Benefits of Deficit-Financed Fiscal Policy

Raman S. Chhina *
University of Chicago

Calvin He
Stanford University

July 31, 2025

Abstract

Deficit-financed fiscal policy plays a crucial role in alleviating the effects of short-run business cycle fluctuations. However, its benefits must be weighed against the costs of future taxation required to service the additional debt. In this paper, we analyze this welfare trade-off by decomposing and quantifying the channels through which fiscal policy impacts aggregate welfare in a Heterogeneous Agent New Keynesian (HANK) model. Our decomposition and quantification shows that, beyond macroeconomic stabilization and redistribution, deficit-financed fiscal policy generates welfare benefits largely through two mechanisms: i) a self-financing channel, and ii) a liquidity channel. We apply our decomposition to create policy ranking measures like 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 'bang for buck'.

Keywords: Welfare Decomposition, Fiscal Policy, Public Debt.

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, Eduardo Davila, Kurt Mitman, Paymon Khorrami and participants at Macro Lunch Seminars at UChicago/Stanford, Yiran Fan Memorial Conference and Trans-Atlantic Doctoral Conference (LBS) for helpful comments and discussions.

1 Introduction

Public debt in the United States and other advanced economies is large and rising. A significant portion of this increase stems from deficit-financed fiscal spending in response to major recessions. In the United States, for example, the debt-to-GDP ratio rose from 60% prior to the Great Recession in 2008 to approximately 100% within just four years. During the COVID-19 crisis, it increased by another twenty percentage points, reaching around 120%.[1]

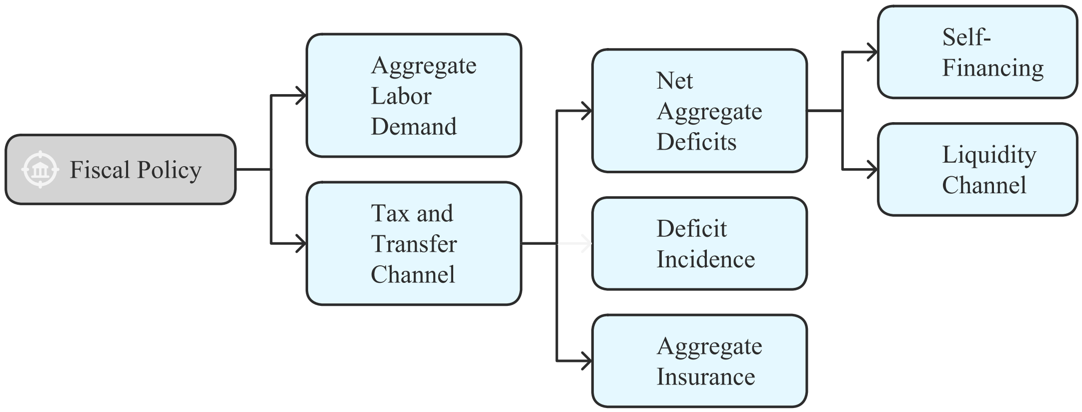
Such fiscal relief spending during recessions, when financed through increased public debt, involves both benefits and costs. Assessing the relative importance of different channels and the net aggregate impact, however, is not trivial. Relief and transfer policies provide direct support to their recipients and can generate general equilibrium multiplier effects—effects that are often amplified by deficit financing (Auclert, Rognlie, and Straub, 2024*b*). At the same time, higher public debt imposes future costs in the form of increased taxes needed to restore fiscal balance, while simultaneously redistributing toward individuals who hold government bonds. Furthermore, even for the same overall fiscal cost, different forms of relief policies can yield vastly different benefits across subgroups of the population, complicating direct one-to-one policy comparisons.

In this paper, we make progress on analyzing the welfare costs and benefits of deficit-financed fiscal policy by first providing an analytical decomposition that linearly separates the key channels through which fiscal policy and government debt affect aggregate welfare in a Heterogeneous Agent New Keynesian (HANK) model (Figure 1). We then implement this decomposition using a standard calibration of a one-account HANK model to quantify the relative importance of each channel. Finally, we use our decomposition to construct policy ranking criteria, allowing us to compare policies in terms of their Benefits-to-Cost Ratio and the Marginal Value of Public Funds within the HANK framework. Using these measures, in an extended model, we evaluate 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'.

Our analytical decomposition consists of three layers. In the first layer, we show that in our baseline HANK model—that is, a model with rigid wages and a monetary authority that keeps the real rate constant, the welfare effects of a uniform transfer financed by running deficits is driven by three effects: (i) an aggregate labor demand channel, (ii) a transfer channel related to benefits from any fiscal transfers from the policy, and (iii) a tax channel that summarizes the net welfare cost from taxation required to achieve fiscal balance. We show that, to first-order, welfare changes from fiscal policy can be calculated using only steady-state objects and the sequence of labor demand, tax rate changes, and transfers.

[1] U.S. Office of Management and Budget and Federal Reserve Bank of St. Louis, Federal Debt: Total Public Debt as Percent of Gross Domestic Product [GFDEGDQ188S], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/GFDEGDQ188S, July 29, 2025.

Figure 1: Welfare Effects of Fiscal Policy



In the second layer, we further decompose the *tax* and *transfer* channels into three key effects: (i) Net Aggregate Deficits, (ii) Deficit Incidence, and (iii) Aggregate Insurance. 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. This channel is captured by the *Deficit Incidence* term. 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 which is captured by the *Aggregate Insurance* term. Lastly, we show that even after accounting for these two effects, the total amount of deficits in the economy also directly impacts welfare; we refer to this as the *Net Aggregate Deficit* effect.

In our third and final layer, we show that two key mechanisms drive the welfare effects specifically associated with the *net aggregate deficit* channel: the *liquidity* and *self-financing* effects. The latter arises from a fiscal externality in the model. The fiscal externality arises because labor unions, which determine households' labor supply, do not internalize that increasing aggregate labor supply also boosts total tax revenue by raising hours worked per household. As a result, part of the initial policy cost is self-financed. The extent of this self-financing depends on the general equilibrium output response, which increases with larger deficit financing in our baseline model. Thus, greater deficit financing leads to higher self-financing of the policy and, consequently, a lower welfare cost from the additional tax rate adjustments required to fund it.

The liquidity channel, by contrast, is determined by the level of public debt in the steady state. We show that its welfare effect depends directly on the gap between the household discount rate ρ and the real return on liquid savings r, which is itself pinned down by the level of public debt in the economy. The presence of idiosyncratic risk and incomplete markets leads households to accumulate precautionary savings. To clear the asset market, given the fixed supply of public debt, the equilibrium market rate of return, r, falls below the discount rate, ρ. This enables deficit-financed fiscal policy to raise welfare: the government can intertemporally shift liquidity by giving households transfers today and financing it with debt. This intertemporal shift of liquidity takes advantage of the differential between the market interest rate and discount rate.

We quantify the magnitude of each welfare channel for a one-time, period-0 uniform transfer shock under a standard calibration of a one-account HANK model. The relative contributions of the welfare channels vary substantially. The aggregate labor demand channel is, by construction, zero to first order around the steady state. However, we find that its magnitude remains small even in a baseline with a large recession. The tax and transfer effects, by contrast, are modest under a balanced-budget policy but increase sharply with slower fiscal adjustment—or, equivalently, with larger amounts of deficit financing. Our quantitative exercise highlights that the welfare gains from deficit financing are primarily driven by the net aggregate deficit effect. We find that, under reasonable levels of deficit financing, both the liquidity and self-financing components contribute positively to this effect, with the self-financing effect becoming dominant at higher levels of deficit financing.

While recent work in the literature has provided welfare decompositions for economies with heterogeneous agents[2], our decomposition and quantification offers several new insights into the welfare effects of deficit financing in economies that feature both heterogeneous agents and New Keynesian elements. First, our decomposition reveals that, in a HANK model, the two distinct approaches to evaluating the welfare effects of public debt, *macro-stabilization* and *pure public finance* —highlighted by Blanchard (2023)—are closely connected.[3] The *aggregate labor demand* term captures the traditional macro-stabilization effect but our quantification shows that a sizable amount of total gains also come from the *liquidity* channel, which is unrelated to demand management and purely depends on the level of public debt in the economy. Second, we show that while macro-stabilization through deficit-financed fiscal policy contributes positively to welfare during a recession, the quantitatively dominant source of welfare gains at high levels of deficit financing arises from the self-financing of fiscal stimulus. Although aggregate stabilization corrects the misallocation caused by nominal rigidities, the resulting welfare gains are modest compared to the income gains the government can achieve by exploiting the fiscal externality. This insight has important implications for optimal policy design in HANK models, as the potential for self-financing gains may bias the planner toward running larger deficits.

Building on the insights from our decomposition, the second part of the paper addresses our next question: Which policies deliver the greatest welfare benefits relative to their financing costs? To answer this, we enrich the baseline HANK model by incorporating short-term debt, long-term mortgages, and unemployment risk, allowing us to analyze and rank a broad set of fiscal policies. These include government spending, targeted transfers, mortgage principal relief,

[2]See Bhandari et al. (2023) and Dávila and Schaab (2022*b*), for example.

[3]Blanchard (2023), for instance, raises this question: "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?"

payment moratoriums, increased unemployment insurance (UI) generosity, and UI extensions. To rank these policies, we introduce two standard metrics from empirical public finance—the Benefits-to-Cost Ratio (BCR) and the Marginal Value of Public Funds (MVPF)—within the HANK framework. These metrics capture the 'bang for the buck' of each policy, measuring the total net benefits, including labor demand effects, direct transfers, and other general equilibrium impacts, relative to the excess tax burden required to finance the policy, accounting for self-financing. Our approach extends these static policy ranking measures to dynamic, general equilibrium environments, while also closing the government budget constraint and explicitly specifying the source of fiscal financing—an often-criticized limitation of static measures (García and Heckman, 2022).

Our results from this exercise echo the findings from the simple model: policies that generate higher levels of self-financing tend to deliver greater 'bang for the buck'. We show that highly targeted policies—such as moratoriums and UI extensions—typically produce greater degrees of self-financing. This is because these policies are directed at households that are more likely to be liquidity constrained, which amplifies their impact on output. In addition, targeted policies are relatively inexpensive, as costs are incurred only when a small subset of the population utilizes them. Taken together, these features imply that highly targeted policies can achieve substantial self-financing at low cost, resulting in high BCR and MVPF.

Lastly, we show that relying solely on measures like the BCR and MVPF can be misleading for policy conclusions. The net aggregate welfare gains from highly targeted policies tend to be modest. Intuitively, policies such as moratoriums and UI extensions benefit only a small subset of households. Moreover, their targeted nature often limits their scalability—they tend to 'empty their chamber' relatively quickly. As a result, despite exhibiting favorable BCR and MVPF ratios, these policies generate limited aggregate welfare effects compared to broader interventions such as principal reductions or uniform transfers.

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, 2024*b*; Hagedorn, Manovskii, and Mitman, 2019; McKay and Reis, 2016; Bayer, Born, and Luetticke, 2024).[4] However, much of this research has 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.[5]

Relative to their work, we contribute in multiple dimensions. First, our decomposition provides

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

[5]Bhandari et al. (2017); Dávila and Schaab (2022*a*); Auclert et al. (2024); LeGrand and Ragot (2023); Bilbiie, Monacelli, and Perotti (2024) study optimal policy in heterogeneous agent environments.

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).[6] 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 output multipliers and deficits (Auclert, Rognlie, and Straub, 2024*b*; 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 debt and liquidity—key mechanisms in the *pure public finance* approach. The impact of the latter channels depends on the equilibrium difference between the discount rate and the real interest rate, which we describe in Section 3.3.2.

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 (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).[7] 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.[8] Empirical studies typically assess the consumption effects of such policies on affected households relative to their fiscal cost without closing the government budget constraint or specifying the source of fiscal financing. 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.

[6]Here, dynamic efficiency plays a central role (Samuelson, 1958; Diamond, 1965; Abel et al., 1989)

[7]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. See Appendix E.1

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

Outline We start with the description of the one-account HANK model in Section 2 and then introduce our welfare decomposition in Section 3. We quantify the various channels in our decomposition in Section 4 and also provide a number of extensions of our baseline environment. Finally, in Section 5 we introduce our policy ranking measures, generalized HANK environment with multiple policy options and provide their corresponding rankings under a realistic calibration.

2 Model: One-account HANK

This section presents a standard one-account heterogeneous agent model with wage rigidities that we will use to study the welfare effects of fiscal policy. Time is continuous in the model and the structure follows closely the discrete time model of Auclert, Rognlie, and Straub (2024*b*). We make one departure by generalizing the labor allocation rule in the union problem, which we describe in Section 2.2.

2.1 Households

There is a unit mass of households denoted by $i \in [0,1]$. Each household is infinitely lived and discounts the future at a rate ρ. Households have separable preferences over consumption and labor, where they receive a flow utility from consumption $u(c_t)$ and a disutility flow from working $v(n_t)$, where n_t denotes the hours worked. Preferences are time separable and maximize the following objective

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

subject to a budget constraint. The expectation is taken over idiosyncratic productivity and households have perfect foresight over aggregate variables. Their state at time t is given by (a_{it}, e_{it}), where a_{it} are their liquid assets and e_{it} is their 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 their current state, households' asset holdings evolve as follows

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

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

Households' income stream consists of interest payments on liquid assets $r_t a_{it}$, government transfers Γ_t, and after-tax income determined by: the tax rates τ_t, effective labor supply $e_{it} n_{it}$, the nominal wage W_t, and the price level P_t. Savings (or borrowing) is determined by flow income net of consumption.

Households maximize Equation 1 subject to Equations 2 and 3 by choosing a path of consumption $\{c_{it}\}_{t\geq 0}$. The labor supply of a household is determined by the labor unions described in Section 2.2. Hence, they take as given the path of labor supply, interest rates, wages, prices, transfers, and tax rates. In the steady state, a recursive formulation of the problem gives optimal consumption policies $c(a,e,\Theta)$, where $\Theta := \{r, W, P, \Gamma, \tau\}$, along with labor supply n_i chosen by the unions. The steady state drift of liquid assets implied by these decision rules and the idiosyncratic productivity process yields a stationary distribution $g(da,de)$. Outside the steady state, each object is time-varying and depends on $\Theta_t := \{r_t, W_t, P_t, \Gamma_t, \tau_t\}$ and n_{it}, which we define next.

2.2 Labor Market

The labor hours n_{it} of an household i are determined by a union (Erceg, Henderson, and Levin, 2000; Schmitt-Grohé and Uribe, 2005; Auclert, Rognlie, and Straub, 2024*b*). 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 maximize member utility, subject to Rotemberg adjustment costs (Rotemberg, 1982) and final demand from the labor packer. We outline the full problem below.

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 for tasks from union k is

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

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

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

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

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

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.

2.2.1 Labor Allocation Rules

Each union is infinitesimal and therefore only takes into account the marginal effect on each household's consumption and labor supply. Moreover, by symmetry, each union sets the same wage $W_{kt} = W_t$ and each union uses the same allocation rule $n_{k,t}(a_t, e_t) = n_t(a_t, e_t)$ to ration labor for its members. As the agents in the model are heterogeneous, it requires an additional assumption on how the aggregate labor is rationed by the unions across agents with different wealth and productivity levels. We consider two different allocation rules

1. *Uniform Allocation Rule*: $n(a_t, e_t) = N_t$ i.e. each individual supplies the same amount of labor (equal to the aggregate labor demand) regardless of their asset and productivity state.

2. *Heterogeneous-Dynamic Allocation Rule*: We assume that the labor allocation is determined by a time-invariant function $\gamma(a_t, e_t)$ of the individual states at time t i.e.

$$n(a_t, e_t) = \frac{\gamma(a_t, e_t)}{\mathbb{E}\gamma(a_t, e_t)} N_t \tag{8}$$

   where N_t is the aggregate labor demand in the economy and $\mathbb{E}\gamma(a_t, e_t) = \int\int \gamma(a_t, e_t) g_t(da, de)$ 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) scaled by the total labor demand in the economy. We chose the $\gamma(\cdot)$ function such that it solves the following equation for all states (a, e)

$$v' \left(\frac{\gamma(a, e)}{\mathbb{E}_{ss}\gamma(a, e)} N_{ss} \right) = u'(c_{ss}(a, e)) \left((1 - \tau_{ss}) \frac{W_{ss}}{P_{ss}} \frac{\gamma(a, e)}{\mathbb{E}_{ss}\gamma(a, e)} N_{ss} \right) \tag{9}$$

   where subscript ss denotes steady-state quantities[9]. This labor allocation rule ensures each household is on their privately optimal consumption and labor choice in steady state (if they could chose labor themselves). Outside of steady state, the rationed labor is determined by function $\gamma(a, e)$ which solves Equation 9.[10]

[9] The expression in Equation 9 corresponds to the household's first order condition, if they could chose privately optimal level of labor, and it equates the marginal utility of consumption to the marginal dis-utility of work.

[10] This allocation rule allows us to be closer to frictionless labor supply benchmark and make a one-on-one comparison with the RANK economy under different social welfare functions.

2.2.2 Wage Philips Curve

Finally, this labor market setup yields aggregate wage inflation, π^w, that evolves according to the following New Keynesian Wage Phillips Curve (for the uniform allocation rule, Appendix C.2 derives the NKWPC for the two alternate rules)

$$\rho\pi^w = \frac{\epsilon}{\Psi}N_t \int \left[v'(n_{it}) - (1-\tau_s)\frac{\epsilon-1}{\epsilon}(1-\tau_t)e_{it}w_t u'(c_{it})\right] di + \dot{\pi}^w \tag{10}$$

where τ_s is a labor subsidy. Equation 10 shows, conditional on future nominal wage inflation, 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 $(1-\tau^s)\frac{\epsilon-1}{\epsilon} = 1$, which eliminates the monopoly distortion.

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 (TFP). There is perfect competition and prices are 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: $\pi_t = \pi_t^w - \frac{\dot{X}_t}{X_t}$. When there are no TFP shocks, price and wage inflation are equal.

2.4 Consolidated Fiscal-Monetary Authority

Fiscal Authority.— Government sets an exogenous plan for spending $\{G_t\}$, taxes $\{T_t\}$, and transfers $\{\Gamma_t\}$, taking the initial level of government debt as given. Changes in total tax revenue are raised by changing the tax rate τ_t. This yields the following law of motion for government debt, B_t,

$$\dot{B}_t = rB_t + G_t + \Gamma_t - T_t \tag{11}$$

where T_t and Γ_t are

$$\int\int \tau_t \left(\frac{W_t}{P_t} e_{it} n_{it}\right) dg_t(da_t, de_t) = T_t \tag{12}$$

$$\int\int \Gamma_t dg_t(da_t, de_t) = \Gamma_t. \tag{13}$$

Fiscal Adjustment 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 $s(t) := T_t - G_t - \Gamma_t$

$$s(t) = s^* + \phi(B(t) - B^*) \tag{14}$$

where s^* is the steady-state level of surpluses, and ϕ governs the speed of fiscal adjustment. A large value of ϕ implies that the debt is repaid quickly, and $\phi \to \infty$ is equivalent to balanced-budget policy that keeps aggregate debt fixed. On the other hand, $\phi \to r$ implies that the government runs the deficit to perpetuity. Thus ϕ is our key policy parameter which varies the *speed* at which government debt is repaid and hence the amount of deficit financing in the economy.

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 4.5.2.

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 $\{T_t, \Gamma_t(\cdot), G_t\}$, exogenous shocks $\{X_t, \rho_t, \epsilon_t\}$, a competitive equilibrium is given by prices $\{P_t, W_t, \pi_t, \pi_t^w, r_t\}$, aggregate quantities $\{Y_t, N_t, C_t, B_t, T_t, \Gamma_t, G_t\}$, individual policies $\{a_t, c_t\}$, union labor allocation $\{n_t(a_t, e_t)\}$, such that the households, unions and, firms optimize, monetary and fiscal policy follow their rules, and the goods, asset, and labor markets clears, and the government balances its budget*

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

3 Welfare Effects of Fiscal Policies

In this section we provide our main analytical results. First, we present a decomposition that separates the first-order welfare effects of fiscal policy in the HANK model into three components: (1) direct benefits from individual transfers provided by the policy, (2) general equilibrium effects (multiplier effect), and (3) welfare losses associated with financing the policy through additional taxes. We provide analytical expressions for each of these components and then further decompose the combined effect of transfers and taxes into three channels: (1) net aggregate deficits, (2) deficit incidence, and (3) aggregate insurance. In the final layer of the decomposition, we split the net aggregate deficit channel into self-financing and liquidity effects. We explain each of these components in detail and also highlight the insights gained from this particular decomposition.

3.1 Social Welfare Function

We use a Social Welfare Function (SWF) to evaluate different policy perturbations in the model. Each individual is indexed by its initial state prior to any shocks. Thus, given Pareto weights indexed by initial states $\alpha(a_0, e_0)$, we define the SWF as

$$W := \int_{e_0} \int_{a_0} \alpha(a_0, e_0) V(a_0, e_0) g(a_0, e_0) da_0 de_0, \tag{15}$$

i.e. the sum of individual household values weighted by the Pareto weights. The aggregate welfare change, thus, after any policy perturbation $d\theta$ is given by

$$\frac{dW}{d\theta} := \int_{e_0} \int_{a_0} \alpha(a_0, e_0) \frac{dV(a_0, e_0)}{d\theta} g(a_0, e_0) da_0 de_0. \tag{16}$$

For simplicity, we use a utilitarian welfare function i.e. Pareto weights $\alpha(a_0, e_0) = 1 \quad \forall (a_0, e_0)$ for the results in Sections 3 and 4. In Section 4.5.4 we generalizes our results to alternate evaluation criteria.

3.2 Fiscal Policy Shock

In this section we study the welfare effects of a fiscal policy shock that provides a sequence of uniform transfers $\{\Gamma\}_{s\geq 0}$ to all the households in the economy, announced at $s = 0$. Given an exogenous value of ϕ i.e. the speed of fiscal adjustment, these transfers simultaneously lead to an increase in output and taxes/government debt in the general equilibrium. In the HANK model defined in Section 2, with a given ϕ, the equilibrium can be expressed as $\mathcal{F}(\{\Gamma_s\}_{s\geq 0}, \{N_s\}_{s\geq 0}; \phi) = 0$ i.e. given the path of transfers, the path of aggregate labor/output is sufficient to solve the equilibrium of the model. Thus, given these two sequences, we can solve for all other model variables, including the path of tax rates, government debt, and consumption.[11],[12]

[11]To see this, note that r_t, w_t are always constant under a real rate rule and no TFP shocks. Given $\{\Gamma_s\}_{s\geq 0}, \{N_s\}_{s\geq 0})$ we can compute the tax rates, government debt and total taxes from Equations 11 and 14. And given transfers, $\{\Gamma_s\}_{s\geq t}$, tax rates, $\{\tau_s\}_{s\geq t}$, and aggregate labor demand, $\{N_s\}_{s\geq t}$ we can solve for the household problem and compute aggregate consumption. Finally, for consistency we need to make sure that the goods market clears, which is the final $\mathcal{F}$ mapping.

[12]However, in the model with Heterogeneous-Dynamic allocation rule we also need to keep track of a third sequence which is a cross-sectional average of the $\gamma(a_t, e_t)$ at time t, $\mathbb{E}\gamma(a_t, e_t)$.

3.3 Welfare Decomposition

In the HANK model defined in Section 2 (with uniform labor allocation rule), the only time-varying prices and quantities that matter for household i's welfare at time t are exogenous transfers, $\{\Gamma_s\}_{s\geq t}$, tax rates, $\{\tau_s\}_{s\geq t}$, and aggregate labor demand, $\{N_s\}_{s\geq t}$.[13] Thus, starting from the steady-state distribution $t=0$, household welfare is entirely determined by these three aggregate sequences and can be expressed as a function of the form —

$$V(a_0, e_o) = \mathcal{V}(\{\Gamma_s\}_{s\geq 0}, \{N_s\}_{s\geq 0}, \{\tau_s\}_{s\geq 0} | a_0, e_0) \tag{17}$$

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

$$W = \mathcal{W}(\{\Gamma_s\}_{s\geq 0}, \{\tau_s\}_{s\geq 0}, \{N_s\}_{s\geq 0}) \tag{18}$$

Here, Γ_s are the aggregate transfers, τ_s the tax rate, and N_s the aggregate labor demand. Using this, we can decompose the aggregate welfare, to first order, in the economy as given by Proposition 1:

Proposition 1 (Welfare Decomposition)**.** *To first order, aggregate welfare gains from a policy perturbation, $d\mathbf{\Gamma}$, can be decomposed into three effects*

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

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 A.1 for analytical expressions of* $\mathbf{\Omega}^{\mathbf{\Gamma}}, \mathbf{\Omega}^{N}$ *and* $\mathbf{\Omega}^{\tau}$

Proof. See Appendix A.1 □

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 leads to a gain in welfare (holding all else constant). Second, there is the *labor demand* effect of the transfer policy, which operates through general equilibrium changes in output leading to changes in 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 Section 3.3.1. Lastly, financing a policy requires the government to adjust the tax rate, τ, over time. Higher taxes reduce welfare by lowering households' disposable income. Taken together, Proposition 1 highlights the trade-offs in the welfare impact of a transfer policy financed by raising taxes — either contemporaneously or in the future. In the next two sections, we examine each of these effects separately and characterize their properties.

[13] Here, $\{\Gamma_s\}_{s\geq 0}$, is the shock, and $\{\tau_s\}_{s\geq 0}$, $\{N_s\}_{s\geq 0}$ are equilibrium responses reached after solving $\mathcal{F}(\cdot) = 0$

3.3.1 Aggregate Labor Demand Channel

Proposition 2 provides an analytical expression for the *aggregate labor demand* channel. It shows that this effect can be expressed using the steady-state values of the households' marginal rate of substitution (MRS) and after-tax income. Specifically, the marginal effect of a increase in aggregate labor supply on aggregate welfare, $\Omega^N(s)$, is determined by the average gap in households' optimal labor supply choice, which we call the individual labor wedge. This wedge arises due to labor rationing by unions, which prevent households from providing their optimal labor supply. Furthermore, as labor rationing rules can vary across models, the *labor demand* 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*

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

where $\mathbb{E}_0^i$ is an expectation w.r.t to the individual idiosyncratic states.

Proof. See Appendix A.2 □

The *labor demand* effect also arises in a Representative Agent New Keynesian (RANK) economy with wage rigidities (Woodford, 2011). In RANK, the *labor demand* channel is zero if the household is on their optimal labor supply choice. However, during recessions the labor wedge becomes positive as rigid wages prevent the representative household from supplying enough labor. Conversely, during booms, the wedge turns negative, as the household cannot immediately increase labor supply due to wage rigidities. Thus, fiscal policy can only improve first-order welfare away from the steady state by stimulating labor supply during recessions and reducing it during booms.[14] However, to first-order, the *labor demand* effect has no welfare from the steady state in a RANK economy.

In contrast, in a HANK economy, the aggregate labor demand effect can be nonzero even close to the steady state. This arises from disagreement between the union's and the welfare relevant wedges. The union's objective, summarized by the WNKPC in Equation 10, closes the average markup-adjusted labor wedge of households in the zero-inflation steady state. Meanwhile, the welfare relevant wedge Ω^N is the Parteo-weights weighted average labor wedge of households. As a result, while the Phillips curve wedge is closed, the welfare-relevant labor wedge may still be positive or negative, even in steady state. To directly compare with the RANK economy, we have to ensure that either each of the households have a zero wedge in the steady state or the

[14] Deficit-financed transfers have no effect as the household is Ricardian.

calibration/Pareto weights are such that the same average is targeted to zero. The heterogeneous dynamic allocation rules ensures that the *labor demand* effects are zero to first-order for each individual. This ensures that aggregate labor wedge is zero for all social welfare functions[15]. Intuitively, this rule guarantees 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. For a utilitarian welfare function, targeting the average household labor wedge to be zero also ensures a zero wedge. Corollary 1 formalizes this insight.

Corollary 1. *The labor demand effect, for small shocks, around steady state is zero (i.e. $\mathbf{\Omega}^N \boldsymbol{dN} = 0$) if*

1. *The unions allocate labor according to Equations 8 (i.e. heterogeneous dynamic allocation rule), or*
2. *Under the calibration in uniform allocation rule that targets zero inflation in the steady state and Pareto-weights are equal to one.*

Proof. See Appendix A.3 □

With Corollary 1, we provide the analogous result of the RANK economy *labor demand* effect from Woodford (2011) for a HANK economy. That is, fiscal policy is ineffective at changing welfare, up to the first order, around the steady state if households are on their optimal labor supply condition. However, fiscal policy can have *labor demand* effect, to the first order, when linearized around any other non-linearly solved perfect foresight path, as the labor wedge is only zero in the steady state. For example, around a large exogenous contractionary shock, where $\Omega^N > 0$, expansionary fiscal policy would have a first-order *labor demand* effect that improves welfare. In Section 4.5.1, we quantify Ω^N in a linearized model where the baseline is not the steady state.

3.3.2 Tax and Transfer Channel

In a RANK economy, fiscal policy affects aggregate welfare solely through the aggregate *labor demand* channel. In contrast, fiscal policy has additional welfare effects in a HANK economy. Specifically, we demonstrate that the terms $\mathbf{\Omega}^{\mathbf{\Gamma}} d\mathbf{\Gamma} + \mathbf{\Omega}^{\tau} d\boldsymbol{\tau}$, which we jointly call the *tax and transfer* channel, are non-zero even when output is at its steady-state level. To illustrate the drivers of the *tax and transfer* channel we further decompose it into three subchannels. Proposition 3 characterizes these three subchannels: deficit incidence, aggregate insurance, and net aggregate deficits.

Proposition 3. *For a uniform transfer shock $d\Gamma_s$ in period s, the effects of deficit financing on welfare are*

[15] In the utilitarian case, providing the correct individual labor subsidy to the union would be sufficient to ensure the *labor demand* effect is, to first order, zero.

given by the following terms

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

$$\int_0^\infty e^{-\rho s} \Bigg[\underbrace{\mathcal{U}_s' [d\Gamma_s - Y_{ss} d\tau_s]}_{\text{Net Aggregate Deficits}} + \underbrace{\mathbb{C}ov_{a,e}\Big(\mathbb{E}_0^i \left[u'(c^{ss}(x_s)) \right], \mathbb{E}_0^i [d\Gamma_s - w e_s n^{ss}(x_s) d\tau_s] \Big)}_{\text{Deficit Incidence}}$$
$$+ \underbrace{\mathbb{E}_{a,e}\Big(\mathbb{C}ov_0^i \left(u'(c^{ss}(x_s)), d\Gamma_s - w e_s n^{ss}(x_s) d\tau_s \right) \Big)}_{\text{Aggregate Insurance Effect}} \Bigg] ds$$

where $\mathcal{U}_s' := \int_{a,e} u'(c_s(a,e)) g_0(a_0, e_0) dade$ *and* $x_s := (a_s, e_s)$. $\mathbb{E}_{a,e}$ *&* $\mathbb{C}ov_{a,e}$ *denote the cross-sectional average and covariance;* $\mathbb{E}_0^i$ *&* $\mathbb{C}ov_0^i$ *denote expectation and covariance w.r.t individual idiosyncratic states.*

Proof. See Appendix A.4 □

Net Aggregate Deficits This term isolates the effect of net aggregate deficits on aggregate welfare for a uniform transfer policy. Intuitively, this term captures the fact that household welfare is increasing in the amount of (uniform) transfers and decreasing in higher tax rates. Specifically, we define net aggregate deficits as $[d\Gamma_s - Y_{ss} d\tau_s]$, which represents the cost of the transfer policy minus the taxes raised in period s, holding output at its steady-state level. Net aggregate deficits are scaled by average marginal utility to convert to welfare units.

On first glance, this term might seem like the "static scoring"[16] value of the policy. However, as $d\tau_s$ is the equilibrium tax rate response given the speed of fiscal adjustment, this term in-fact corresponds the gain in household value due to self-financing of the policy. To understand the *net aggregate deficits* term more clearly, we combine it 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 term into two components: self-financing and liquidity.

$$\bar{\mathcal{U}}' \int_0^\infty e^{-\rho s} [d\Gamma_s - Y_{ss} d\tau_s] = \underbrace{\bar{\mathcal{U}}' \int e^{-rs} \tau_{ss} dY_s ds}_{\text{Self-financing}} + \underbrace{\bar{\mathcal{U}}' \int_0^\infty \left[e^{-\rho s} - e^{-rs} \right] [d\Gamma_s - Y_{ss} d\tau_s]}_{\text{Liquidity effect}} \tag{19}$$

Equation 19 highlights two externalities through which fiscal policy drives welfare changes in the HANK economy. The first term captures the net present value, discounted at the real interest rate r, of the policy's *self-financing* effect. A stimulative policy—such as uniform transfers—can be partly self-financing in HANK for two key reasons. First, households are non-Ricardian, so debt-financed transfers raise consumption, unlike in the RANK economy. Second, unions, which determine household labor supply, are infinitesimal and thus fail to internalize that increasing

[16] See https://taxfoundation.org/taxedu/glossary/conventional-scoring-static-scoring/

labor supply also boosts tax revenues, even with fixed tax rates. Together, these effects generate a welfare change from *self-financing*, given by $\bar{\mathcal{U}}' \int e^{-rs} \tau_{ss} dY_s ds$.

The second welfare effect from *net aggregate deficits* arises from a liquidity channel (Aiyagari, 1995).[17] This channel operates through the equilibrium liquidity spread, $\rho - r$, defined as the gap between the household's (welfare-relevant) discount rate and the market interest rate. In the HANK economy, this spread arises from excess demand for savings. Incomplete markets generate a precautionary savings motive, which is further amplified by the risk of future borrowing constraints. Together, these forces create a positive liquidity spread, i.e., $\rho - r > 0$. Deficit-financed fiscal policy can exploit this spread by using government bonds to reallocate resources intertemporally at the market rate r. Since future utility is discounted more heavily by households (at rate ρ), it is welfare-enhancing to raise liquidity today and repay the debt—plus interest—in periods that are valued less, given $\rho > r$.

Although neither of the channels underlying the *net aggregate deficit* effect depends directly on the presence of heterogeneous agents, this effect is absent in a RANK economy. Specifically, self-financing does not arise in RANK because households are Ricardian: debt-financed transfers do not affect the consumption path, as lifetime wealth remains unchanged. Moreover, the liquidity channel is also inactive, since markets are complete and there are no borrowing constraints. As a result, the steady-state interest rate on government debt equals the household discount rate, i.e., $\rho = r$.

Liquidity Effect and the level of Public Debt: There is a close relationship between the *net aggregate deficit* channels and the steady-state level of debt. First, the strength of the *self-financing* channel depends on the fiscal multiplier of the policy, dY_s, which in turn is determined by the intertemporal marginal propensities to consume (iMPCs) of the household sector (Auclert, Rognlie, and Straub, 2024*b*). A higher level of assets or debt allows households to accumulate more savings, reducing the likelihood of hitting borrowing constraints. This lowers iMPCs and, consequently, the fiscal multiplier, as more households become unconstrained (or fewer remain hand-to-mouth). Second, the liquidity spread, $\rho - r$, declines with the level of debt. As discussed earlier, this spread arises from household saving motives driven by market incompleteness and borrowing constraints. Intuitively, if the government supplies a sufficiently large stock of safe assets, households' desire to save is satisfied, and the economy converges toward a complete markets outcome where $\rho = r$. More precisely, in a HANK model, as $B \to \infty$, we have $r \to \rho$. Taken together, these mechanisms suggest that a higher steady-state level of debt weakens the potency of the *net aggregate deficit* channels. We quantitatively examine this relationship in Section 4.4.1.

[17] This is distinct from the pecuniary externality in Davila et al. (2012), which operates through price changes. As they note, "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." In contrast, the analysis here holds the two prices, r and w, fixed.

Deficit Incidence Even with a fiscal policy based on uniform transfers, there is heterogeneity in net income changes across households. This occurs because the income taxes used to finance the policy depend on each household's idiosyncratic productivity and labor supply, which can differ across individuals. As a result, the policy implicitly redistributes resources. Under a utilitarian welfare criterion, this redistribution leads to welfare changes, since marginal utilities are not equalized across households.

The welfare effect of redistribution depends on how net transfers are allocated relative to individuals' marginal utilities. For instance, if the tax-transfer system reallocates resources toward individuals with higher marginal utility, it generates welfare gains from the perspective of a utilitarian planner. The following expression (Equation 20) formalizes this intuition: the net welfare effect depends on the cross-sectional covariance (denoted by $\mathbb{C}ov_{a,e}$) between each individual's expected marginal utility in period s and their expected net transfer. If individuals with higher marginal utility receive larger net transfers, this term is positive; otherwise, it is negative.

$$\text{Deficit Incidence} = \int_{s=0}^{\infty} e^{-\rho s}\mathbb{C}ov_{a,e}\Big(\mathbb{E}_0^i\left[u'(c^{ss}(x_s))\right], \mathbb{E}_0^i[d\Gamma_s - we_s n^{ss}(x_s)d\tau_s]\Big) \tag{20}$$

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. In this special case, the *deficit incidence* channel vanishes.

Aggregate Insurance The *aggregate insurance* channel arises from the interaction between an individual household's marginal utility and their net transfers *across states over time*. Households experience varying marginal utilities in different states—for example, those with high income and wealth tend to have higher consumption and therefore lower marginal utility. At the same time, income taxes are levied on effective labor supply, which also depends on the household's state. As a result, uniform transfers financed by income taxes generate variation in net income across different states of the same household's life. Intuitively, households benefit from a positive covariance between marginal utility and net income across states. If effective labor supply is negatively correlated with marginal utility, then increased taxation provides insurance by shifting resources toward states where marginal utility is higher. This insurance benefit for an individual household is captured by the covariance term in Equation 21, and the overall welfare effect is given by the cross-sectional average of these covariances across all households.

$$\text{Aggregate Insurance} = \int_{0}^{\infty} e^{-\rho s}\mathbb{E}_{a,e}\Big(\mathbb{C}ov_0^i\left(u'(c^{ss}(x_s)), d\Gamma_s - we_s n^{ss}(x_s)d\tau_s\right)\Big)ds. \tag{21}$$

Similar to the *deficit incidence* channel, the *aggregate insurance* channel vanishes in a special case where labor allocation is constant and taxes are levied only on the non-idiosyncratic component of household income. In this case, deficit-financed uniform transfers would not redistribute income across different states, and the welfare effects from the policy would operate solely through the *net aggregate deficit* channel.

4 Quantification of Welfare in One-account 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	0.052	Discount rate
γ	1	IES
ν	0.5	Frisch Elasticity
φ	1.04	Labor disutility
$\underline{a}$	0	Borrowing constraint
G	0.2	Govt. spending
B	1.05	Liquid bonds
(ρ_e, σ_e)	(0.91, 0.92)	Productivity persistence and std. dev.
Statistics		
Quarterly MPC	0.27	
% borrowing constrained	0.14	

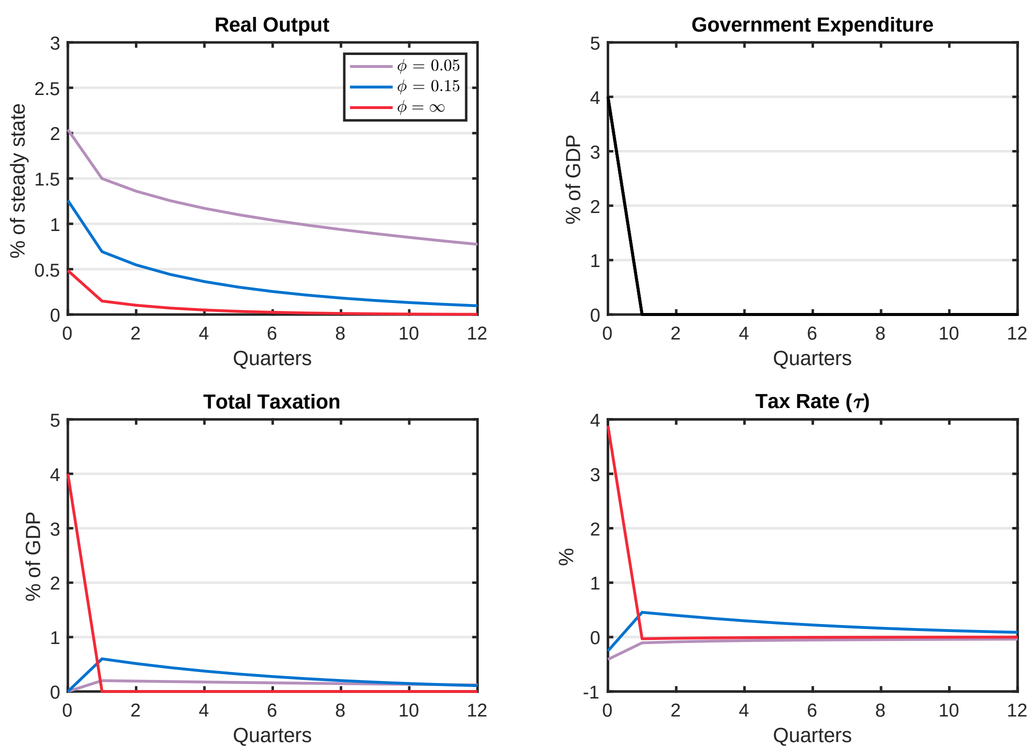
Table 1 presents our baseline calibration. Household preferences follow a separable constant elasticity utility function specification: $u(c_t, n_t) = \frac{c^{1-\gamma}}{1-\gamma} - \varphi\frac{n_t^{1+\nu}}{1+\nu}$. In our baseline calibration, we set $\gamma = 1$, implying a log utility over consumption,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

The income process follows an AR(1) using Floden and Lindé (2001)'s estimate of US wage persistence and standard deviation of log gross earnings. 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, 2024*b*). We target an annual MPC of 0.51. To achieve the MPC target, the model requires a low steady-state level of government debt, approximately one-quarter of annual GDP.

4.2 Aggregate Consumption and Output Effects a Uniform Transfer

Figure 2 plots the effects of a period-zero uniform transfer shock, of size 1% of annual GDP (4% of quarterly GDP), for 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, $\phi \to \infty$, the output multiplier is the smallest. While as deficit-financing increases, the output multiplier increases. 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 varies significantly over different levels of deficit financing. 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 when deficit financing is higher.

Figure 2: Impact of Period-0 Uniform Transfer Fiscal Stimulus



Notes: The plot shows the impulse response functions (IRFs) to a period-0 one-time uniform transfer shock of size 4% of quarterly GDP (or 1% of annual GDP) for various levels of deficit financing. The red line is for $\phi = \infty$ representing the balanced-budget case, while the blue and purple lines represent IRFs at deficit financing parameters $\phi = 0.15$ and $\phi = 0.05$, respectively.

The results show that the uniform transfer necessarily leads to an increase in output. However, the welfare effects and the relative contributions of different channels are unclear. In the next two sections, we quantify the relative size of the welfare channels described in Section 3 for this uniform transfer policy.

4.3 Welfare Units

In this section, we present the results for welfare changes in units of period-0 consumption. By this, we mean the amount of consumption that would need to be given to all agents in period 0 to make them indifferent between the policy scenarios—i.e., the equivalent variation in period-0 consumption $dW^{\text{period-0 consumption units}} = \frac{dW^{utils}}{\int u'(c_{i,ss})di}$.

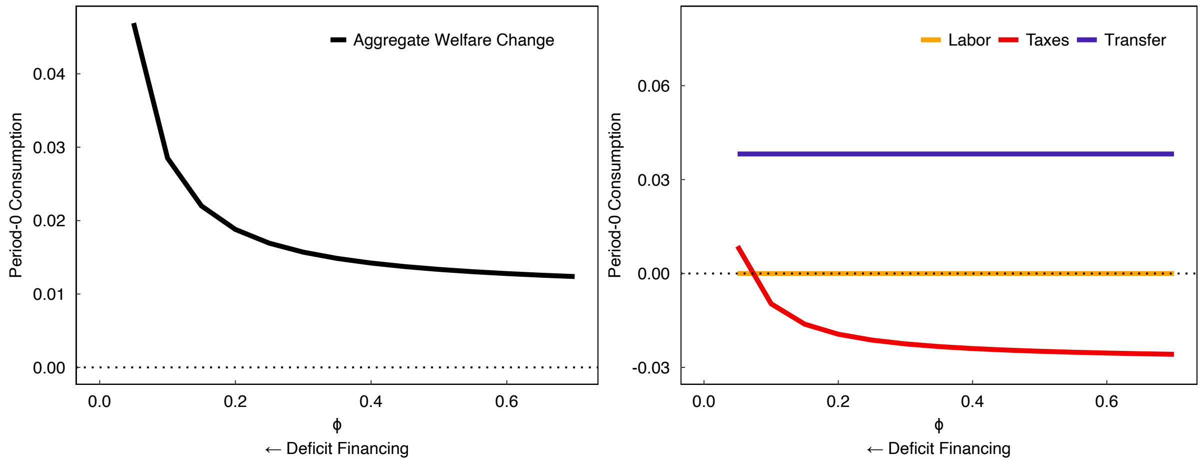
4.4 Aggregate Welfare Change and Decomposition

Figure 3a plots the utilitarian welfare change in period-0 consumption units in response to a period-0 uniform transfer for different levels of deficit financing. It shows that the welfare change is positive for all levels of ϕ in our baseline calibration. Moreover, the welfare change increases monotonically with the amount of deficit financing, i.e., as $\phi \to r$. The welfare change in Figure 3a 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 welfare change into three terms: $\mathbf{\Omega}^{\mathbf{\Gamma}} d\mathbf{\Gamma}, \mathbf{\Omega}^{N} d\mathbf{N}$ and $\mathbf{\Omega}^{\tau} d\boldsymbol{\tau}$. Figure 3b 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. This follows directly from Corollary 1, which states that under a calibration which targets zero steady state inflation, the *labor demand* channel is zero for a utilitarian social welfare function.

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 determine the shape of aggregate welfare 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 welfare losses from taxes fall, and at high enough levels of deficit financing, the tax effect even contributes positively to welfare.

Figure 3: Welfare change from uniform transfer for different deficit financing in HANK



(a) Aggregate Welfare Change

(b) Welfare Breakdown

Notes: The figures show the welfare changes in period-0 consumption units to a one-time period-0 uniform transfer shock of size 1% of annual GDP over different levels of deficit financing. The left panel shows the aggregate welfare change to the policy. The right panel shows the contributions to aggregate welfare from the labor demand, transfer, and tax channels as in Proposition 1.

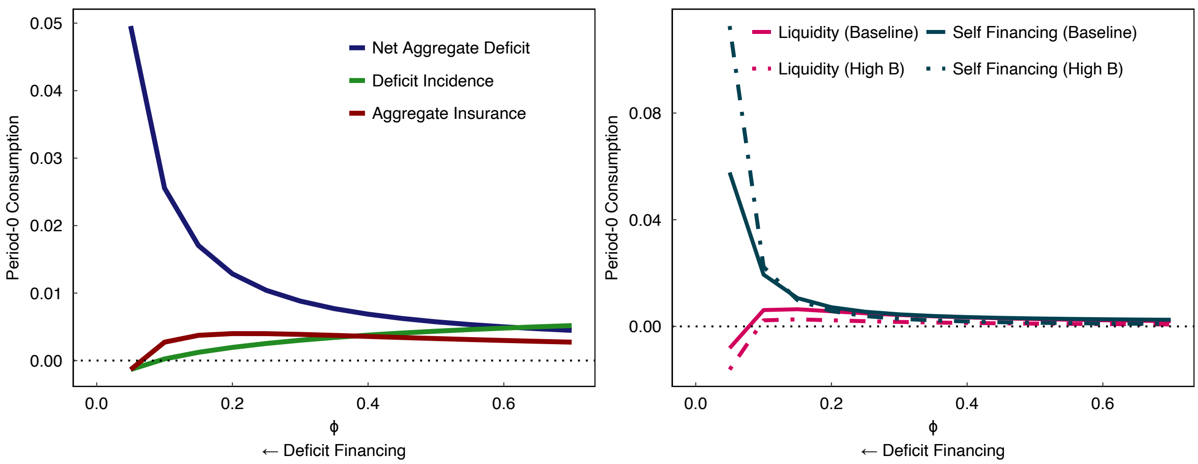
4.4.1 Tax and Transfer Effect

To understand the tax-and-transfer channel, we apply the results from Proposition 3 to the tax and transfer terms in our model, $\boldsymbol{\Omega}^{\Gamma} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{\tau} d\boldsymbol{\tau}$, to quantify the roles of net aggregate deficits, aggregate insurance, and deficit incidence in shaping the welfare response. Figure 4a illustrates the contributions of these three components—net aggregate deficits, deficit incidence, and aggregate insurance—as defined in Proposition 3, across different levels of deficit financing.

First, all three components vary with the level of deficit financing. By construction, the *net aggregate deficits* term is directly influenced by the size of the deficit. However, the *deficit incidence* and *aggregate insurance* channels are also affected, as deficit financing alters the equilibrium path of the tax rate. This change interacts with heterogeneity in idiosyncratic productivity and labor supply across individuals. As a result, variations in the level of deficit financing influence not only the aggregate welfare effect but also its distribution across households, depending on their individual states.

Second, while the *deficit incidence* and the *aggregate insurance* channels decrease with deficit financing and eventually become negative, the *net aggregate deficit* term is increasing in deficit financing and is always positive. At high levels of deficit financing, the *net aggregate deficits* channel is also substantially larger than the other two channels. This implies that, as deficit financing increases, the policy's welfare gains primarily stem from the self-financing driven by larger multiplier and the liquidity benefits, outweighing the welfare losses from redistribution towards lower marginal utility individuals and income/asset states.[18]

Figure 4: Tax and Transfer Effect



(a) Tax and Transfer Decomposition

(b) Self-financing and Liquidity Channel

Notes: The figures further decompose welfare to a one-time period-0 uniform transfer shock of size 1% of annual GDP over different levels of deficit financing. The welfare changes are expressed as period-0 consumption units. The left panel decomposes the Tax and Transfer effect as in Proposition 3. The right panel further decomposes the Net Aggregate Deficit term into a self-financing and liquidity effect as in Equation 19. The dotted lines show the same effects but for a calibration with double the amount of government bonds.

Further breaking down the *net aggregate deficit* term, Figure 4b plots its two sub-components: self-financing ($\bar{\mathcal{U}}' \int e^{-rs}\tau_{ss} dY_s ds$) and the liquidity effect ($\bar{\mathcal{U}}' \int_0^\infty \left[e^{-\rho s} - e^{-rs}\right] [d\Gamma_s - Y_{ss} d\tau_s] ds$). The *liquidity* effect, moving right to left in the figure, increases gradually as deficit financing increases. This increase occurs as higher deficit financing defers future tax increases, taking further advantage of the liquidity spread between household and market discount rates. However, there is a turning point of deficit financing where the direction of the liquidity effect reverses and becomes negative. This occurs in the extreme case where the policy becomes completely self-financing and, rather than increasing, the tax rate *falls* in the future.

The magnitude of the *self-financing* effect depends on the output multiplier. As shown in Figure 2, higher deficits correspond with larger output multipliers, which have a positive effect on welfare through the *self-financing* channel. Moreover, when deficit financing reaches high enough levels we observe a substantial increase in the output multiplier and hence the self-financing effect. This increase in welfare from self-financing more than offsets the decline in welfare from the liquidity effect at these high levels of deficit-financing, and causes the steep increase in welfare at these levels of deficit-financing. Overall, we find that the *net aggregate deficit* term, the most important welfare channel, is largely driven by the liquidity effect at modest levels of deficit financing, but

[18]The *liquidity effect* is positive for most levels of deficit financing. It becomes negative if the policy completely self finances such that the tax rate decreases following the transfer.

is driven by the self-financing effect at very high levels of deficit financing.

Lastly, Figure 4b also plots the *self-financing* and *liquidity* channels under a calibration where government debt is double the original calibration.[19] This change reduces the MPC of the model, and in general, should decrease the output multiplier and reduce the liquidity spread, attenuating these channels. The figure shows that this change in the calibration does reduces the magnitude of two channels for most levels of deficit financing, but they do not change much from the baseline.[20] The *self-financing* and *liquidity* channel remain substantial even under this calibrations.

4.5 Extensions

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

4.5.1 Fiscal Stabilization with Output Gaps

In the previous section, the welfare effects from the labor demand channel were zero because households were, on average, at their optimal labor allocations in the steady-state baseline around which we linearize. However, linearizing around a different baseline—such as a large recession when output is depressed—fiscal policy can improve welfare by addressing the labor misallocation caused by wage rigidities. In such environments, the *labor demand* channel yields a non-zero welfare effect. In this section, we examine the quantitative significance of this channel.

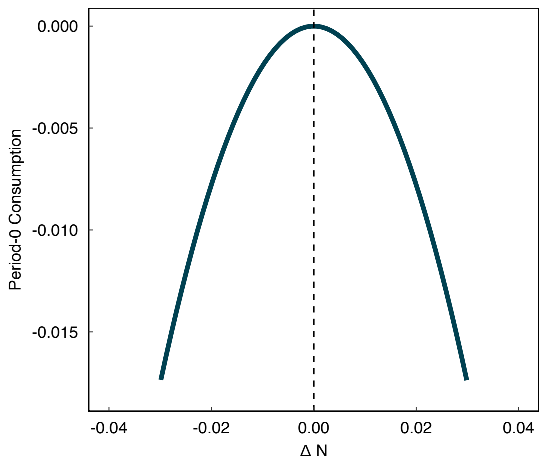
To illustrate the *labor demand* channel, Figure 5a plots the welfare change from a permanent change in labor demand N_t, while holding τ and Y at their steady-state levels. As households are already, on average, on their optimal labor choices in the steady state, welfare is maximized in the steady state (with the heterogeneous-dynamic allocation rule, all individual labor wedges are closed). However, an increase or decrease in labor demand results in welfare reduction, as it leads to suboptimal labor supply. Overall, we find that the potential welfare effects from the labor demand channel are relatively modest, with a permanent 2 percent decline in labor demand associated with only around a 1.5% welfare decline (in period-0 consumption units).

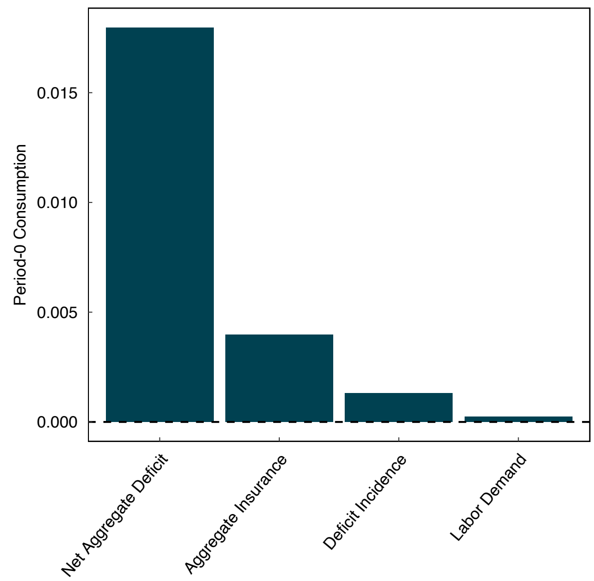
To compare the magnitude of the labor demand channel with our baseline results, we study the same period-0 uniform transfer, but linearize around a path in which the economy is experiencing a contractionary real interest rate shock. Specifically, we begin with a baseline scenario featuring a large positive real rate shock of 2%, decaying at a quarterly rate of 0.2, and evaluate the welfare change resulting from an additional, deficit-financed, one-time uniform transfer as a fiscal stimulus. Figure 5b plots the welfare components of this experiment. The labor demand

[19] We do this by recalibrating r to ensure asset market clearing.

[20] The larger deviations at high levels of deficit financing are induced by the change in r from recalibrating the model, making like-for-like comparison difficult.

Figure 5: Welfare Under a Recession





(a) Aggregate Welfare Change to Permanent Output Gaps

(b) Welfare Decomposition to Uniform Transfer with a baseline recession with $\phi = 0.15$

Notes: Figure 5a shows the aggregate welfare change in period-0 consumption units to permanent changes in labor demand. Figure 5b shows the welfare decomposition to a period-0 uniform transfer shock of size 1% of annual GDP where the baseline is a recession. The baseline shock includes a 0.01 shock to the Taylor rule with a quarterly decay rate of 0.4. All figures use the uniform labor allocation rule.

channel now contributes positively to the welfare impact of the policy, underscoring how labor rationing combined with wage rigidity generates positive aggregate labor wedges outside the steady state. Stabilization policy improves welfare by increasing consumption and, consequently, labor supply, thereby reducing the aggregate labor wedge. However, the magnitude of the labor demand effect remains small relative to the net aggregate deficit channel. The latter continues to dominate the welfare outcome, as the baseline recession also raises average marginal utility, thereby amplifying the contribution of the net aggregate deficit channel.

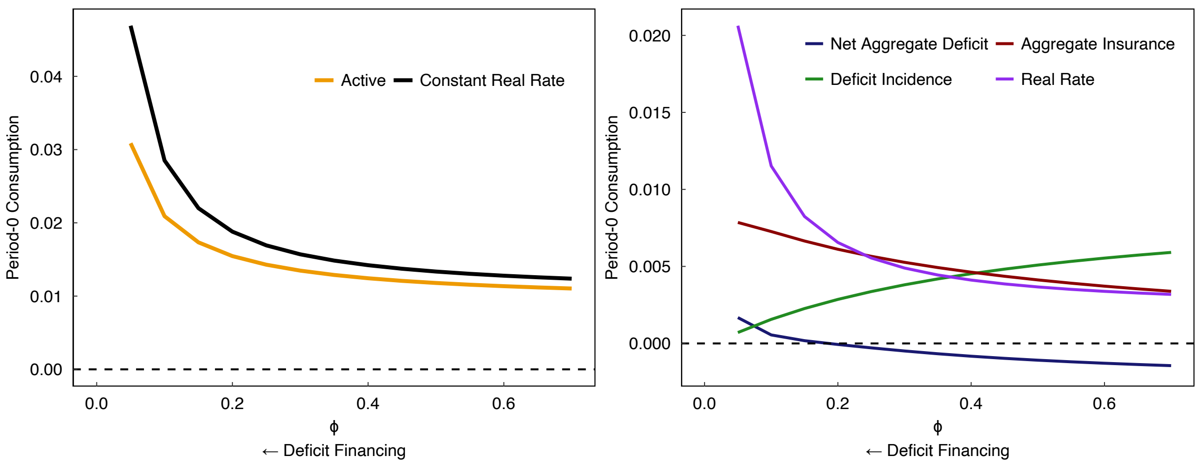
4.5.2 Active Monetary Policy

In the baseline model, the monetary authority follows a constant real rate rule. Thus, the changes in wage inflation from fiscal stimulus are not passed on to households as the monetary authority increases nominal rates one-for-one, keeping the real rate constant. However, with 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.[21] Figures 6a and 6b plot the aggregate welfare change and the decomposition from Proposition 1 (augmented to include real-rate changes) for a one-time uniform transfer fiscal stimulus and active monetary policy, i.e., $\phi_\pi = 1.5$. The aggregate

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

welfare gain is slightly lower when monetary policy is active relative to the constant real-rate rule.

FIGURE 6: WELFARE UNDER ACTIVE MONETARY POLICY



(A) AGGREGATE WELFARE CHANGE

(B) WELFARE BREAKDOWN

Notes: The figure above shows various welfare effects (in period-0 consumption units) to a one-time period-0 uniform transfer shock of size 1% of annual GDP over different levels of deficit financing. Figure 6a compares the aggregate welfare effects to the shock with and without active monetary policy, where active monetary policy is a Taylor rule with coefficient $\phi_\pi = 1.5$. The right panel (Figure 6b) decomposes the welfare effects of the shock using Proposition 3 and also includes the welfare effects from the changes in the real rate induced by active monetary policy. Recall that the labor demand effect is zero to first-order.

The decomposition in Figure 6b provides insight into the dampened response. First, the role of net aggregate deficits is significantly smaller than before, though still positive. This reduction occurs because active monetary policy dampens the output multiplier, limiting the extent of self-financing to generate net income gains for households. Meanwhile, the deficit incidence and aggregate insurance channels remain relatively minor and do little to offset the decline in the net aggregate deficit channel.

Additionally, changes in the real interest rate now directly affect 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 slightly mutes the welfare effects of expansionary fiscal policy by dampening the output multiplier and, in turn, limiting the degree of policy self-financing.

4.5.3 Heterogeneous Dynamic Labor Rationing Rule and Persistent Fiscal Policy Shocks

Heterogeneous Dynamic Rule Our baseline results rely on the uniform labor allocation rule. In the next subsection, we extend the analysis to alternative social welfare functions, for which we employ a heterogeneous dynamic labor allocation rule that solves Equation 9 in the steady state. Here, we illustrate how this rule alters the welfare implications of fiscal policy under a utilitarian welfare function. Appendix B.1 presents the results and shows that, overall, they are quantitatively very similar.

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

4.5.4 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 $W = \int \int \alpha(a_0, e_0) V(a_0, e_0) dade$ with Pareto weights $\alpha(a_0, e_0)$ defined on the initial state (a_0, e_0) of the household, a normalized welfare (Dávila and Schaab, 2022*b*) change resulting from a policy perturbation $d\theta$ is defined as

$$\frac{dW^\lambda}{d\theta} = \underbrace{\frac{1}{\int \int \alpha(a_0, e_0) \Lambda(a_0, e_0) g(a_0, e_0) dade}}_{\text{Normalization}} \underbrace{\left(\int \int \alpha(a_0, e_0) \frac{dV(a_0, e_0)}{d\theta} g(a_0, e_0) dade \right)}_{\text{Social Welfare Function}}$$

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, $\Lambda(a_0, e_0)$ is simply equal to $V_a(a_0, e_0) = u'(c(a_0, e_0))$ i.e. the marginal utility of getting an additional consumption unit in period zero. In the second case, $\Lambda(a_0, e_0) = \int e^{\int_0^t \rho_s ds} \mathbb{E}[u'(c_t(a, e)) | a(0), e(0) = a_0, e_0] dt$, 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.

$$\frac{dW^{\lambda}}{d\theta} = \underbrace{\int\int \text{WTP}(a_0, e_0) g(a_0, e_0) dade}_{\text{Efficiency, } \frac{dW^E}{d\theta}} + \underbrace{Cov\left(\omega(a_0, e_0), \text{WTP}(a_0, e_0)\right)}_{\text{Redistribution, } \frac{dW^{RD}}{d\theta}} \tag{22}$$

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

$$\text{WTP}(a_0, e_0) = \frac{\frac{dV(a_0, e_0)}{d\theta}}{\Lambda(a_0, e_0)} \qquad \omega(a_0, e_0) = \frac{\alpha(a_0, e_0)\Lambda(a_0, e_0)}{\int\int \alpha(a_0, e_0)\Lambda(a_0, e_0) g(a_0, e_0) dade}$$

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.[22]. The results with the efficiency planner are presented in Appendix B.3.

5 Welfare Ranking of Fiscal Policies in a Generalized HANK Model

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, we take our insights from the previous sections to address our second question: Which fiscal stabilization policies provide the largest welfare benefits relative to their costs?

We begin by applying the decomposition in Proposition 1 and the Aggregate Efficiency Planner framework outlined in Section 4.5.4 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) within the HANK model. We then extend our baseline model from Section 2 to incorporate unemployment risk and long-term mortgages. Using these evaluation criteria, we rank six popular 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 welfare costs.

[22] 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.

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

5.1 Policy Ranking Criteria Definition and Example from the Simple HANK Model

Our previous sections used utilitarian welfare for simplicity. In this section, we follow the rich public finance literature and instead evaluate welfare from a Kaldor-Hicks efficiency perspective i.e. the welfare criteria is aggregate willingness-to-pay (WTP).

Similar to Proposition 1 we can decompose the aggregate WTP for the policy shock into three components i.e. $dW^E = \mathbf{\Omega}^{\mathbf{\Gamma},E} d\mathbf{\Gamma} + \mathbf{\Omega}^{N,E} d\mathbf{N} + \mathbf{\Omega}^{\tau,E} d\boldsymbol{\tau}$ 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 perturbation are defined as*

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

$$MVPF := \frac{\textit{Welfare Benefits}}{\textit{Net Cost to Government}} = \frac{\mathbf{\Omega}^{\mathbf{\Gamma},E} d\mathbf{\Gamma} + \mathbf{\Omega}^{N,E} d\mathbf{N}}{\int_{s\geq 0} e^{-rs} \left[\left(e^{(\phi-r)s} \left(\int_{t=0}^{s} e^{-(\phi-r)t} \phi d\Gamma(t)\, dt \right) \right) - \tau_{ss} dY(s) \right] ds}$$

The numerators of BCR and MVPF capture 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 any general equilibrium benefits from the labor demand channel. The denominator in the BCR represents the WTP for the welfare loss generated by the higher tax rates required to finance the policy, whereas the denominator of MVPF reflects the 'net fiscal cost,' which is the initial cost of the policy minus any self-financing effects.[23]

The BCR 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 but follows Hendren and Sprung-Keyser (2020) to define the policy cost as the net expenditure of the government in terms of period-0 dollars.[24] This method ignores welfare effects of raising funds, but it does account for the 'fiscal externality' of the policy and the net cost is determined by adjusting the discounted sum of the expenditure on the policy by the self-financing of the policy. As aforementioned, self-financing depends on the degree of deficit-financing (ϕ), which we make explicit in our formulation of MVPF.[25]

[23] Appendix D derives the denominator of MVPF presented in Definition 2.

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

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

$$\text{BCR}^j = \frac{\text{MVPF}^j}{\text{MCPF}^j} \qquad \text{where, MCPF} = \frac{\mathbf{\Omega}^{\tau,E}}{\int_{s\geq 0} e^{-rs} \left[\left(e^{(\phi-r)s} \left(\int_{t=0}^{s} e^{-(\phi-r)t} \phi d\Gamma(t)\, dt \right) \right) - \tau_{ss} dY(s) \right] ds}$$

5.2 Generalized Environment: HANK with Mortgages and Unemployment Risk

5.2.1 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_{it} and a flow disutility from working $n_{it} \in [0,1]$, where n_{it} denote the hours worked as a fraction of the unit time endowment. Preferences are time separable. Agents maximize the following objective

$$V_0^i(\cdot) = \mathbb{E}_0 \int e^{-\rho t} u(c_{it}, n_{it}) dt. \tag{23}$$

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 finance using long-term mortgages m_t. Mortgage principal is repaid at a rate ζ_t and accrues interest at rate r_t^m. The evolution of household asset holdings is governed by the following equations:

$$\dot{a}_{it} = r_t^a a_{it} + \omega^{cc} a_{it}^- - c_{it} - (r_t^m + \zeta_t) m_t + T^a(a_t, m_t) + y_{it} + r_t^a \bar{K} + \Pi_t \tag{24}$$

$$\dot{m}_t = -\zeta_t m_t - T^m(a_t, m_t) \tag{25}$$

$$a_{it} \geq \underline{a} \tag{26}$$

where y_{it} is income received from labor income or government benefits as described in Section 5.2.2. Households also receive government transfers $T^a(a_t, m_t)$ and $T^m(a_t, m_t)$ that 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 are bank profits.

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 5.2.7). This fixed cost varies depending on whether the household prepays its mortgage, i.e., if the household prepays, it is subject to the following constraint

$$a' + m' = a_t + m_t - \kappa^{pre}, \text{ such that } m' \in [0, m_t), \ \& \ a' \leq a_t \tag{27}$$

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

$$a' + m' = a_t + m_t - (\kappa^{adj} - \tau^m), \text{ such that } m' \in [m_t, \underline{m}), \ \& \ a' \geq a_t. \tag{28}$$

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 prepay a mortgage as compared to 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 from κ^{adj} to $\kappa^{adj} - \tau^m$.[26] [27] Reducing the equity withdrawal cost works as a *moratorium*, as the household gets the option of increasing liquid balances and consumption today but will have to make higher payments in the future. This also implies that only the individuals who find it privately optimal to draw equity at a lower cost will use this option.[28]

5.2.2 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 (NILF). 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 $\omega^{UI} w_t$, 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 $\bar{y}$.

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

$$y_{it} = \begin{cases} (1 - \tau_t)(w_t z_{it} n_{it})^{1-\lambda} & \text{if } e \in e^E \\ \omega^{UI} w_t & \text{if } e = e^U \\ \bar{y} & \text{if } e = e^N \end{cases} \tag{29}$$

[26] 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*

[27] 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

[28] Again, this is consistent with the data as Cherry et al. (2021) note, "More than 90% of borrowers decided not to take-up rate the option of debt relief among eligible mortgages, suggesting that borrowers' self-selection is a powerful force in determining forbearance rates."

where z_{it} follows a continuous-time Ornstein-Uhlenbeck (OU) process.[29]

Households maximize the Equation 23 subject to the budget constraint and idiosyncratic income and employment shocks. They 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.[30] 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 $\Theta_{t\geq 0}$.

5.2.3 Labor Market and Production

Unions and Labor Market Similar to the baseline model, households are represented by labor unions that decide household labor supply but according to the heterogeneous dynamic allocation rule $\gamma(\cdot)$[31]. However, as there are both employed and unemployed agents, the unions only represent the mass of individuals who are employed. With an appropriate labor subsidy, we show in Appendix F that aggregate wage inflation evolves according to the following New Keynesian Wage Philips Curve—

$$\rho\pi^w = \frac{\epsilon}{\Psi} N_t \int_i \left[\gamma_{i,t} v'(n_{it}) - (1-\tau_t)(1-\lambda)(w_t e_{it})^{1-\lambda} n_{it})^{-\lambda} u'(c_{it})\right] \mathbb{1}[e \in e^E] di + \dot{\pi}^w \qquad (30)$$

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

$$P_t X_t = W_t$$

Further, the price and wage inflation are related as $\pi_t = \pi_t^w - \frac{\dot{X}_t}{X_t}$. Which implies that in absence of shocks to aggregate TFP, price and wage inflation are equal.

5.2.4 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

[29] 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.

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

[31] This ensures that Efficiency Planners agree with the utilitarian planner in terms of the aggregate labor wedge

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.

5.2.5 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

$$T_t := \int \left(\frac{W_t}{P_t} e_{it} n_{it} - (1 - \tau_t) \left(\frac{W_t}{P_t} e_{it} n_{it} \right)^{1-\lambda} \right) d\mu_t. \tag{31}$$

Where μ_t represents the density over state variables liquid assets, mortgage balances, and idiosyncratic income (a, m, y).

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

$$E_t = G_t + UI_t + T^a(a_t, m_t) + T^m(a_t, m_t) + \chi\tau^m \int d^{eq}(a, m, e, t) d\mu_t \tag{32}$$

where $\int d^{eq}(a, m, e, t) d\mu_t$ denotes the mass of individuals who use the moratorium option.

5.2.6 Equilibrium

Definition 3. *Competitive Equilibrium: Given an initial distribution of household assets, mortgage balances and idiosyncratic income $\mu_0(da, dm, dy)$, 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*

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

5.2.7 Household Value Functions

The household state is summarized by four variables: liquid assets/debt (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. This value function, implicitly depends on the value of adjusting long-term mortgages as the household can use this option at any given time. Thus, we first explain the two value functions that constitute the adjustment value.

Value of mortgage adjustment:— Household can adjust mortgages, first, by drawing equity after paying a fixed cost. The value of doing this is given by

$$
\begin{gathered}
V^{eq}(a + m, \tilde{e}) = \max_{a', m'} V^n(a', m', \tilde{e}) \\
\text{subject to} \\
a' + m' = a + m - \kappa^{adj} + \tau^m, \text{ given } a' > a, m' > m
\end{gathered}
$$

It can also adjust by prepaying a part of its mortgage and the value of doing this, after paying the fixed cost, is given by

$$
\begin{gathered}
V^{pre}(a + m, \tilde{e}) = \max_{a', m'} V^n(a', m', \tilde{e}) \\
\text{subject to} \\
a' + m' = a + m - \kappa^{pre}, \text{ given } a' < b, m' < m
\end{gathered}
$$

The household has both of these options available at any given point in time. However, it chooses the one which provides the highest net value after paying the fixed costs. Thus, using the above two value functions we can write the final adjustment value function as

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

The household value function:— The final household value function is given by the HJB equation in Equation 33. 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. 34.

$$\begin{aligned}\rho V^n(a, m, \tilde{e}, t) = \max_c u(c) &+ V_a \left[r_t a + \omega^{cc} a^- - c - (r_t^m + \zeta)m + T_t^a(a, m) + y_t(\tilde{e})\right] \\ &+ V_m \left[-\zeta m - T_t^m(a, m)\right] \\ &+ \sum_{\tilde{e}' \neq \tilde{e}} \lambda^{\tilde{e} \to \tilde{e}'} \left[V^n(;\tilde{e}') - V^n(;\tilde{e})\right] \\ &+ \chi d(b, m, \tilde{e}, t) \left[V^{adj}(a + m, \tilde{e}, t) - V^n(b, m, \tilde{e}, t) - \Psi\right]\end{aligned} \tag{33}$$

where Ψ is the utility cost of adjusting and

$$d(a, m, \tilde{e}, t) = \begin{cases} 1 & \text{if } V^{adj}(a + m, \tilde{e}, t) > V^n(a, m, \tilde{e}, t) \\ 0 & \text{otherwise.} \end{cases} \tag{34}$$

Moratorium Option and Household Value Function:— The value of adjusting, V^{adj} implicitly depends on the fixed costs required to draw equity or prepay the mortgage. The moratorium option acts by changing the value from $V^{adj}(\cdot; \kappa^{eq})$ to $V^{adj}(\cdot; \kappa^{eq} - \tau^m)$. This leads to more individuals to use this option but as the individual decisions have to be privately optimal only a subset of the individuals end up taking this option. Appendix H discusses this in more detail.

5.3 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: $u(c_t, n_t) = \frac{c^{1-\gamma}}{1-\gamma} - \varphi \frac{n_t^{1+\nu}}{1+\nu}$. We set $\gamma = 2$ and $\nu = 2$. Following Heathcote, Storesletten, and Violante (2017), we set the labor tax progressivity (λ) to 0.181. Conditional on staying employed, the income process is the same as in the simple model. Furthermore, we calibrate the Poisson jumps across labor force status to match empirical job-finding and separation rates observed in the data.

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 of 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 the three key moments highlighted in the table.

TABLE 2: CALIBRATION

Parameter	Description	Value	Target
Preferences			
γ	Risk aversion	2	
υ	Inverse Frisch elasticity	2	
ψ	Labor disutility	0.895	$\pi^{ss} = 0$
ρ	Discount rate	0.0127	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
λ	Tax progressivity	0.181	Heathcote, Storesletten, and Violante (2017)
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	0.7%	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)
$\lambda^{e^U \to e^E}$	Poisson intensity of unemployed to employed	0.5	Average unemployment duration of 2 quarters
$\lambda^{e^N \to e^E}$	Poisson intensity of unemployed to employed	0.4	Not in labor force average of 2.5 quarters
$\lambda^{e^E \to e^U}$	Job separation rate	0.05	Employment spell average 25 quarters
Phillips Curve			
κ	Slope of Phillips curve	0.03	Auclert, Rognlie, and Straub (2024*b*)
ϵ	Elasticity of substitution	6	

5.4 Policy Menu

Our goal in this section is to rank various different policies within the HANK model in terms of their Benefits to Cost Ratio and the Marginal Value of Public Funds described in Section 5.1. Towards this end we provide the fiscal authority with a menu of policies summarized in Table 3. We allow them to chose between eight different policy options including government spending, uniform transfers, targeted transfers to low income households, targeted transfers to debtors, mortgage principal reductions, mortgage moratoriums, UI benefit increases, and UI extensions. These policies represent a set of tools commonly used for macroeconomic stabilization during the recessions in United States[32].

Total spending and size vary by policy. For government spending, transfers, and mortgage principal reduction, we set the initial size of the policy to be 1% of annual GDP. While UI-related policies are scaled up based on their initial steady-state values, with the initial UI generosity increasing by 25% and UI extension reducing the Poisson transition from unemployment to NILF from 0.3 to 0.15. Scaling the UI polices by the initial steady state makes the policies more realistic but also results in smaller absolute spending as they target a smaller segment of the population. A similar issue occurs with mortgage moratoriums. Here, the government subsidizes the cost of accessing their illiquid account by 50% of the steady-state cost. The total cost of the mortgage moratorium policy is an endogenous object that depends on how many households choose to draw equity from their mortgage account (Appendix G shows the adjustment regions for the mortgage moratorium polic)y. Our policy ranking measures (Section 5.1), however, account for the differing sizes of the policies as the welfare benefits are normalized by the total welfare or net fiscal costs of the policy. Thus, these measures provide a one-to-one comparison between different policies regardless of their size. This, obviously, assumes linearity in the scaling-up of different policies and can be misleading in the case of policies whose welfare effects change highly non-linearly with their size.

TABLE 3: POLICY MENU

Policy	**Change**	**Initial period size**
Government spending	G	1% of annual GDP
Transfer - Uniform	T^a	1% of annual GDP
Transfer - Low income	$T^a(e < \underline{e})$	1% of annual GDP
Transfer - Mortgage holders	$T^a(m > 0)$	1% of annual GDP
Mortgage Principal Reduction	$T^m(m > 0)$	1% of annual GDP
Mortgage moratorium	τ^m	Reduces cost of drawing equity by 50%, $\tau^m = 0.5\kappa^{adj}$
UI increase	$\uparrow \omega^{UI}$	Increase UI generosity by 25%
UI extension	$\downarrow \lambda^{u\to n}$	Quarterly outflow from $U \to N$ from 0.3 to 0.15

Notes: All policies decay at exponential rate 0.693 i.e. $e^{-0.693t}$, where t is quarters since the shock, and are deficit-financed with parameter $\phi = 0.06$.

Policy IRFs The impulse response functions for macroeconomic aggregates of each policy are reported in Appendix G. All policies are deficit-financed with a deficit-financing parameter, ϕ, of 0.06, resulting in deviations in government debt having a half-life of approximately 4 years. Moreover, unlike Section 4, we allow the policies to be persistent. For all policies, we set the decay rate to 0.693, which translates to the policy size halving every quarter. This calibration

[32]Appendix E.1 provides a historical background on the use of mortgage reductions and payment pauses/moratoriums during the US recessionary episodes

represents a reasonable path for government programs aimed at macroeconomic stabilization.

The policies exhibit substantial variation in their output and consumption effects. While targeted transfers amounting to 1% of annual GDP raise quarterly output by nearly 0.6%, a 50% reduction in the fixed cost of extracting equity (a moratorium) leads to an increase of only around 0.03%. However, these policies also differ significantly in their fiscal costs and the types of individuals they target. As previously discussed, the policy ranking measures account for these varying costs. The differences in targeting, in turn, have several distinct welfare implications. First, a policy can enhance welfare by directing resources toward individuals with high marginal utilities or larger Pareto weights. Second, targeting high-MPC individuals can boost welfare by triggering a stronger general equilibrium response and increasing the policy's degree of self-financing. Our policy ranking measure addresses the first channel by computing the aggregate willingness to pay (WTP), thereby making the rankings independent of Pareto weights and redistributive concerns. The Benefit-Cost Ratio (BCR) and Marginal Value of Public Funds (MVPF) measures also incorporate the second channel: the numerator captures all general equilibrium effects (which empirical public finance studies typically omit), while the denominator reflects the extent of self-financing.

5.5 Results

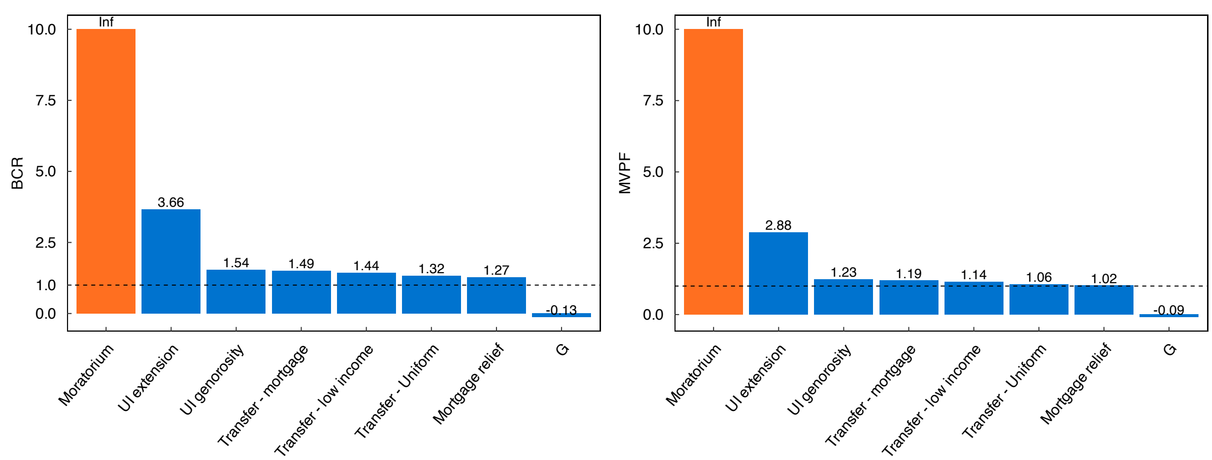
Figure 7 and Table 4 present the main results from the quantitative exercise. Figure 7 ranks policies based on their Benefit-Cost Ratio (BCR) and Marginal Value of Public Funds (MVPF), relative to steady-state welfare. A BCR or MVPF greater than one indicates that the policy delivers benefits that exceed its costs, where the notion of cost depends on the specific metric used.

Focusing on the BCR, the figure shows that all policies—except government spending—yield a BCR above one. The lower BCR for government spending arises mechanically, as households do not derive direct utility from it. Excluding government spending, there is considerable variation in BCRs across policies. Mortgage relief and uniform transfers exhibit relatively low BCRs, while moratoriums and unemployment insurance (UI) extensions deliver the highest BCRs. This variation reflects differences in both the targeting of policies and their effects on output.

Poorly targeted policies yield low BCRs. Uniform transfers, which lack any targeting, are costly and fail to generate a meaningful output response. This weak response stems from the transfers reaching low-MPC agents, who are less likely to increase consumption. Mortgage principal relief faces similar challenges, with the added limitation that the transfer is deposited into illiquid accounts, further constraining its immediate impact on consumption. As a result, both policies exhibit the lowest cumulative multipliers in the policy menu. This reflects their dual shortcomings: they are expensive to implement and generate limited output gains, leading to minimal self-financing and modest welfare improvements.

In contrast, well-targeted policies yield higher BCRs. The debt moratorium specifically targets liquidity-constrained households, resulting in low fiscal costs while still generating a meaningful increase in output—thereby enhancing the policy's self-financing properties. Unemployment insurance (UI) extensions are similarly targeted, focusing on low-income households. In addition to their direct effects, UI extensions deliver broad welfare benefits by reducing the likelihood that any agent falls to the minimum level of government support. This general effect arises because the policy lowers the probability of all agents reaching very low income levels. At the same time, the realized fiscal costs remain modest, as they are limited to the small share of unemployed individuals who, due to the policy, no longer transition to being out of the labor force (NILF). Together, these features result in high BCR and MVPF values for both policies.

FIGURE 7: BCR AND MVPF OF DIFFERENT POLICIES



(A) BCR (B) MVPF

Notes: The figures show the BCR and MVPF of the policies specified in Section 5.4. The columns in blue represent the BCR/MVPF, while the orange bars are truncated. The text above the columns are the actual BCR/MVPF values for the policies.

While BCR and MVPF provide useful metrics, they can obscure the aggregate welfare impact of a policy. Table 4 also reports the aggregate welfare gain associated with each policy. Part of the variation in welfare arises from differences in government expenditure across policies. However, it is notable that the policies with the highest BCR and MVPF—such as moratoriums, UI extensions, and increased UI generosity—generate the *lowest* aggregate welfare gains. This is in part due to their highly targeted nature, which limits scalability. For instance, UI benefits cannot realistically exceed the income one receives while employed, and moratoriums can only be extended to fully cover the cost of extracting equity from mortgage accounts. In this sense, these policies "empty the chamber" quickly—their marginal benefits diminish at relatively low levels of implementation, and the total welfare gains plateau early.

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

Policy	BCR	MVPF	Cumulative Multiplier	Cumulative Y (% annual GDP)	dW^E
Moratorium	Inf	Inf	2.71	0.03	0.03
UI extension	3.66	2.88	0.87	0.07	0.61
UI generosity	1.54	1.23	0.31	0.08	0.40
Transfer - mortgage	1.49	1.19	0.46	0.81	2.30
Transfer - low income	1.44	1.14	0.37	0.64	2.09
Transfer - Uniform	1.32	1.06	0.28	0.48	1.64
Mortgage relief	1.27	1.02	0.25	0.42	1.36
G	-0.13	-0.09	1.24	2.14	-2.96

Notes: The table presents key policy evaluation metrics for each of the policies considered in Section 5.4. The cumulative multiplier is calculated as the ratio of the present value (discounted by) r of all output changes and government expenditure changes, Cumulative Multiplier $= \frac{\int_{s>0} dY_s e^{-rs} ds}{\int_{s>0} dE_s e^{-rs} ds}$, where E is government expenditure. The cumulative Y is the cumulative change in output discounted by r, Cumulative Y $= \int_{s>0} dY_s e^{-rs} ds$. Lastly, dW^E represents the total change in welfare from a Kaldor-Hicks efficiency perspective.

Overall, the policy evaluation exercise highlights two key points. First, policies that target agents with high marginal propensities to consume (MPC)—such as UI extensions and moratoriums—deliver high BCR and MVPF values, i.e., high bang for the buck. These results arise because such policies impose relatively low fiscal costs by targeting a narrow subset of the population, yet still generate substantial consumption and output responses. These responses, in turn, lead to partial or even full self-financing of the policy. This finding builds on the insights from Section 4, which underscored the importance of self-financing in welfare evaluations. Second, however, high BCR or MVPF values can paint an incomplete picture by masking aggregate welfare effects. While policies with high BCR/MVPF may be highly effective at the margin, they can fail to produce large *net aggregate welfare gains* for the overall economy. This limitation stems precisely from their targeted nature, which restricts the scope for broader impact. The tension between marginal effectiveness and total welfare gains presents a fundamental trade-off for policymakers responding to large shocks: maximizing bang for the buck versus maximizing net aggregate welfare gains.

5.6 Policy Rankings from a Recession Baseline

To conduct our policy ranking exercise in the last section we linearized the model around the steady state where aggregate labor demand channel or the stabilization effect is by definition zero. In Appendix I we report the results from an exercise where the stabilization channel is active. We first non-linearly solve for a large recession in the economy. Specifically, we induce the recession using an increase in real rates that drives a 3% fall in output. Then we linearize the model around this non-linearly solved transition path. Around this new baseline, labor demand channel becomes an additional benefit to expansionary fiscal policies. The results are presented in Appendix I. For most policies, starting from a recession does not meaningfully change the BCR or MVPF rankings. The overall result generally reaffirms that the labor demand channel represents only a small amount of the welfare benefits of expansionary fiscal policy even outside of steady state (as shown in Section 4.5.1).

6 Conclusion and Future Research

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 gains 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 identifies and quantifies each of these channels. Finally, we use these insights to rank a range of business cycle policies based on their Benefits-to-Cost Ratio (BCR) and highlight important caveats regarding the limitations of such ratio-based measures.

Our paper also points to several promising directions for future research. For instance, our model abstracts from nominal government debt—an unrealistic assumption, as debt erosion through inflation is another important channel through which public debt may be reduced, alongside self-financing. Second, our framework offers a basis for generalizing policy ranking measures such as the BCR and MVPF to account for how the government budget constraint is closed—specifically, whether a policy is financed through deficits or tax increases. Developing dynamic policy rankings that reflect the fiscal position of the economy could be a valuable extension for future work.

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. 2024*a*. "Fiscal and monetary policy with heterogeneous agents." National Bureau of Economic Research.

Auclert, Adrien, Matthew Rognlie, and Ludwig Straub. 2024*b*. "The intertemporal keynesian cross." *Journal of Political Economy*, 132(12): 4068–4121.

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."

Bayer, Christian, Benjamin Born, and Ralph Luetticke. 2024. "Shocks, Frictions, and Inequality in US Business Cycles." *American Economic Review*, 114(5): 1211–47.

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."

Bilbiie, Florin O, Tommaso Monacelli, and Roberto Perotti. 2024. "Stabilization vs. Redistribution: The optimal monetary–fiscal mix." *Journal of Monetary Economics*, 147: 103623.

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.

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.

Floden, Martin, and Jesper Lindé. 2001. "Idiosyncratic risk in the United States and Sweden: Is there a role for government insurance?" *Review of Economic dynamics*, 4(2): 406–437.

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 Section 3 Proofs: Welfare Effects of Fiscal Policies

A.1 Proof of Proposition 1

Proposition (Welfare Decomposition)**.** *To first order, aggregate welfare gains from a policy perturbation, $d\mathbf{\Gamma}$, can be decomposed into three effects*

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

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* $\mathbf{\Omega}^{\tau} d\boldsymbol{\tau} = \int_{s=0}^{\infty} \frac{\partial W}{\partial \tau(s)} d\tau(s) ds$.

Proof. Consider the value function of an individual who has state a, e at time t. The time-dependent HJB, representing the value function can be written as

$$\rho V\left(a, e, t; \{r, w, n, \tau, \Gamma\}_{s \geq t}\right) = \max_{c} \Big[u(c, e, t) - v(n_t, e, t) + \partial_a V(a, e, t)((1 - \tau_t) w_t e n_t + r_t a - c + \Gamma_t) \\ + \mathcal{A}_t V(a, e, t) + \partial_t V(a, e, t) \Big] \tag{35}$$

Here the households take the prices $\{r, w\}_{s \geq t}$, taxes/transfers quantities $\{\tau, \Gamma\}_{s \geq t}$ and labor supply $\{n\}_{s \geq t}$ 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

$$u_c(c, e, t) = \partial_a V(a, e, t) \tag{36}$$

At the optimum, for an exogenous sequence of shocks $\{dn_s\}_{s \geq t}$, $\{d\tau_s\}_{s \geq t}$ and $\{d\Gamma_s\}_{s \geq t}$ at time t[33], the change in the value of the 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

$$\begin{aligned} \rho dV(a, e, t) &= - v_n(n_t, e, t) dn_t + d\left(\partial_a V(a, e, t) s(a, n)\right) + \partial_a V(a, e, t)[(1 - \tau) w e dn_t - w e n d\tau_t + d\Gamma_t] \\ &\quad + \mathcal{A}_t dV(a, e, t) + \partial_t dV(a, e, t) \\ &= \partial_a V(a, e, t)[(1 - \tau) w e dn_t - w e n d\tau_t + d\Gamma_t] - v_n(n, e, t) dn_t + \partial_a \left(dV(a, e, t) s(a, n)\right) \\ &\quad + \mathcal{A}_t dV(a, e, t) + \partial_t dV(a, e, t) \\ &= [\partial_a V(a, e, t)(1 - \tau) w e - v_n(n, e, t)] dn_t - \partial_a V(a, e, t) w e n d\tau_t + \partial_a V(a, e, t) d\Gamma_t \\ &\quad + \partial_a \left(dV(a, e, t) s(a, n)\right) + \mathcal{A}_t dV(a, e, t) + \partial_t dV(a, e, t) \end{aligned}$$

where $s(a, n) := (1 - \tau) w_t e n_t + r_t a - c + \Gamma_t$.

[33] The assumptions of the model make r_t and w_t constant in the baseline

We differentiated the HJB at an interior point in the state space; and used the envelope theorem (which implies that all the derivatives w.r.t the control variable c are zero). Applying the Feynman-Kac formula to the above expression, and using the first order condition in Equation 36, we get

$$dV(a,e,t) = \mathbb{E}_t \Bigg(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'} \Big[[\partial_a V(a,e,s)(1-\tau)we_s - v_n(n,e,s)]dn_s \\ - \partial_a V(a,e,s) we_s n_t d\tau_s + \partial_a V(a,e,s) d\Gamma_s \Big] ds \Bigg) \tag{37}$$

$$\begin{aligned} &= \mathbb{E}_t \left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'} \Big[(1-\tau)we_s u'(c_t(a_s,e_s)) - v'(n_t(a_s,e_s)) \Big] dn_s ds \right) \\ &+ \mathbb{E}_t \left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'} u'(c_t(a_s,e_s)) d\Gamma_s ds \right) \\ &- \mathbb{E}_t \left(\int_t^{T\wedge\tau} e^{-\int_t^s \rho dt'} u'(c_t(a_s,e_s)) we_s n_t d\tau_s ds \right) \end{aligned} \tag{38}$$

Here $T \wedge \tau := \inf\{t \geq 0 | a_t = \underline{a}\}$ is the stopping time at which the wealth reaches the borrowing constraint. However, as both the FOC and the envelope hold at the borrowing constraint, we drop the stopping time notation in the following equations for simplicity.

A.1.1 Aggregation

Again, denote by $t = 0$, the initial steady state of the model and the time at which agents receive the perfect foresight about aggregate variables. And let (a_0, e_0) denote the value of the individual state variables at time zero and let $g_0(a_0, e_0)$ be the stationary distribution at time zero. Then utilitarian welfare change to any perturbation is just the sum of changes of individual value functions weighted by the initial distribution i.e.

$$\frac{dW^\lambda}{d\theta} = \int\int dV(a_0,e_0) g(a_0,e_0) dade \tag{39}$$

As the sequences $\{d\tau_t\}_{t\geq 0}$ and $\{d\Gamma_t\}_{t\geq 0}$ are independent of the initial individual states they can be factored out of the integrals when aggregating over individuals in Eq. 39. However, $\{dn_t\}_{t\geq 0}$, could be individual specific given our assumption on the allocation rule. So we present two results separately for our two different assumptions on the allocation rules

1. **Uniform Allocation Rule**: Under this allocation rule the aggregate welfare change is given

by the following three terms

$$\frac{dW^{\lambda}}{d\theta} = \int_{s=0}^{\infty} \left[\Omega^{\Gamma(s)} d\Gamma(s) + \Omega^{N(s)} dN(s) + \Omega^{\tau(s)} d\tau(s) \right] ds \tag{40}$$

$$= \mathbf{\Omega^{\Gamma}} d\mathbf{\Gamma} + \mathbf{\Omega}^{N} d\mathbf{N} + \mathbf{\Omega}^{\tau} d\boldsymbol{\tau} \tag{41}$$

where $d\mathbf{N}$ is the change in aggregate labor demand.

$$\int_{s=0}^{\infty} \Omega^{N(s)} dN(s) = \int_{a_0,e_0} \left[\mathbb{E}_0^i \left(\int_{s=0}^{\infty} e^{-\int_0^s \rho dt'} \left[(1-\tau) w e_s u'(c_0(a_s, e_s)) - v'(N_0) \right] dN(s) ds \right) \right] g_0(a_0, e_0) dade$$

$$\int_{s=0}^{\infty} \Omega^{\Gamma(s)} d\Gamma(s) = \int_{a_0,e_0} \left[\mathbb{E}_0^i \left(\int_{s=0}^{\infty} e^{-\int_0^s \rho dt'} \left[u'(c_0(a_s, e_s)) d\Gamma(s) ds \right] \right) \right] g_0(a_0, e_0) dade$$

$$\int_{s=0}^{\infty} \Omega^{\tau(s)} d\tau(s) = \int_{a_0,e_0} \left[\mathbb{E}_0^i \left(\int_{s=0}^{\infty} e^{-\int_0^s \rho dt'} \left[u'(c_0(a_s, e_s)) w e_s N_0 d\tau(s) ds \right] \right) \right] g_0(a_0, e_0) dade$$

Here we have just plugged the Equation 38 in Equation 39, and then, due to linearity, we switch the time and distribution integrals.

c_0 refers to the steady state policy function, and the expectation $\mathbb{E}_0^i$ is with respect to the individual (i) state variables a_s, e_s; both are simply steady state objects and are independent of the aggregate shocks.

2. **Heterogeneous-Dynamic Allocation Rule**: Under the allocation rule specified in Equation 8, the aggregate welfare change is given by the following three terms

$$\frac{dW^{\lambda}}{d\theta} = \int_{s=0}^{\infty} \left[\Omega^{\Gamma(s)} d\Gamma(s) + \Omega^{\tilde{N}(s)} d\tilde{N}(s) + \Omega^{\tau(s)} d\tau(s) \right] ds \tag{42}$$

$$= \mathbf{\Omega^{\Gamma}} d\mathbf{\Gamma} + \mathbf{\Omega}^{\tilde{N}} d\tilde{\mathbf{N}} + \mathbf{\Omega}^{\tau} d\boldsymbol{\tau} \tag{43}$$

where $d\tilde{\mathbf{N}} := \left\{ d \frac{N(s)}{\int_{a,e} \gamma(a_s, e_s) g_s(a_s, e_s) dade} \right\}_{s \geq 0}$ i.e. it is the aggregate labor demand adjusted by the correction term to make sure that individual labor supplies under the allocation rule correctly aggregate up to the total labor supply. And the Ω expressions now include terms for the $\gamma(\cdot)$ allocation rule.

$$\int_{s=0}^{\infty} \Omega^{\tilde{N}(s)} d\tilde{N}(s)$$
$$= \int_{a_0,e_0} \left[\mathbb{E}_0^i \Big(\int_{s=0}^{\infty} e^{-\int_0^s \rho dt'} \Big[(1-\tau) w e_s u'(c_0(a_s,e_s)) - v'(\gamma(a_s,e_s)N_0) \Big] d\tilde{N}(s) ds \Big) \right] g_0(a_0,e_0) dade$$

$$\int_{s=0}^{\infty} \Omega^{\Gamma(s)} d\Gamma(s) = \int_{a_0,e_0} \left[\mathbb{E}_0^i \left(\int_{s=0}^{\infty} e^{-\int_0^s \rho dt'} \Big[u'(c_0(a_s,e_s)) d\Gamma(s) ds \Big] \right) \right] g_0(a_0,e_0) dade$$

$$\int_{s=0}^{\infty} \Omega^{\tau(s)} d\tau(s) = \int_{a_0,e_0} \left[\mathbb{E}_0^i \left(\int_{s=0}^{\infty} e^{-\int_0^s \rho dt'} \Big[u'(c_0(a_s,e_s)) w e_s \gamma(a_s,e_s) N_0 d\tau(s) ds \Big] \right) \right] g_0(a_0,e_0) dade$$

□

A.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 with a uniform allocation rule is*

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

Proof. Follows directly from the result in Sec. A.1 with $n^{ss}(x_s) = N_0$ and a uniform allocation. □

A.3 Proof of Corollary 1

Corollary. *The labor demand effect around steady state is zero to first order (i.e. $\boldsymbol{\Omega}^N \boldsymbol{dN} = 0$) if*

1. *The unions allocate labor according to Equations 8 (i.e. heterogeneous dynamic allocation rule), or*
2. *Under the calibration in uniform allocation rule that targets zero inflation in the steady state and pareto-weights are equal to one.*

Proof. In the uniform allocation rule case, the labor wedge if we use Utilitarian weights is given by

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

and the wedge in the Philips curve is given by

$$\int \left[v'(n_{it}) - (1-\tau_s)\frac{\epsilon - 1}{\epsilon}(1-\tau_t)e_{it}w_t u'(c_{it}) \right] di$$

Thus with $(1-\tau_s)\frac{\epsilon-1}{\epsilon}$, ensuring that the WNKPC wedge is zero implies that the $\Omega^N = 0$.

For Heterogeneous Dynamic Allocation Rules the welfare relevant labor wedge are given by

$$\int_{s=0}^{\infty} \Omega^{N(s)} dN(s) = \int_{a_0,e_0} \left[\mathbb{E}_0^i \left(\int_{s=0}^{\infty} e^{-\int_0^s \rho dt'} \left[(1-\tau) w e_s u'(c_0(a_s,e_s)) - v'(\gamma(a_s,e_s)N_0) \right] d\tilde{N}(s) ds \right) \right] g_0(a_0,e_0) dade$$

Given the we chose the γ function such that Equation 9 holds in the steady state i.e. the households are on their optimal labor choices given consumption, the $\Omega^N = 0$ □

A.4 Proof of Proposition 3

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

$$\begin{aligned} &\boldsymbol{\Omega}^{\boldsymbol{\Gamma}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{\tau} d\boldsymbol{\tau} = \\ &\int_0^{\infty} e^{-\rho s} \Bigg[\underbrace{\mathcal{U}_s'[d\Gamma_s - Y_{ss} d\tau_s]}_{\text{Net Aggregate Deficits}} + \underbrace{\mathbb{C}ov_{a,e}\Big(\mathbb{E}_0^i \left[u'(c^{ss}(x_s)) \right], \mathbb{E}_0^i [d\Gamma_s - w e_s n^{ss}(x_s) d\tau_s] \Big)}_{\text{Deficit Incidence}} \\ &\qquad + \underbrace{\mathbb{E}_{a,e}\Big(\mathbb{C}ov_0^i \left(u'(c^{ss}(x_s)), d\Gamma_s - w e_s n^{ss}(x_s) d\tau_s \right) \Big)}_{\text{Aggregate Insurance Effect}} \Bigg] ds \end{aligned}$$

where $\mathcal{U}_s' := \int_{a,e} u'(c_s(a,e)) g_0(a_0,e_0) dade$ and $dT_s = d(Y_s \tau_s)$ and $x_s := (a_s, e_s)$. $\mathbb{E}_{a,e}$ & $\mathbb{C}ov_{a,e}$ denotes the cross-sectional average and covariance, while $\mathbb{E}_0^i$ & $\mathbb{C}ov_0^i$ denote expectation and covariance w.r.t individual idiosyncratic states.

Proof. **Uniform Labor Allocation Rule** First, add the following two expressions

$$\int_{s=0}^{\infty} \Omega^{\Gamma(s)} d\Gamma(s) = \int_{a_0,e_0} \left[\mathbb{E}_0^i \left(\int_{s=0}^{\infty} e^{-\int_0^s \rho dt'} \left[u'(c_0(a_s,e_s)) d\Gamma(s) ds \right] \right) \right] g_0(a_0,e_0) dade$$

$$\int_{s=0}^{\infty} \Omega^{\tau(s)} d\tau(s) = \int_{a_0,e_0} \left[\mathbb{E}_0^i \left(\int_{s=0}^{\infty} e^{-\int_0^s \rho dt'} \left[u'(c_0(a_s,e_s)) w e_s N_0 d\tau(s) ds \right] \right) \right] g_0(a_0,e_0) dade$$

This implies (after interchanging the integrals)

$$\boldsymbol{\Omega}^{\boldsymbol{\Gamma}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{\tau} d\boldsymbol{\tau} = \int_{a_0,e_0} \left[\int_{s=0}^{\infty} e^{-\rho s} \left(\mathbb{E}_0^i \Big[u'(c_0(a_s,e_s))[d\Gamma_s - we_s N_{ss} d\tau_s] ds \Big] \right) \right] g_0(a_0,e_0) dade$$

Now using the fact that $E[XY] = E[X]E[Y] + \text{Cov}(X,Y)$, break up the expectation

$$\begin{aligned}&\boldsymbol{\Omega}^{\boldsymbol{\Gamma}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{\tau} d\boldsymbol{\tau} \\ &= \int_{a,e} \left[\int_0^{\infty} e^{-\rho s} \left(\mathbb{E}_0^i[u'(c_0(a_s,e_s))] \mathbb{E}_0^i[d\Gamma_s - we_s N_{ss} d\tau_s] + Cov^i(u'(c_0(a_s,e_s)), d\Gamma_s - we_s N_{ss} d\tau_s) \right) ds \right] g_0(a,e) dade\end{aligned}$$

Take the term $\int_{a,e} \left[\int_0^{\infty} e^{-\rho s} \left(\mathbb{E}_0^i[u'(c_0(a_s,e_s))] \mathbb{E}_0^i[d\Gamma_s - we_s n_s d\tau_s] \right) ds \right] g_0(a,e) dade$. And interchange the time and cross section integrals

$$\int_0^{\infty} e^{-\rho s} \left[\int_{a,e} \left(\mathbb{E}_0^i[u'(c_0(a_s,e_s))] \mathbb{E}_0^i[d\Gamma_s - we_s n_s d\tau_s] \right) g_0(a,e) dade \right] ds$$

Again use $E[XY] = E[X]E[Y] + \text{Cov}(X,Y)$ and call $\mathcal{U}_s' := \int_{a,e} u'(c_0(a_s,e_s)) g_0(a,e) dade = \mathbb{E}_{a,e}[u'(c_0(a_s,e_s)]$ and we can use the fact that

$$\int_{a,e} \mathbb{E}_0^i[d\Gamma_s(a,e) - we_s n_s d\tau_s] g_0(a,e) dade = \int \mathbb{E}_0^i[d\Gamma_s] g_0(a,e) dade - \int \mathbb{E}_0^i[we_s N_{ss} d\tau_s] g_0(a,e) dade$$

Using this we can re-write $\int_{a,e} \left[\int_0^{\infty} e^{-\rho s} \left(\mathbb{E}_0[u'(c_s)] \mathbb{E}_0[d\Gamma_s - we_s n_s d\tau_s] \right) ds \right] g_0(a,e) dade$ as

$$\int_{s=0}^{\infty} e^{-\rho s} \left[\underbrace{\mathbb{E}_0^i \mathcal{U}_s'[d\Gamma_s - wN_{ss} d\tau_s]}_{\text{Net Aggregate Deficits}} + \underbrace{Cov_{a,e} \left(\mathbb{E}_0^i[u'(c_s)], \mathbb{E}_0^i[d\Gamma_s - we_s N_{ss} d\tau_s] \right)}_{\text{Incidence of Deficits}} \right] ds$$

Now take the second term

$$\int_{a,e} \left[\int_{s=0}^{\infty} e^{-\rho s} \left(Cov^i(u'(c_0(a_s,e_s)), d\Gamma_s - we_s n_s d\tau_s) \right) ds \right] g_0(a,e) dade$$

Interchanging the integrals

$$\int_{s=0}^{\infty} e^{-\rho s} \underbrace{\left[\int_{a,e} \left(Cov^i(u'(c_s), d\Gamma_s - we_s N_{ss} d\tau_s) \right) g_0(a,e) dade \right]}_{\text{Aggregate Insurance Effect}} ds$$

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

$$= \int_{s=0}^{\infty} \Bigg[\underbrace{\mathbb{E}_0^i \mathcal{U}_s'[d\Gamma_s - wN_{ss}d\tau_s]}_{\text{Net Aggregate Deficits}} + \underbrace{\mathbb{C}ov_{a,e}\left(\mathbb{E}_0^i[u'(c_s)], \mathbb{E}_0^i[d\Gamma_s - we_s N_{ss} d\tau_s]\right)}_{\text{Incidence of Deficits}}$$
$$+ \underbrace{\mathbb{E}_{a,e}\left(Cov^i(u'(c_s), d\Gamma_s - we_s N_{ss} d\tau_s)\right)}_{\text{Aggregate Insurance Effect}} \Bigg] ds$$

Heterogeneous Dynamic Allocation Rule For the heterogeneous dynamic allocation rule, we follow exactly the same steps to arrive at

$$\boldsymbol{\Omega}^{\boldsymbol{\Gamma}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{\tau} d\boldsymbol{\tau} = \int_{s=0}^{\infty} \Bigg[\underbrace{\mathbb{E}_0^i \mathcal{U}_s'[d\Gamma_s - wN_{ss}d\tau_s]}_{\text{Net Aggregate Deficits}} + \underbrace{\mathbb{C}ov_{a,e}\left(\mathbb{E}_0^i[u'(c_s)], \mathbb{E}_0^i[d\Gamma_s - we_s \gamma(a_s, e_s) N_{ss} d\tau_s]\right)}_{\text{Incidence of Deficits}}$$
$$+ \underbrace{\mathbb{E}_{a,e}\left(Cov^i(u'(c_s), d\Gamma_s - w\gamma(a_s, e_s) e_s N_{ss} d\tau_s)\right)}_{\text{Aggregate Insurance Effect}} \Bigg] ds$$

□

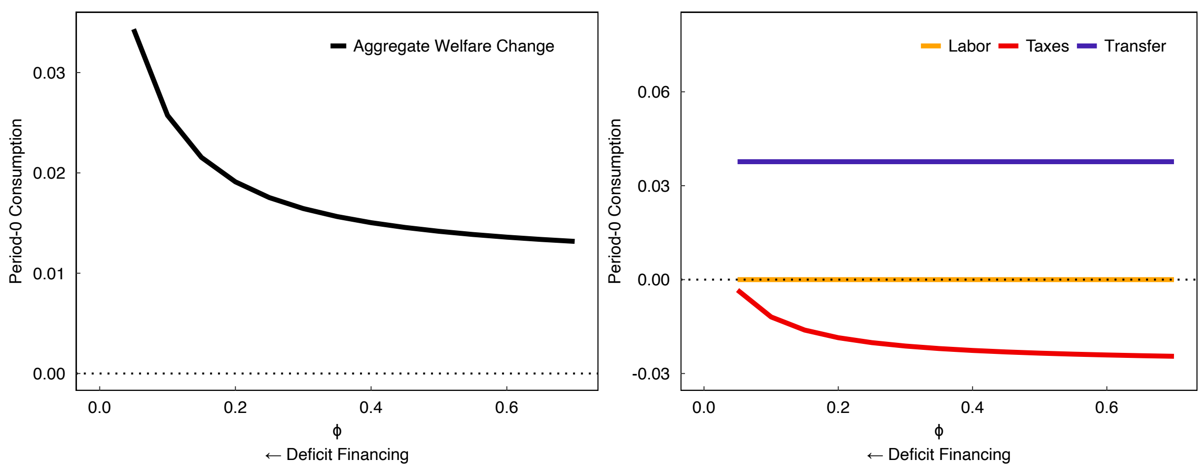
B Baseline Extensions

B.1 Heterogeneous-Dynamic Allocation Rule

We also present the results for the same uniform transfer shock as in Section 4, but for a model where the labor union implements the Heterogeneous Dynamic Allocation Rule as specified in Equation 8. This allocation rule is chosen such that all labor wedges for all households are closed in the steady state and ensures the *labor demand* channel is zero for any choice of planner.

Figures 8a and 8b show the overall welfare effect and the welfare decomposition to the uniform transfer shock when using the alternative allocation rule. Two points are worth highlighting. First, the effects are qualitatively the same as the baseline model with constant labor allocation. That is, higher levels of deficit financing yield larger welfare improvements. Second, the magnitude of the welfare change is small with the alternate allocation rule.

Figure 8: Welfare change from uniform transfer for different deficit financing in HANK



(a) Welfare Change

(b) Welfare Breakdown

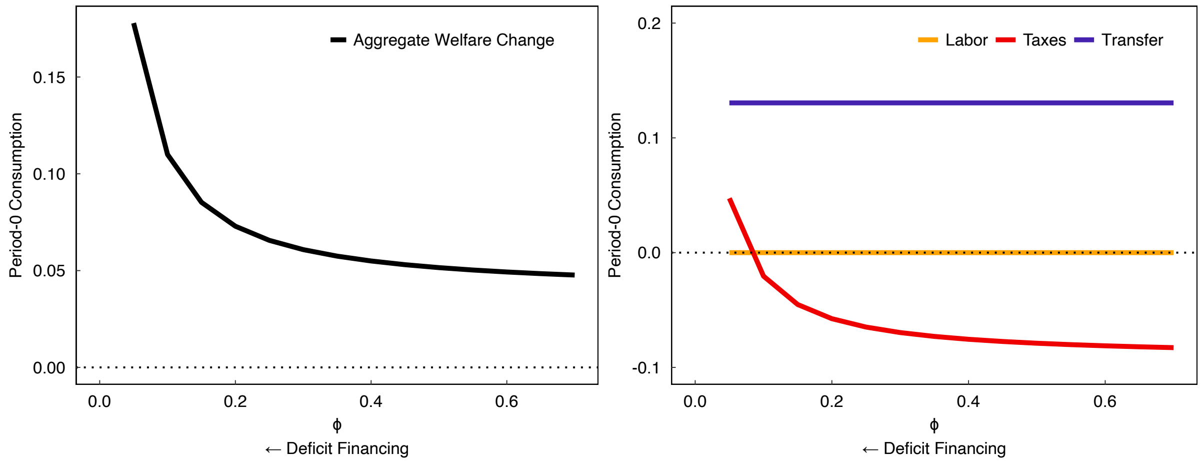
We omit the tax and transfer effect plots for brevity, but we confirm that welfare remains largely driven by the self-financing term when deficit financing increases.

B.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.

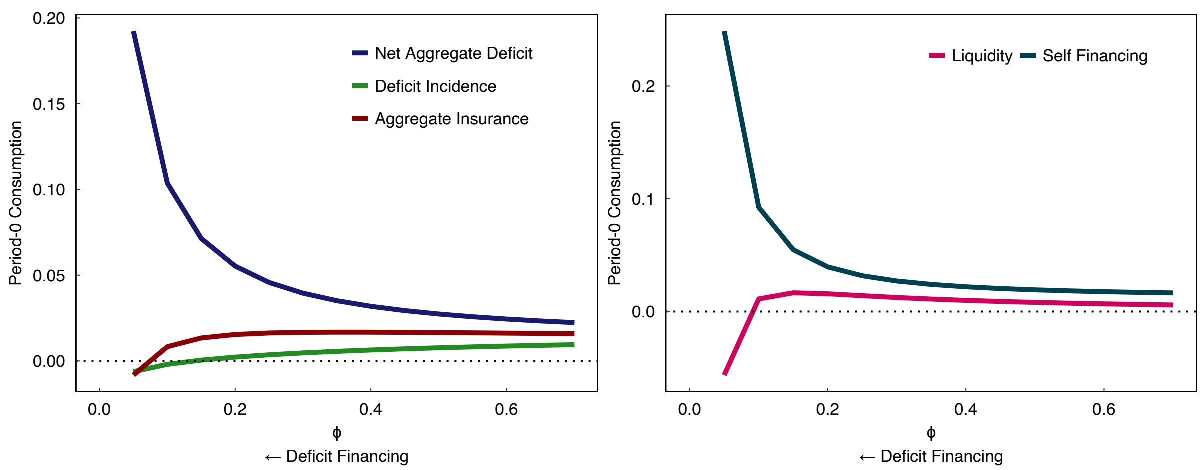
Figures 9a and 9b show the welfare change to the persistent uniform transfer shock and the welfare components. Qualitatively the shape of the responses are similar to the one-time shock. The primary difference is simply that the magnitude of the responses are larger. As shown in Figures 10a and 10b, 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 9: Welfare change from persistent uniform transfer for different deficit financing in HANK



(a) Welfare Change (b) Welfare Breakdown

Figure 10: Welfare Decomposition to Persistent Shock



(a) Tax and Transfer Channel (b) Decomposition of Deficits Term.

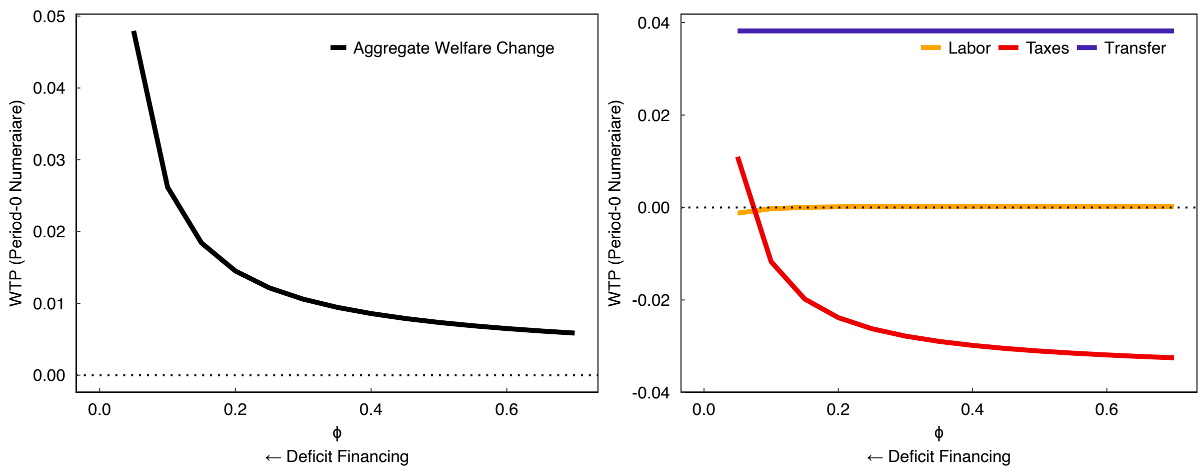
B.3 Alternative Planners

In this appendix, we present the same results as Section 4 but using a Kaldor-Hicks efficiency planner (Dávila and Schaab, 2022*b*). We use two different numeraires to get the Willingness-to-Pay for each policy change: i) the period-0 consumption numeraire and the lifetime numeraire. The latter follows directly from Dávila and Schaab (2022*b*) and is useful to study their decomposition.

B.3.1 Period-0 Numeraire

We define the Kaldor-Hicks numeraire for each agent as simply their marginal utility of period-0 consumption i.e. $\Lambda(a_0, e_0) = u'(c_0(a_0, e_0))$. Figures 11a and 11b show the welfare decomposition of the one-time uniform transfer shock over various levels of deficit financing. The results are similar to the baseline utilitarian welfare results. The figures also illustrate that the labor demand channel is small even when the planner and labor union do not apply the same weightings.

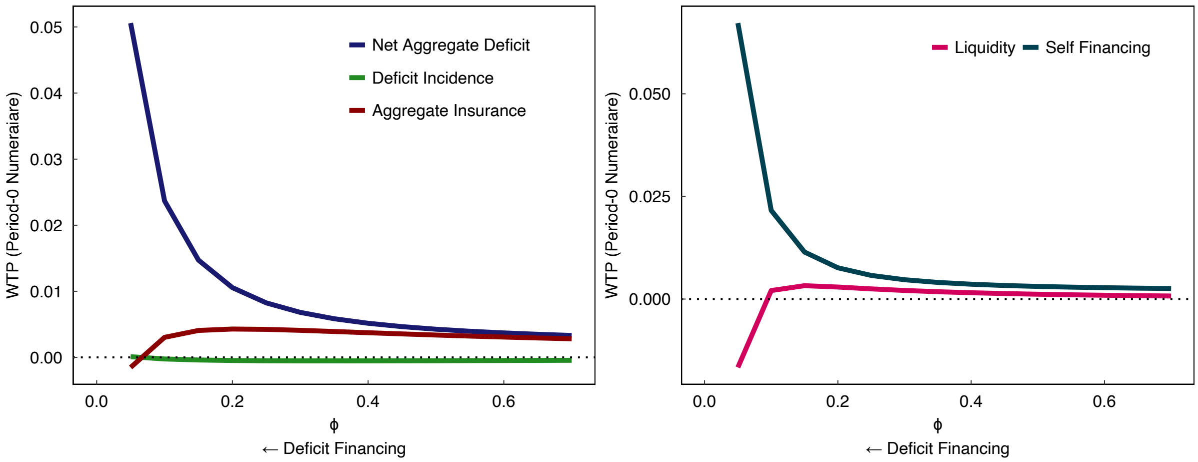
FIGURE 11: WELFARE CHANGE IN PERIOD-0 CONSUMPTION UNITS FROM UNIFORM TRANSFER FOR DIFFERENT DEFICIT FINANCING IN HANK



(A) WELFARE CHANGE (B) WELFARE BREAKDOWN

Figures 12a and 12b 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 12: Welfare Decomposition in Period-0 consumption units



(a) Tax and Transfer Channel

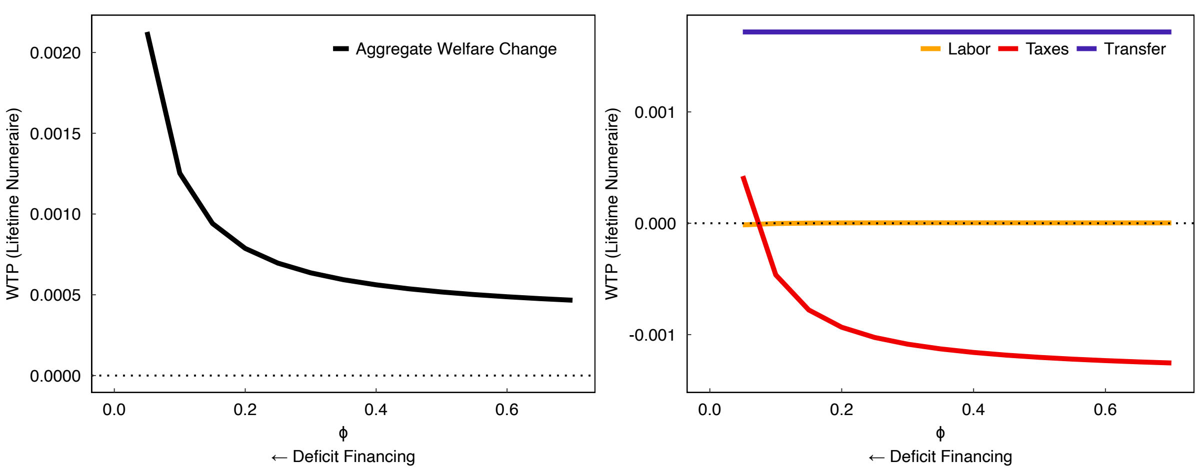
(b) Decomposition of Deficits Term

B.3.2 Lifetime Numeraire

We define the lifetime numeraire in the same way as Dávila and Schaab (2022*b*), $\Lambda(a_0, e_0) = \int_{s\geq 0} e^{-\rho s}\mathbb{E}_0 u'(c_0(a_s, e_s))ds$, where the expectation is taken over all possible states (a_s, e_s). This numeraire corresponds to the value of giving a household an extra unit of consumption across all states (a_s, e_s) and all time periods.

Figures 13a, 13b, 14a and 14b present the same figures as in the main text but now using the lifetime numeraire. The components follow the same profile and are simply rescaled to be smaller, which reflects the fact that the lifetime numeraire is larger than the other numeraires used.

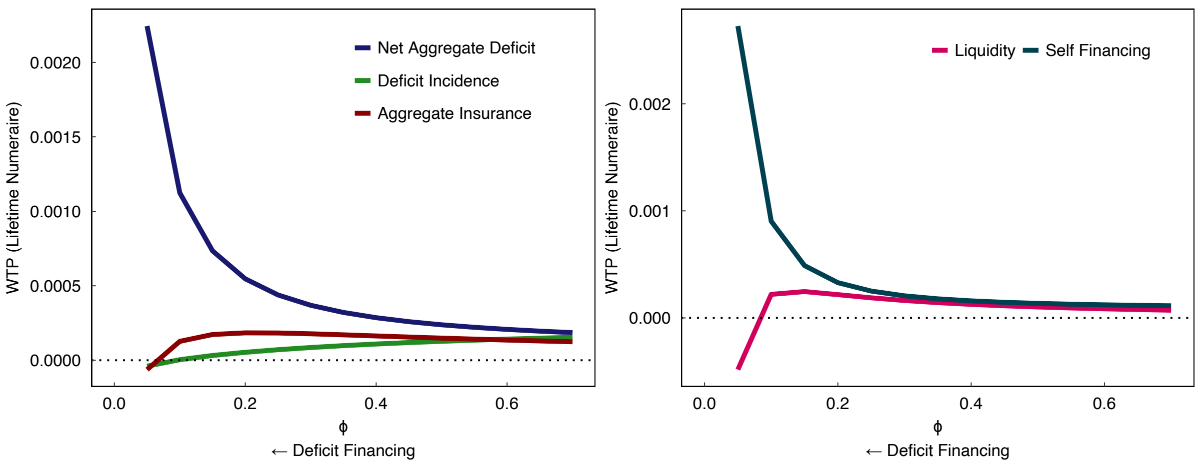
Figure 13: Welfare change in lifetime welfare units from uniform transfer for different deficit financing in HANK



(a) Welfare Change

(b) Welfare Breakdown

Figure 14: Welfare decomposition in lifetime welfare units consumption units



(a) Tax and Transfer Channel

(b) Decomposition of Deficits Term

C 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

$$n_{k,t}(w_{k,t}) = \left(\frac{w_{k,t}}{w_t} \right)^{-\epsilon} N_t \qquad \text{where } w_t = \left(\int_0^1 w_{k,t}^{1-\epsilon} dk \right)^{\frac{1}{1-\epsilon}} \tag{44}$$

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

$$\int_0^\infty e^{-\rho t}\left(\int\left\{u(c_t(a,y)) - v\left(\int_0^1 \gamma_i n_{k,t} dk\right) d\mu_t\right\} - \frac{\Psi}{2}\left(\frac{\dot{w}_{k,t}}{w_t}\right)\right) dt \tag{45}$$

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.

C.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.

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

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

$$\begin{aligned}
&= (1-\tau_t)(1-\theta)\left(\frac{e_{it}\gamma_i}{P_t} w_{kt} n_{kt}\right)^{-\theta}\left((1-\epsilon)\frac{e_{it}\gamma_i}{P_t} n_{kt}\right) && (50)\\
&= \left(1 - \underbrace{\left(1-(1-\theta)(1-\tau_t)\left(\frac{e_{it}\gamma_i}{P_t} w_{kt} n_{kt}\right)^{-\theta}\right)}_{MTR_{it}}\right)\frac{e_{it}\gamma_i}{P_t} n_{kt}(1-\epsilon) && (51)\\
&= (1-MTR_{it})\frac{e_{it}\gamma_i}{P_t} n_{kt}(1-\epsilon) && (52)
\end{aligned}$$

Household i's total hours worked are

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

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

$$\frac{\partial z_{it}}{\partial n_{it}} = \frac{\partial}{\partial n_{it}} (1-\tau_t) \left(\frac{e_{it}\gamma_i}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon} N_t \right)^{1-\theta} \tag{53}$$

$$= \frac{\partial}{\partial n_{it}} (1-\tau_t) \left(\frac{e_{it}\gamma_i N_t}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon} \right)^{1-\theta} \tag{54}$$

$$= (1-\tau_t)(1-\theta) \left(\frac{e_{it}\gamma_i N_t}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon} \right)^{-\theta} \left(\frac{e_{it}}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon} \right) \tag{55}$$

$$= (1-\tau_t)(1-\theta) \left(\frac{e_{it}\gamma_i}{P_t} w_{kt} n_{kt} \right)^{-\theta} \left(\frac{e_{it}}{P_t} w_{kt}^{1-\epsilon} w_t^{\epsilon} \right) \tag{56}$$

$$(w_{kt} = w_t)$$

$$= (1 - MTR_{it}) \frac{e_{it} w_t}{P_t} \tag{57}$$

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

$$\frac{\partial z_{it}}{\partial n_{it}} = \frac{\partial}{\partial n_{it}}(1-\tau_t)\left(\frac{w_{kt}}{P_t}e_{it}\gamma_i n_{kt}\right)^{1-\theta} \tag{58}$$

$$= (1-\tau_t)(1-\theta)\left(\frac{w_t}{P_t}e_{it}n_{it}\right)^{-\theta}\frac{w_t}{P_t}e_{it} \tag{59}$$

$$= (1-\tau_t)(1-\theta)\left(\frac{w_t}{P_t}\right)^{1-\theta}e_{it}^{1-\theta}n_{it}^{-\theta} \tag{60}$$

$$= (1-\tau_t)(1-\theta)\left(\frac{w_t}{P_t}\right)^{1-\theta}e_{it}^{1-\theta}(\gamma_i N_t)^{-\theta} \tag{61}$$

$$= (1-\theta)\underbrace{(1-\tau_t)\left[\frac{w_t}{P_t}e_{it}\gamma_i N_t\right]^{1-\theta}}_{z_{it}}\frac{1}{\gamma_i N_t} \tag{62}$$

$$= (1-\theta)\frac{z_{it}}{\gamma_i N_t} \tag{63}$$

C.2 Back to the Problem

Drift of state variable

$$\pi_{k,t} = \frac{\dot{w}_{k,t}}{w_{k,t}} \tag{64}$$

$$dw_{k,t} = \pi_{k,t}w_{k,t}dt \tag{65}$$

Re-write the objective in Eq. 45 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

FOC: $\Psi\frac{\pi_w}{w} = J_w(w,t)$

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 C.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

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

D MVPF Denominator Formulation

Definition 4. *In the HANK model of Section 2 i.e. with wage rigidities and a constant real-rate rule the Marginal Value of Public Funds (MVPF) for a fiscal policy perturbation can be defined as*

$$MVPF := \frac{\textit{Welfare Benefits}}{\textit{Net Cost to Government}} = \frac{\mathbf{\Omega}^{\mathbf{\Gamma},\mathbf{E}} d\mathbf{\Gamma} + \mathbf{\Omega}^{N,E} d\mathbf{N}}{\int_s e^{-rs} \left[dT(s) - \tau_{ss} dY(s) \right] ds}$$

Definition 4 presents an alternative formulation of MVPF, which is equivalent to the one presented in Definition 2. In this appendix, we show this equivalence.

Denote the fiscal surpluses $s(t) = T(t) - \Gamma(t) - G(t)$. Two equations govern the evolution of deficits:

$$T(t) = T^* + \phi(B(t) - B^*) \tag{66}$$
$$\dot{B}(t) = r(t)B(t) - s(t) \tag{67}$$

From the first equation we have $B(t) = B^* - \frac{(T^* - T(t))}{\phi}$. Substitute this into Equation 67.

$$\dot{B}(t) = r(t)\left(B^* - \frac{(T^* - T(t))}{\phi}\right) - \left[T(t) - \Gamma(t) - G(t)\right] \tag{68}$$
$$\frac{dB}{dt} = r(t)B^* - r(t)\frac{T^*}{\phi} + \frac{(r(t) - \phi)}{\phi} T(t) + \Gamma(t) + G(t) \tag{69}$$
$$B(t) = \int_0^t r(k)B^* dk - \int_0^t r(k)\frac{T^*}{\phi} dk + \int_0^t \frac{(r(k) - \phi)}{\phi} T(k) dk + \int_0^t \Gamma(k) dk + \int_0^t G(k) dk \tag{70}$$

Substitute this into $T(t) = T^* + \phi(B(t) - B^*)$ to get

$$T(t) = T^* + \phi \left(\int_0^t r(k)B^* dk - \int_0^t r(k)\frac{T^*}{\phi} dk + \int_0^t \frac{(r(k)-\phi)}{\phi} T(k)dk + \int_0^t \Gamma(k)dk + \int_0^t G(k)dk \right)$$
$$T(t) = T^* + \phi \int_0^t r(k)B^* dk - \int_0^t r(k)T^* dk + \int_0^t (r(k)-\phi)T(k)dk + \phi \int_0^t \Gamma(k)dk + \phi \int_0^t G(k)dk$$
$$T(t) = T^* + \int_0^t (\phi - r(k))r(k)B^* dk - \int_0^t r(k)G^* dk - \int_0^t (\phi - r(k))T(k)dk + \phi \int_0^t \Gamma(k)dk + \phi \int_0^t G(k)dk$$

Solve for the case with r constant

$$T(t) = T^* + \int_0^t (\phi - r)rB^* dk - \int_0^t rG^* dk - \int_0^t (\phi - r)T(k)dk + \phi \int_0^t \Gamma(k)dk + \phi \int_0^t G(k)dk$$

where ϕ and r are constants, and $\Gamma(k)$ is a given function. Differentiating both sides with respect to t gives:

$$\frac{dT(t)}{dt} = (\phi - r)T(t) + \phi \left[\Gamma(t) + G(t)\right]$$

From now on, we drop $G(t)$ as we keep it constant in our policy experiments.

This results in a first-order linear differential equation:

$$\frac{dT(t)}{dt} - (\phi - r)T(t) = \phi\Gamma(t).$$

The general solution to a first-order linear differential equation of the form:

$$\frac{dy}{dt} + P(t)y = Q(t) \qquad \text{is given by} \qquad y(t) = e^{-\int P(t)\,dt} \left(\int e^{\int P(t)\,dt} Q(t)\,dt + C \right),$$

where C is the constant of integration. For our equation:

$$P(t) = -(\phi - r), \quad Q(t) = \phi E(t).$$

The integrating factor is:

$$e^{\int (\phi - r)\,dt} = e^{(\phi - r)t}.$$

Using the integrating factor, the solution becomes:

$$T(t) = e^{(\phi - r)t} \left(\int_0^t e^{-(\phi - r)s} \phi\Gamma(s)\,ds + C \right),$$

where C is the constant of integration. Starting from the steady state gives $C = T^*$. Now, denoting $dT(t) = T(t) - T^*$ and $d\Gamma(t) = \Gamma(t) - \Gamma^* = \Gamma(t)$, where the last equality falls from transfers being zero in steady state. We get

$$dT(t) = e^{(\phi-r)t}\left(\int_0^t e^{-(\phi-r)s}\phi d\Gamma(s)\, ds\right)$$

Now, plugging the above into our MVPF formula in Definition 4 we get

$$\text{MVPF} = \frac{\boldsymbol{\Omega}^{\boldsymbol{\Gamma},\boldsymbol{E}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{N,E} d\mathbf{N}}{\int_{s\geq 0} e^{-rs}\left[dT(s) - \tau_{ss} dY(s)\right] ds} \tag{71}$$

$$= \frac{\boldsymbol{\Omega}^{\boldsymbol{\Gamma},\boldsymbol{E}} d\boldsymbol{\Gamma} + \boldsymbol{\Omega}^{N,E} d\mathbf{N}}{\int_{s\geq 0} e^{-rs}\left[\left(e^{(\phi-r)s}\left(\int_{t=0}^{s} e^{-(\phi-r)t}\phi d\Gamma(t)\, dt\right)\right) - \tau_{ss} dY(s)\right] ds} \tag{72}$$

E Generalized HANK Model Appendix

E.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[34]. 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.[35]. 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.[36]

With the valuable lessons learned from the Great Recession, the outbreak of Covid-19 pandemic saw immediate calls for debt relief policies[37]. The CARES Act of March 2020 granted forbearance

[34]" *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)

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

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

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

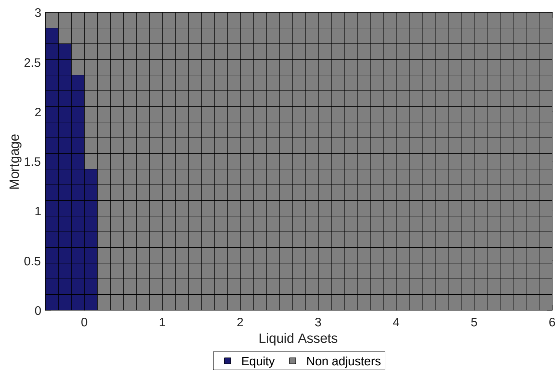
on debt payments for most credit types including residential mortgages, auto, revolving, and student debt. The choice to enter forbearance was optional[38] and once the moratorium period ended the borrowers had the choice to add the missed payments as amortization in their existing schedule or do a one 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"

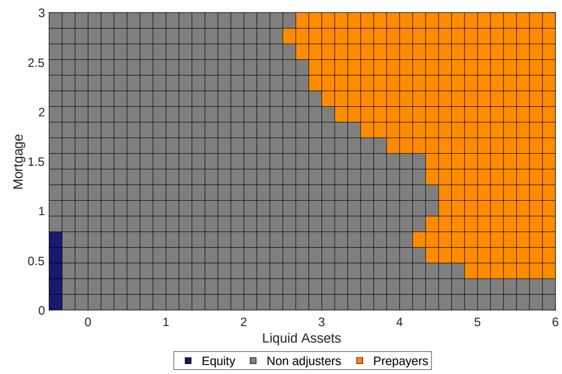
[38] Except all federal student loans which were automatically entered to forbearance and their interest rate set to zero percent (Cherry et al., 2021)

E.2 Steady State of the Model

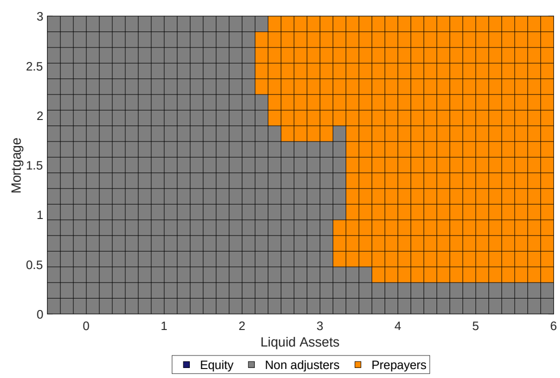
FIGURE 15: ADJUSTMENT REGIONS FOR HOUSEHOLDS WITH DIFFERENT INCOME LEVELS



(A) ADJUSTMENT REGION FOR NILF HOUSEHOLDS



(B) ADJUSTMENT REGION FOR LOW-INCOME HOUSEHOLDS



(C) ADJUSTMENT REGION FOR HIGH INCOME HOUSEHOLDS

Notes: The above plots show the mortgage account adjustment regions in the steady state across the liquid asset and income distribution for different income states.

F 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 45, 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 44, solves the following:

$$\int_0^\infty e^{-\rho t} \left(\int \left\{ u(c_t(a,y)) - v\left(\int_0^1 \gamma_i n_{k,t} dk \right) d\mu_t \cdot \mathbb{1}[i_3 \in e^E] \right\} - \frac{\Psi}{2} \left(\frac{\dot{w}_{k,t}}{w_t} \right) \right) dt \tag{73}$$

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

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

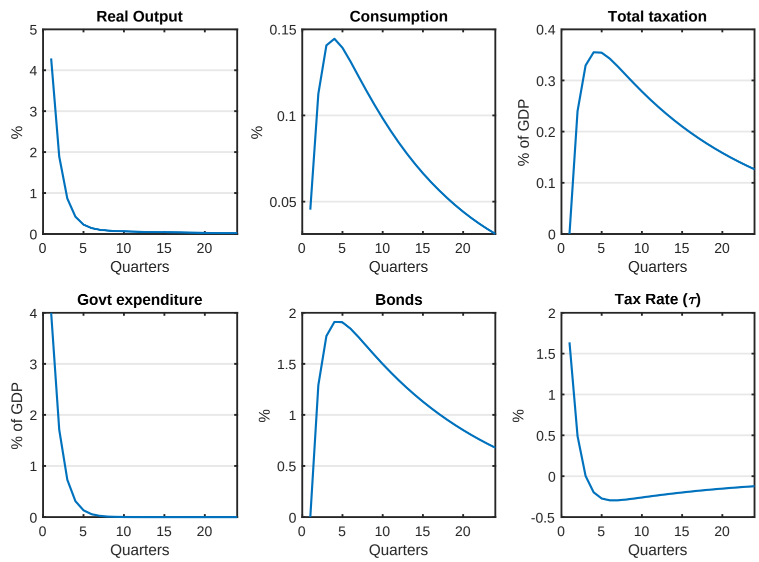
The subsidy is by lump-sum taxes. For each employed household the funds from the wage subsidy are offset by the lump-sum taxes, leaving post-tax income as specified in the household problem.

G Policy IRFs

The figures below display the IRFs to each of the policies detailed in Section 5.4.

G.1 Government spending

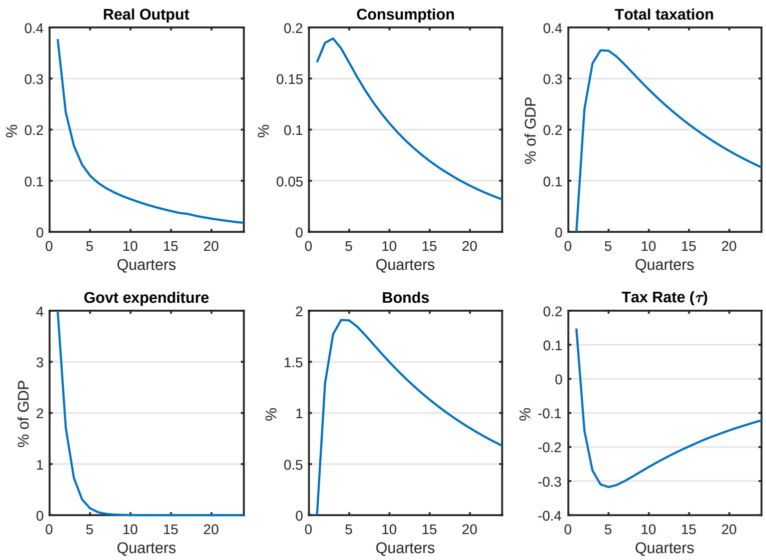
FIGURE 16: IRF TO GOVERNMENT SPENDING



Notes: All plots are presented as percentage deviations from steady-state levels or, when specified, deviations as a percentage of steady-state output.

G.2 Uniform Transfers

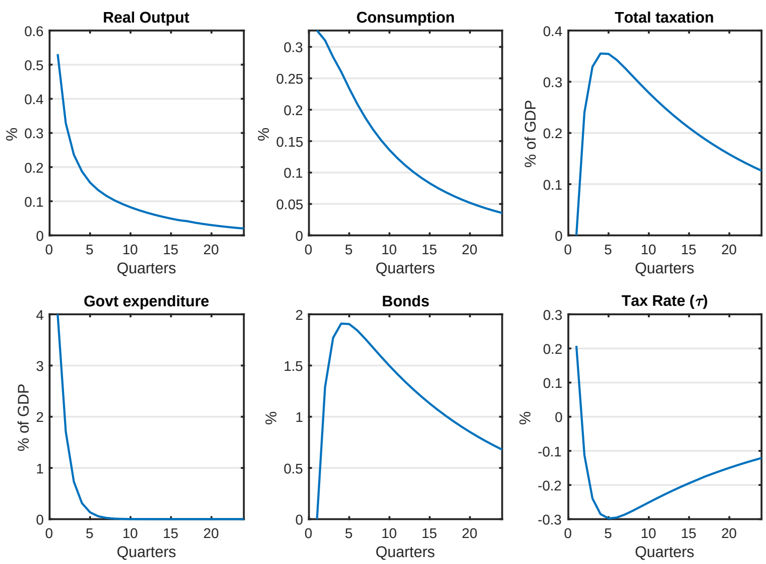
Figure 17: IRF to Transfer - Uniform



Notes: All plots are presented as percentage deviations from steady-state levels or, when specified, deviations as a percentage of steady-state output.

G.3 Transfers to low-income households

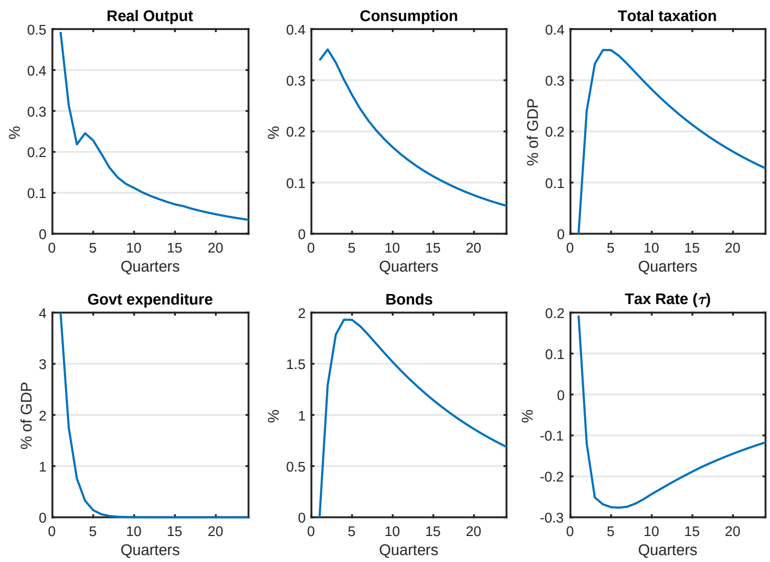
Figure 18: IRF to Transfer - Low Income



Notes: All plots are presented as percentage deviations from steady-state levels or, when specified, deviations as a percentage of steady-state output.

G.4 Transfers to mortgage holders

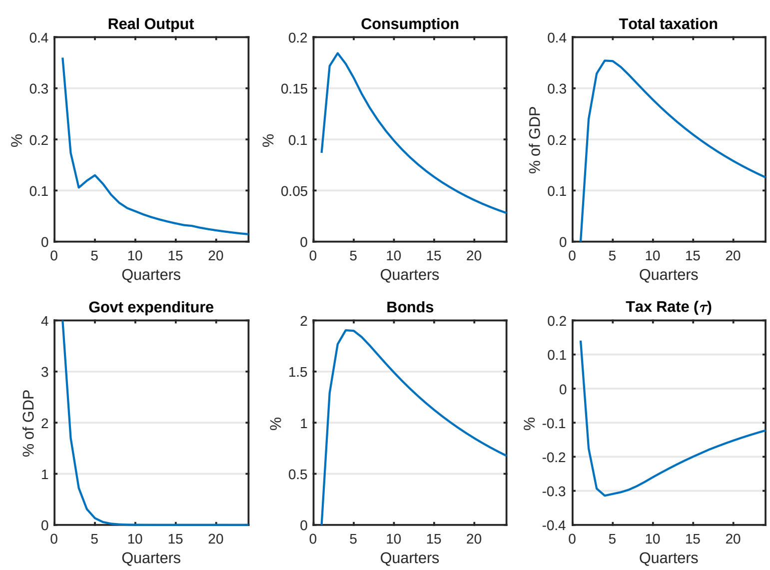
Figure 19: IRF to Transfer - Mortgage



Notes: All plots are presented as percentage deviations from steady-state levels or, when specified, deviations as a percentage of steady-state output.

G.5 Transfers to mortgage account

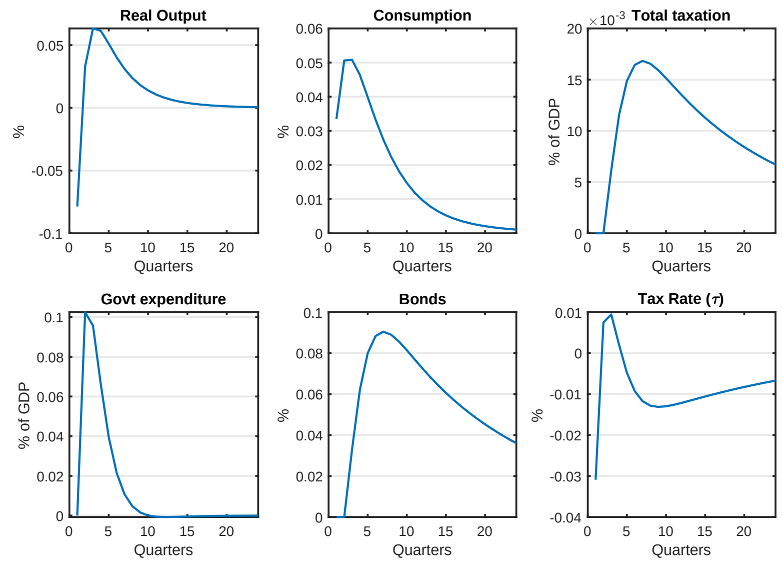
Figure 20: IRF to Mortgage Relief



Notes: All plots are presented as percentage deviations from steady-state levels or, when specified, deviations as a percentage of steady-state output.

G.6 UI extensions

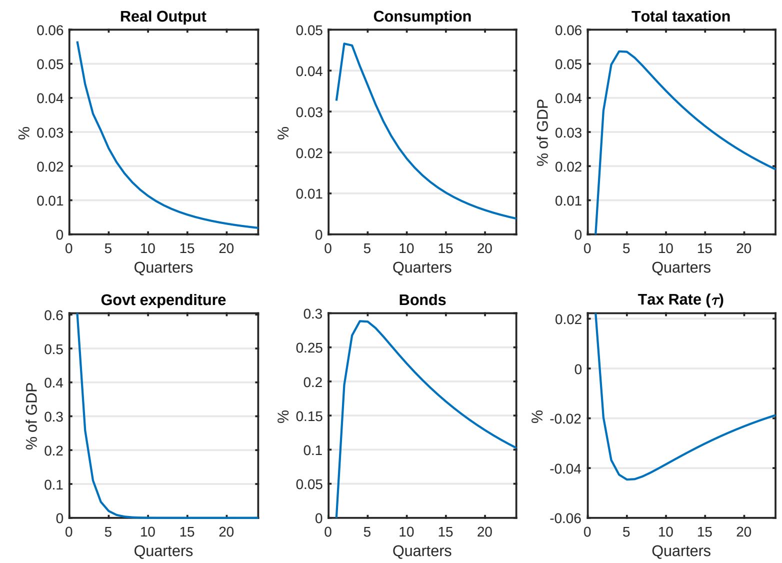
Figure 21: IRF to UI extensions



Notes: All plots are presented as percentage deviations from steady-state levels or, when specified, deviations as a percentage of steady-state output.

G.7 UI generosity

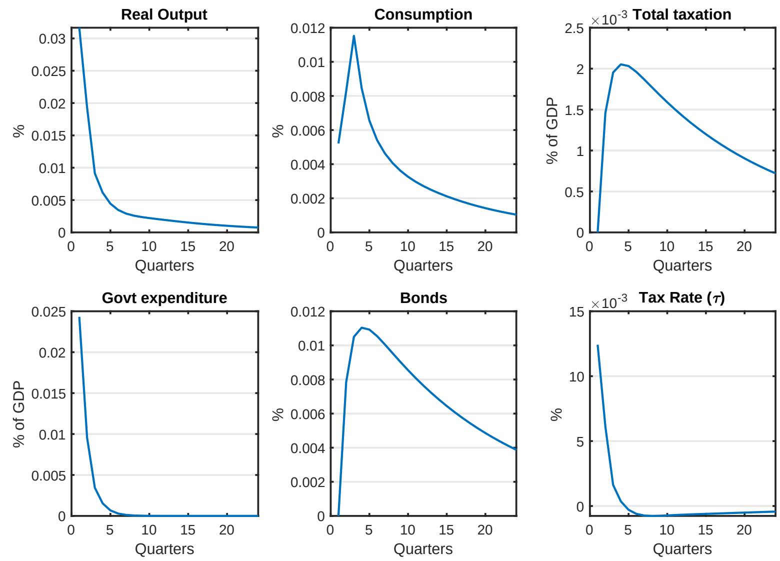
Figure 22: IRF to UI generosity



Notes: All plots are presented as percentage deviations from steady-state levels or, when specified, deviations as a percentage of steady-state output.

G.8 Mortgage moratoriums

FIGURE 23: IRF TO MORTGAGE MORATORIUMS



Notes: All plots are presented as percentage deviations from steady-state levels or, when specified, deviations as a percentage of steady-state output.

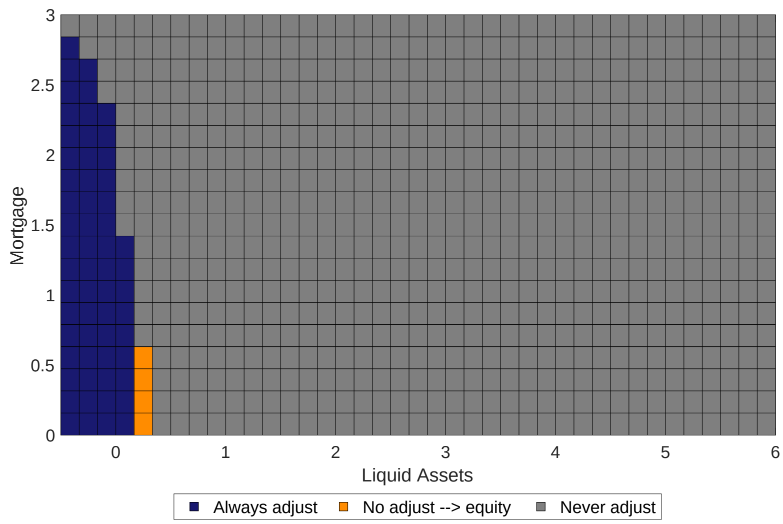
H How does the moratorium option works?

Figure 24 demonstrates how the moratorium policy affects the decision to draw equity from the mortgage account. By subsidizing the equity withdrawal cost (κ^{adj}), the policy is able to endogenously generate more equity withdrawal. Specifically, households 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 mortgage account

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

The Type A individuals often have very low liquid assets, draw equity even without the moratorium. Meanwhile, Type C households are already at their optimal portfolio composition and hence are not affected by the moratorium option. Type B individuals who would like to increase their consumption by adjusting, but do not find it worthwhile to pay the fixed cost. By reducing the adjustment cost from κ^{eq} to $\kappa^{mora} = \kappa^{eq} - \tau^{m}$, the policy is able to increase consumption by specifically targeting these individuals. This limits the scope of the policy as it only affects a small proportion of households.

FIGURE 24: INITIAL PERIOD MORTGAGE MORATORIUM TAKERS - LOWEST INCOME STATE



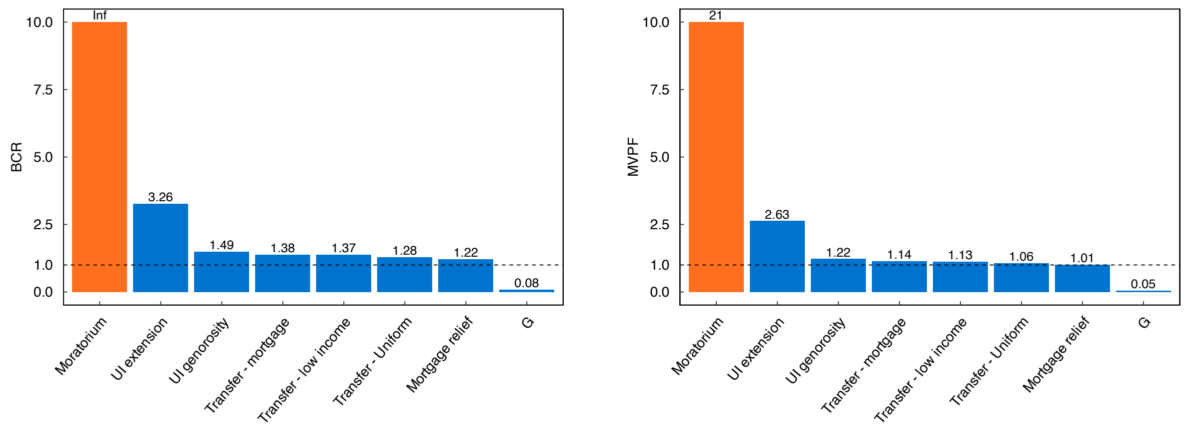
Notes: The figure above shows the change in the equity withdrawal decision in the initial period following the mortgage moratorium shock across liquid assets and mortgage balances. The blue represents the area of the state space where households choose to draw equity from their house in steady state and under the moratorium policy, the grey represents households that do not draw equity in steady state and under the moratorium policy, and the oranage represents households that in steady state do not draw equity but then choose to draw equity under the moratorium policy.

I Policy evaluation from a baseline recession

We also evaluate the BCR and MVPF of the same policies in Section 5.4 but starting from a baseline recession.[39] We highlight a few key points. First, the order of the policies by BCR remains unchanged. Second, the ordering and magnitudes of policies by MVPF are similar with the exception of moratoriums, which now have a finite MVPF. This occurs because under the baseline recession, the multiplier on moratoriums becomes slightly smaller, which in turn means the policy does not become fully self-financing from the perspective of the government. However, using the BCR formulation, the moratorium welfare 'costs' are completely offset. Lastly, it is worth highlighting that government spending has a positive BCR and MVPF starting from a recession, but still has values less than 1.

[39]We generate a recession through a Taylor rule shock of 0.04 with a decay rate of 0.3.

Figure 25: BCR and MVPF of different policies under baseline recession



Notes: The figure above shows the BCR and MVPF of the same policies in Section 5.4 but starting the economy from a baseline recession. This recession is induced by a Taylor rule shock of size 0.04 and a decay rate of 0.3. The bars in orange represent BCR/MVPF numbers that go beyond the scale of the plot. Numbers on top bars represent the calculated BCR/MVPF of the policy.