Stimulus effects of common fiscal policies*

Tobias Broer†, Jeppe Druedahl‡, Karl Harmenberg§, Erik Öberg¶

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Abstract

We study the output responses to common fiscal transfer policies in a macroeconomic framework with a frictional labor market, incomplete asset market and nominal rigidities. The framework admits data-consistent macro-level dynamics of unemployment transitions and micro-level consumption responses to job loss, making it suitable for comparing the stabilizing effects of several household transfer policies and firm subsidies. Despite its richness, the model's sequence-space representation is analytically tractable as a directed cycle graph between three blocks. This allows an "information-poor" ranking of fiscal multipliers on the basis of their partial-equilibrium fiscal costs alone, and identifies their key determinants. A baseline calibration predicts large differences in fiscal multipliers across policies. Relative to an increase in government consumption, the efficacy of universal or conditional transfers to households hinges on the degree of partial consumption insurance (through marginal propensities to consume and the response of precautionary savings). The relative efficacy of firm transfers depends on the elasticities of vacancies and separations to job values, the marginal propensity to consume out of dividend income, and the degree of nominal frictions.

Keywords: Fiscal Policy, Heterogeneous Agents, Precautionary Savings, Frictional Labor Markets, Sequence Space

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†Paris School of Economics, IIES Stockholm University and CEPR. tobias.broer@psemail.eu.

‡University of Copenhagen and CEBI. jeppe.druedahl@econ.ku.dk.

§University of Oslo and HOFIMAR at BI Norwegian Business School. karl.harmenberg@econ.uio.no.

¶Uppsala University, CeMoF and UCLS. erik.oberg@nek.uu.se.

1 Introduction

The macroeconomic literature on fiscal stimulus policy centers around the size of *the* fiscal multiplier to government consumption shocks.[1] In practice, fiscal stimulus policy often comes as transfers to private households and firms, which can take many different forms. This has become ever so clear in recent years: since the Great Recession, governments have spent unprecedented resources on a multitude of discretionary transfer measures to sustain their economies, ranging from stimulus checks, unemployment benefit extensions, and short-time work schemes to different job-creation subsidies. In this paper, we quantify the heterogeneity in fiscal multipliers across such commonly used transfer policies, and investigate the underlying determinants of this heterogeneity.

We propose a structural general-equilibrium framework with pricing frictions in the goods market, incomplete asset markets, and search frictions in the labor market. Despite the model's richness, we show that we can analyze fiscal propagation in the model as a circular transmission of shocks through three blocks associated with, respectively, each of the three types of frictions. This reduction of model complexity allows us to identify, in part analytically, the model features and parameters that make different policies effective at stimulating output. The benchmark calibration of our framework implies strong differences in cumulative fiscal multipliers across different transfer policies, which range from 0.3 to 1.6. Relative to the benchmark of government consumption, the efficacy of transfers to households—in the form of universal stimulus checks or conditional transfers to the (long-term) unemployed—is particularly sensitive to the degree of partial consumption insurance that determines marginal propensities to consume (MPCs) and their effects on precautionary savings. The efficacy of transfers to firms—in the form of retention or hiring subsidies—hinges on the elasticity of separation and vacancy posting to firm profits, the marginal propensity of households to consume out of dividend payments, and the degree of nominal frictions.

Our model is of the kind that Kaplan et al. (2018) and Ravn and Sterk (2021) dubbed Heterogeneous-Agent (HA) New-Keynesian (NK) models with Search-And-Matching (SAM) frictions. Its elements are as follows: on the household side, the consumption-saving responses to changes in household transfers and taxes depend, in particular, on different households' propensities to consume transfer payments and on movements in precautionary savings in response to policy-

[1] See Auclert et al. (2024) for a summary and an analysis based on the recent literature using models with rich household heterogeneity, Christiano et al. (2011) for a summary of the older literature and an analysis in a representative-agent framework, and Ramey (2016) for a summary of the empirical literature.

induced changes in income risk. Our framework therefore includes rich household heterogeneity, with incomplete asset markets, endogenous idiosyncratic income risk, and a share of households that always consume hand-to-mouth (HtM), calibrated to capture the degree of consumption insurance observed in the U.S. economy. To capture the endogenous nature of job creation and employment risk in the U.S., our framework features a labor market with search-and-matching frictions, unemployment-duration-dependent search efficiency, endogenous separations, and sluggishness in vacancy creation that replicate observed lead-lag dynamics of separations and job finding. By matching the responses of both match creation and separation to innovations in productivity, we also discipline the effects on hiring and firing of any policy-induced movement in the revenue product of labor, which are key determinants of the supply-side effect of firm subsidies. Finally, to create realistic general-equilibrium feedback between household consumption-saving choices and firm hiring-and-firing decisions, our framework includes nominal rigidities in the goods market. The monetary arm of the government operates a standard monetary policy rule. The fiscal arm finances an unemployment insurance system and interest rate payments on outstanding debt through collecting labor income taxes, and adjusts the debt stock to smooth taxes in response to aggregate shocks.

With this framework, we study the stimulative effect of three types of transfers to households– homogeneous cash transfers to all households, and extensions of the duration or generosity of unemployment benefits– as well as two types of transfers to firms–retention subsidies to existing firms, and job-creation subsidies to new firms. We recast and solve the model in sequence space, following Auclert et al. (2023a). Key to our analysis is that the sequence-space equilibrium can be described as a *directed cycle graph* (DCG) between three model blocks: an HA block, reflecting the asset market equilibrium given the sequence of household income determined in the labor market; an NK block, reflecting the goods market equilibrium given the real interest rate sequence determined in the asset market; and a SAM block, reflecting the labor market equilibrium, given the sequence of markups in the goods market. This characterization reduces model complexity and allows us analytically characterize several model properties. In particular, the equilibrium response to any of the considered fiscal shocks can be written as infinite geometric sum of cycles in the DCG. As such, the equilibrium propagation can be decomposed into a policy-specific first-round partial-equilibrium effect and a policy-invariant general-equilibrium feedback loop. This result comes together with an intuitive determinacy condition: a unique equilibrium is obtained as long as each block defines a unique bounded mapping from input to output sequences and the circular interaction between the blocks is not too strong, such that the geometric sum is bounded. Moreover, the decomposition implies that we can learn about the heterogeneity of fiscal multipliers across different policies in general equilibrium by studying the fiscal cost of spending policies in partial equilibrium. In particular, the relative efficacy of fiscal multipliers associated with different household transfer policies only depends on parameters contained in the HA block, and, in the limit of negligible market incompleteness, the relative efficacy of firm subsidies only depends on parameters in the SAM block.

The analytical results provide a basis for interpreting the quantitative analysis, which focuses on cumulative fiscal multipliers (defined as the policy-induced accumulated increase in output relative to that in taxes) and their determinants. We illustrate how the average level of multipliers hinges on the general-equilibrium interaction of nominal frictions (including the reactivity of monetary policy, in the NK block), the degrees of debt financing and of market incompleteness (in the HA block), and the elasticities of hiring and firing (in the SAM block). In our calibration to U.S. data these frictions combine to a benchmark government-spending multiplier slightly below one. In comparison, household transfer policies have fiscal multipliers of 0.3 (for universal transfers), of 0.4 (for increasing the level of unemployment benefits), and slightly above 1 (for extending unemployment benefit duration). As indicated by our analytical results, the efficacy of these household transfers relative to the benchmark policy is determined by the structure of the HA block, so independent of nominal and labor-market frictions. Our quantitative analysis shows that the structure of partial consumption insurance is key, since with full insurance, all household transfer multipliers shrink to zero. A high average MPC thus boosts relative transfer multipliers, while an increase in the precautionary savings motive boosts those of unemployment insurance policies, especially of duration extensions. A move from debt to tax financing reduces in particular the multipliers of policies that are less well targeted, increasing the spread of relative multipliers.

Turning to firm transfers, hiring subsidies have a fiscal multiplier of 0.7, substantially smaller than that of retention subsidies, equal to 1.6. In line with the theoretical prediction for the particular case of complete asset markets, this ranking of firm transfer policies is invariant to parameter changes outside the SAM block. We show how retention subsidies are relatively more stimulative partly because, in our calibration to U.S. labor-market transitions, separations respond relatively stronger to fluctuations in match values than vacancy creation. We also show that both the absolute and the relative size of firm transfer multipliers are sensitive to the distribution of intermediate-goods fims' profits that are strongly boosted by firm transfers. In our baseline model, profit income is evenly distributed to all households, such that the average MPC out of profit income equals that of uniform transfers. In an alternative environment where almost all profits accrue to a small set of permanent-income consumers, the hiring and retention subsidy multipliers shrink considerably. Finally, the stimulus effect of firm transfers (that increase both supply and demand and thus have a limited effect on the excess demand for assets) relative to household transfers (which raise asset supply by more than demand) hinges on the degree of nominal rigidity in the NK block that determines the general-equilibrium propagation from the asset market to output.

Taken together, our model results provide guidance to an empirical research program for evaluating the efficacy of government stimulus programs. In particular, we highlight conditions under which the comparison of different transfer policies only depends on a small set of partial-equilibrium elasticities. The growing literatures on the MPC out of transitory income shocks and on precautionary saving responses provides credibility to our comparison of the different household transfer policies. There is more uncertainty regarding the marginal propensity of firms to create and destruct jobs in response to changes in match values, and the MPC out of profit income, which are key to the evaluation of firm transfer policies.

Relation to the literature

Our paper joins a recent and growing literature on the effects of fiscal stimulus policy in HANK environments. Relative to studies that quantify government-consumption multipliers in Heterogeneous-Agent New-Keynesian (HANK) environments and discuss their determinants (see, e.g., Hagedorn et al. (2019); Auclert et al. (2023b)) we show that different *kinds* of government stimulus policies differ strongly in their potency to stabilize the economy, and discuss the features of the economic environment that determine these differences.[2] A similar comparative focus is found in Carroll et al. (2023), but their analysis focuses is limited to household transfer policies in partial equilibrium with exogenous labor-market risk.

A closely related paper is Wolf (2023). He shows that the stimulus effect of a government transfer to households can be derived from micro evidence on consumption effects and general-equilibrium responses to government-consumption innovations, assuming that their respective tax paths are the same. Our result that the stimulus effect of any transfer policy can be decomposed into a policy-specific partial-equilibrium effect and a policy-invariant general-equilibrium feedback loop generalizes this insight, and highlights under which conditions the

[2] See Ramey (2011) for a survey of earlier contributions in the neoclassical and New Keynesian tradition with a representative consumer.

determinants of relative fiscal multipliers can be separated from those that shape the "average" multiplier. In so doing, our result does not hold the tax financing of different policies constant, but is instead derived under a standard financing rule.

We identify incomplete asset markets, sticky prices and a search-and-matching frictions as key features that determine the effects of fiscal policies. HANK-SAM environments with these features have previously been studied in Den Haan et al. (2018), Challe (2020), Ravn and Sterk (2021), Gornemann et al. (2021) and Cho (2023).[3] Several previous studies look at the stabilizing effect of individual labor-market-centered fiscal policies in this class of models. Dengler and Gehrke (2021) find a strong stabilizing effect of a short-time work scheme. Kekre (2023) shows how unemployment benefit extensions at longer horizons have a higher output multiplier than those at shorter horizons. McKay and Reis (2021) and Graves (2023) study the ability of institutional, i.e., expected, unemployment insurance to stabilize business cycles. Again, our focus is comparative and we highlight the model features that determine the heterogeneity in multipliers across different transfer policies.

Relative to all these studies, we show that a careful quantification of unemployment risk, including the dynamic responses of separation and job-finding rates to business-cycle shocks, is an important factor for the propagation of business cycles and of fiscal policy. In so doing, we build on the literature that has studied the consumption effects of cyclical income risk, see, e.g., Challe and Ragot (2016), McKay (2017), and Harmenberg and Öberg (2021). We also build on the literature that has studied which features of the labor market are needed to generate such cyclicality. In particular, we highlight the importance of endogenous separations and sluggish vacancy creation, following Coles and Kelishomi (2018) and our own earlier work (Broer et al., 2023).

[3] The HANK-SAM abbreviation was first proposed by Ravn and Sterk (2021). Like these studies, we thus connect the literature on heterogeneous agent New-Keynesian macroeconomics without search-and-matching frictions (see, e.g., Oh and Reis, 2012; McKay and Reis, 2016; Guerrieri and Lorenzoni, 2017; Bayer et al., 2019; Hagedorn et al., 2019; Auclert et al., 2020; Luetticke, 2021), to that studying representative-agent models with frictional labor markets (see, e.g., Walsh, 2005; Krause and Lubik, 2007; Gertler et al., 2008; Trigari, 2009; Gertler and Trigari, 2009; Galí, 2010; Ravenna and Walsh, 2012; Christiano et al., 2016, 2021).

2 Model

2.1 Overview

Our model extends the zero-liquidity environment in our earlier work (Broer et al., 2023), which in turn extends that of Ravn and Sterk (2021). The economy consists of infinitely-lived workers indexed by $i \in [0,1]$, different types of firms, and a government. A mass θ of the workers consume their income hand-to-mouth (HtM), while the remaining workers self-insure against unemployment risk by accumulating government bonds.[4] Households can be employed, in which case they provide one unit of labor, or unemployed.

Production has three layers:

1. Intermediate-goods producers can hire labor by posting vacancies if they pay a one-time stochastic entry cost. Once matched with a worker, they produce Z_t units of a homogeneous good sold in a perfectly competitive market at price P_t^X. Stochastic idiosyncratic cost shocks imply that a time-varying fraction of them terminates their match every period.

2. Wholesale firms buy intermediate goods and produce differentiated goods that they sell in a market under monopolistic competition. The wholesale firms set their prices subject to a Rotemberg (1982) adjustment cost.

3. Final-good firms buy goods from wholesale firms and bundle them into a final good, which is sold in a perfectly competitive market.

The government issues bonds and collects taxes to finance an unemployment-insurance system, and discretionary fiscal expenditures. A monetary authority sets the interest rate according to a Taylor rule.

The model has no aggregate risk, we solve for perfect-foresight paths in response to unexpected ("MIT") shocks. In response to small enough shocks, the perfect-foresight solutions are first-order approximations to the rational-expectations equilibrium where these shocks are drawn from stochastic processes (Boppart et al., 2018).

We first describe the within-period timing in the model, then the remaining model equations. We color all variables that are subject to fiscal policy shocks with the color blue.

[4] One may think of hand-to-mouth households as having preferences implying a sufficiently strong degree of impatience to make them constrained in equilibrium.

2.2 Timing

Step 0: Stocks and shocks. At the beginning of each period t, all aggregate shocks are revealed. The endogenous labor-market state variables are the (beginning-of-period) stocks of unemployed workers u_{t-1} and of vacancies v_{t-1}.

Step 1: Vacancy creation and destruction. Vacancies are destroyed, for simplicity, at a constant rate equal to the steady state separation rate, δ_{ss}. For idle firms, firm-specific costs of entering the labor market are realized and firms that pay this cost post a new vacancy, generating an endogenous, time-varying vacancy entry rate ι_t. The post-entry-and-destruction vacancy rate is denoted by $\tilde{v}_t$, and is given by

$$\tilde{v}_t = (1 - \delta_{ss})v_{t-1} + \iota_t. \tag{1}$$

Step 2: Separations and matching. Matched firms realize a continuation-cost shock, and decide whether to continue or exit, implying an endogenous, time-varying separation rate δ_t. Concurrently, unemployed workers and vacancies match randomly. The matching technology is Cobb-Douglas with matching elasticity α. Market tightness is denoted by

$$\theta_t = \frac{\tilde{v}_t}{S_t u_{t-1}} \tag{2}$$

where S_t is the average search intensity of workers (described below). The job-filling rate λ_t^v and job-finding rate λ_t^u are given by

$$\lambda_t^v = A\theta_t^{-\alpha}, \tag{3}$$
$$\lambda_t^u = A\theta_t^{1-\alpha}. \tag{4}$$

The resulting stocks of (end-of-period) unemployed workers and vacancies evolve according to

$$u_t = (1 - \lambda_t^u)u_{t-1} + \delta_t(1 - u_{t-1}), \tag{5}$$
$$v_t = (1 - \lambda_t^v)\tilde{v}_t. \tag{6}$$

Step 3: Production, consumption and saving. Production takes place, dividends and wages are paid, taxes are levied. All workers, both employed and unemployed, make their consumption-saving decisions and the asset and goods markets clear.

2.3 Intermediate goods producers

A continuum of firms produce a homogeneous intermediate good X_t sold in a competitive market. The real price of the intermediate good, relative to that of the numeraire, is P_t^X and one unit of labor produces Z_t units of the intermediate good. The total production of intermediate goods is thus given by

$$X_t = Z_t(1 - u_t). \tag{7}$$

To hire a worker, firms must post vacancies which are filled with probability λ_t^v, taken as given by each one-worker firm.

Match value and separations. The value of a match for the firm is denoted by V_t^j. While the actual stochastic discount factors are heterogeneous in the population, we assume for simplicity that the firms discount profits at the steady-state risk-free interest rate, which in equilibrium equals the time preference parameter β. To produce, a firm must pay a virtual continuation cost $\chi_t \sim G$ at the beginning of the period.[5] There is no additional heterogeneity among operating firms. Consequently, there exists a common cost cutoff $\chi_{c,t}$, such that for all $\chi_t > \chi_{c,t}$, firms choose to separate. The Bellman equation for the value of a match after the separation decision is

$$V_t^j = P_t^X Z_t - W_t + \mathrm{rs}_t + \beta \int^{\chi_{c,t+1}} (V_{t+1}^j - \chi_{t+1}) dG(\chi_{t+1}) \tag{8}$$

where W_t is the real wage, and rs_t is a transfer that may be paid out by the government in the event of a successful match. Upon receiving such a transfer, the cutoff value for separations $\chi_{c,t}$ increases—we therefore call these transfers *retention subsidies*. We choose the functional form of

[5] Following Mortensen and Pissarides (1994), separation decisions are typically modeled as a result of idiosyncratic productivity shocks, such that low-productivity firms optimally decide to exit. The assumption of stochastic idiosyncratic continuation cost shocks have similar material consequences, but avoids ex-post heterogeneity in firm outcomes.

G so that total separations δ_t respond with a constant elasticity ψ to the value of a match V_t^j,[6]

$$\delta_t = \delta_{ss} \left(\frac{V_t^j}{V_{ss}^j} \right)^{-\psi}. \tag{9}$$

In the special case with $\psi = 0$, separations occur exogenously at rate δ_{ss}.

Vacancy creation. The value of a vacancy is denoted by V_t^v. Its Bellman equation is

$$V_t^v = -\kappa + \lambda_t^v (V_t^j + \text{hs}_t) + (1 - \lambda_t^v)(1 - \delta_{ss}) \beta V_{t+1}^v \tag{10}$$

where κ is a vacancy-posting cost to be paid every period, and hs_t is a transfer that may be paid out by the government. Vacancies are destroyed with exogenous probability δ_{ss}. Vacancy creation stems from a constant mass F of prospective firms that in each period draw a stochastic virtual idiosyncratic entry cost c from a distribution H. The prospective firm posts a vacancy if and only if the realized entry cost is larger than a common reservation entry cost, equal to the value of a vacancy. Upon receiving a transfer from the government, the reservation entry cost increases—we therefore call these transfers *hiring subsidies*.

The total number of vacancies created is $\iota_t = F \cdot H(V_t^v)$. Following Coles and Kelishomi (2018), we choose the functional form of H so that vacancy creation ι_t responds with a constant elasticity ξ to the value of a vacancy V_t^v,[7]

$$\iota_t = \iota_{ss} \left(\frac{V_t^v}{V_{ss}^v} \right)^{\xi}. \tag{11}$$

Wage rule. For the wage rule, we follow Hall (2005) and assume that real wages are fixed,

$$W_t = W_{ss}. \tag{12}$$

[6] The continuation-cost distribution G is a mixture of a point mass and a Pareto distribution with shape parameter ψ, location parameter Υ and mixture parameter p. We choose p and Υ so that in steady state, job separations are δ_{ss} and the continuation costs are approximately zero, $\mu_{ss} \approx 0$. See Appendix A for details.

[7] The entry-cost distribution has a cumulative distribution function $H(c) = F \cdot (c/h)^{\xi}$ on $c \in [0, h]$. With the parameter h sufficiently large so that $h > V_t^v$, the resulting number of vacancies created is $\iota_t = F \cdot (V_t^v)^{\xi}$. In the limit where $\xi \to \infty$, we must have $V_t^v = V_{ss}^v$ so that all entrants pay the same deterministic entry cost. We set $V_{ss}^v = \kappa_0$ and treat κ_0 as a free parameter. The free entry model is the double limit $\xi \to \infty$ and $\kappa_0 \to 0$, which implies $V_t^v = 0$. To facilitate comparisons with the free entry model we fix κ at a small positive value across all calibrations.

In Section 5, we consider a specification with endogenous wages.

2.4 Wholesale and final goods producers

A continuum of wholesale firms indexed by $k \in [0,1]$ produce differentiated goods using the production function $Y_{kt} = X_{kt}$ where X_{kt} is the amount of the intermediate good purchased by firm k at the intermediate-good price P_t^X. The representative final-good firm has the production function $Y_t = \left(\int_k Y_{kt}^{\frac{\epsilon_p - 1}{\epsilon_p}} dk\right)^{\frac{\epsilon_p}{\epsilon_p - 1}}$ where Y_{kt} is the quantity of the input of wholesale firm k's output used in production. The implied demand curve is $Y_{kt} = \left(\frac{P_{kt}}{P_t}\right)^{-\epsilon_p} Y_t$ where $P_t = \left(\int_k P_{kt}^{1-\epsilon_p} dk\right)^{\frac{1}{1-\epsilon_p}}$ is the aggregate price level. The wholesale firms face virtual price adjustment costs, with scale factor ϕ. Since production is linear, the marginal cost of production is the input price P_t^X. In a symmetric equilibrium, optimal price setting implies a standard Phillips curve where $\Pi_t = \frac{P_t}{P_{t-1}}$ is the gross inflation rate:

$$1 - \epsilon_p + \epsilon_p \cdot P_t^X = \phi(\Pi_t - 1)\Pi_t - \beta\phi(\Pi_{t+1} - \Pi_{ss})\Pi_{t+1}\frac{Y_{t+1}}{Y_t}. \tag{13}$$

Total output is given by

$$Y_t = \int_k X_{kt} dk = 1 - u_t. \tag{14}$$

2.5 Dividends

All adjustment costs are assumed to be virtual. Total dividends are thus

$$\begin{aligned} \mathrm{div}_t &= Y_t - (W_t - \mathrm{rs}_t)(1 - u_t) + \mathrm{hs}_t \lambda_t^v \tilde{v}_t \\ &= (1 - W_t - \mathrm{rs}_t)(1 - u_t) + \mathrm{hs}_t \lambda_t^v \tilde{v}_t. \end{aligned} \tag{15}$$

Dividends are distributed equally to all households. The government levies a lump-sum tax equal to the steady state value of dividends, such that only the cyclical fluctuations of dividend income, but not it steady state level, affect household consumption-saving decisions. In Section 5, we consider different profit distribution arrangements.

2.6 Households

Worker problem. A mass Θ of the workers consume income hand-to-mouth. The remaining workers may self-insure against unemployment risk by accumulating government bonds. All workers face the same earnings process.

Earnings process. The worker earnings process $y(u_{it})$ captures the key features of the US unemployment insurance system, in particular the duration dependence in replacement rates and limited take-up rates. If $u_{it} = 0$, then the worker is employed and receives wage W_t. For $u_{it} > 0$, u_{it} denotes months of unemployment. With probability π^{UI} the worker claims the unemployment benefit and receives a high replacement rate $\overline{\phi}_t$ for the first $\overline{u_t}$ months and a lower replacement rate $\underline{\phi}$ thereafter. With probability $1 - \pi^{UI}$, the worker receives the lower replacement rate directly, allowing for limited take up. We include time subscripts on the replacement rate $\overline{\phi}_t$ and the UI duration $\overline{u}_t$, as these are subject to shocks. If $\overline{u}_t$ is not an integer (as in our policy experiment, where we consider a marginal change to UI duration), the worker receives a weighted average of the high and the low replacement rate in the month of expiration. Let E_{it} be an indicator for those households that claim unemployment benefits.

We summarize the earnings process as,

$$y_t(u_{it}, E_{it}) = \begin{cases} W_t & \text{if } u_{it} = 0, \\ \mathrm{UI}_{it}\overline{\phi_t}W_t + (1 - \mathrm{UI}_{it})\underline{\phi}W_t & \text{otherwise,} \end{cases} \tag{16}$$

where

$$\mathrm{UI}_{it} = \begin{cases} 1 & \text{if } u_{it} \leq \overline{u}_t \text{ and } E_{it} = 1, \\ u_{it} - \overline{u_t} & \text{if } u_{it} \in (\overline{u}_t, \overline{u_t} + 1) \text{ and } E_{it} = 1, \\ 0 & \text{if } u_{it} \geq \overline{u}_t + 1 \text{ or } E_{it} = 0. \end{cases} \tag{17}$$

Employed workers transit to unemployment with the separation probability δ_t. To capture the observed decline in job-finding rates for workers with longer unemployment duration, the search intensity of an unemployed worker depends, exogenously, on the length of the unemployment spell. Let u_{it-1} denote the length of the unemployment spell of worker i at the end of period $t - 1$ (with $u_{i,t-1} = 0$ indicating that the worker was employed). Then the worker-specific job-finding rate is given by $\lambda^u_{it} = A\theta_t^{1-\alpha}s(u_{it-1})$ and the average economy-wide search effort is given by $S_t = \mathbb{E}_i[s(u_{it-1})|u_{it-1} > 0]$. The function $s(\cdot)$ is chosen in the calibration to match evidence from the U.S. on duration dependence in job-finding rates.

Total non-dividend household income before and after taxes are

$$\tilde{Y}_t^{hh} = (1 - u_t)w_t + \mathrm{UI}_t^{hh}\overline{\phi}_t + \left(u_t - \mathrm{UI}_t^{hh}\right)\underline{\phi}w_t, \tag{18}$$

$$Y_t^{hh} = (1 - \tau_t)\tilde{Y}_t^{hh}, \tag{19}$$

where $\mathrm{UI}_t^{hh} = \int \mathbb{1}\{u_{it} > 0\}\mathrm{UI}_{it}E_{it}di$ is the mass of unemployed households that take up unemployment insurance.

Value functions. The self-insuring workers can save in government bonds subject to a no-borrowing constraint, where a_{it} denotes the quantity of bond holdings at the beginning of period t. Bonds pay an ex-post real gross return R_t^{real}. A worker's state is given by her unemployment duration u_{it}, an indicator for UI take-up E_{it}, and her assets from the previous period, a_{it-1}. The self-insuring worker's Bellman equation is

$$\begin{aligned} V_t^w(u_{it}, E_{it}, a_{it-1}) = &\max_{c_{it}, a_{it}} \frac{c_{it}^{1-\sigma}}{1-\sigma} + \beta \underline{V}_{t+1}^w\left(u_{it}, E_{it}, a_{it}\right) \\ &\text{s.t. } a_{it} + c_{it} = R_t^{\text{real}} a_{it-1} + (1 - \tau_t)y_t(u_{it}, E_{it}) + T_t + \mathrm{div}_t - \mathrm{div}_{ss}, \\ &\quad a_{it} \geq 0, \end{aligned} \tag{20}$$

where $y(u_{it})$ is earnings, T_t is a uniform lump-sum transfer from the government, div_t are dividends from firm ownership, and τ_t is a flat earnings tax levied by the government.

The continuation value of the employed ($u_{it-1} = 0$) is

$$\begin{aligned} \underline{V}_t^w\left(0, E_{it-1}, a_{it-1}\right) = &(1 - \delta_t)V_t^w(0, 0, a_{it-1}) \\ &+ \delta_t \pi^{UI} V_t^w(1, 1, a_{it-1}) \\ &+ \delta_t(1 - \pi^{UI})V_t^w(1, 0, a_{it-1}) \end{aligned} \tag{21}$$

where $1 - \pi^{UI}$ is the probability that workers are not eligible for unemployment benefits.

The continuation value of the unemployed ($u_{it-1} > 0$) is

$$\begin{aligned} \underline{V}_t^w\left(u_{it-1}, E_{it-1}, a_{it-1}\right) = &\lambda_t^u s(u_{it-1})V_t^w(0, 0, a_{it-1}) \\ &+ (1 - \lambda_t^u s(u_{it-1}))V_t^w(u_{it-1} + 1, E_{it-1}, a_{it-1}). \end{aligned} \tag{22}$$

The hand-to-mouth workers face an identical earnings process, but simply consume all of the income in each period.

2.7 Fiscal policy

The government collects taxes, issues bonds and spends funds on on government consumption G_t, unemployment insurance by choosing the replacement rate $\overline{\phi}_t$ and duration $\overline{u}_t$, universal transfers to all households T_t, retention subsidies to matched firms, rs_t, and hiring subsidies to newly formed matches, hs_t.

As in Auclert et al. (2020), one unit of government bonds is a promise to a sequence of geometrically decaying coupon payments, paying out δ_q^{k-1} units of consumption k periods into the future. The government's budget is thus given by

$$q_t(B_t - \delta_q B_{t-1}) = B_{t-1} + \mathrm{expenses}_t - \mathrm{taxes}_t, \tag{23}$$

where q_t is the price of government bonds, the tax revenue is

$$\mathrm{taxes}_t = \tau_t \tilde{Y}_t^{hh} + \mathrm{div}_{ss} \tag{24}$$

and the government expenses are

$$\begin{aligned} \mathrm{expenses}_t = & \mathrm{UI}_t^{hh} \overline{\phi}_t + \left(u_t - \mathrm{UI}_t^{hh}\right) \underline{\phi} w_t \\ & + \mathrm{T}_t + G_t \\ & + \mathrm{rs}_t \cdot (1 - u_t) \\ & + \mathrm{hs}_t \cdot \lambda_t^v \tilde{v}_t. \end{aligned} \tag{25}$$

The government smooths taxes τ_t in the following way: let $\tilde{\tau}_t$ be the per-period tax rate that brings outstanding liquidity immediately back to its steady-state level $q_{ss} B_{ss}$. This is given by

$$\tilde{\tau}_t = \frac{(1 + q_t \delta_q) B_{t-1} + \mathrm{expenses}_t - q_{ss} B_{ss}}{\tilde{Y}_t^{hh}}. \tag{26}$$

The tax rate is then set as a weighted average between $\tilde{\tau}_t$ and the tax rate in steady state, τ_{ss},

$$\tau_t = \omega \tilde{\tau}_t + (1 - \omega) \tau_{ss}, \tag{27}$$

where ω determines the response in government debt. With $\omega = 1$, any increase in expenditure is fully tax financed. With $\omega = 0$, any increase in expenditure is fully debt financed.

2.8 Monetary policy and asset prices

A monetary authority sets the nominal interest rate according to a conventional Taylor rule,

$$R_t = R_{ss}\Pi_t^{\phi_\pi}, \tag{28}$$

where R_t is the ex-ante nominal interest rate on the government bonds.
The Fisher equation implies the real interest rate,

$$R_{t+1}^{\text{real}} = \frac{R_t}{\Pi_{t+1}}, \tag{29}$$

and arbitrage in the bond market implies the return of purchasing government bonds equals the real interest rate,

$$\frac{1 + \delta_q q_{t+1}}{q_t} = R_{t+1}^{\text{real}}, \tag{30}$$

with the initial capital gain or loss given by $R_0^{real} = \frac{1+\delta_q q_0}{q_{ss}}$.

2.9 Market clearing conditions

Labor supply is exogenous. The asset and goods markets both clear when

$$A_t^{hh} = q_t B_t, \tag{31}$$

$$Y_t = G_t + C_t^{hh} + C_t^{\text{cap.}}. \tag{32}$$

3 Analytical characterization

In this section, we analytically characterize the transmission of policy in our model before calibrating and quantitatively evaluating different fiscal policies in the subsequent section. We analyze the perfect-foresight equilibrium response to fiscal policy shocks in sequence space (Auclert et al., 2021): at time 0 the economy is in steady state and the sequences of exogenous variables, in particular of different fiscal policies, are announced. We then trace out the perfect-foresight sequences of the endogenous variables. To a first order, the sequence-space representation can be arranged as a *directed cycle graph* (DCG) consisting of three separate and cyclically ordered blocks: the Heterogeneous-Agent (HA) block, the New Keynesian (NK) block and the Search-And-Matching (SAM) block. Each block maps sequences of its input variables into sequences of output variables that feed into the next block and the equilibrium can be described as a circular feedback loop between the blocks.

This DCG representation makes the equilibrium analytically tractable, provides simple conditions for uniqueness, and identifies the determinants of relative vs. absolute stimulus effects: household transfers and government purchases have different direct effects on demand in the first round but share a common general equilibrium multiplier. For a given targeted output stimulus, their *relative* effectiveness thus hinges only on direct fiscal costs as determined by parameters of the HA block, but is independent of the structure of the NK and SAM blocks (that determine common general equilibrium effects). For the relative effectiveness of firm transfers (for the retention and hiring of workers) a similar independence from parameters outside the SAM block holds only when incomplete-market frictions are negligible, thus providing a benchmark for the quantitative analysis in the following section.

3.1 Equilibrium as a directed cycle graph

For any variable X_t, the sequence of deviations from steady state is denoted by lowercase boldface variables, i.e. $\boldsymbol{x} = [X_0 - X_{ss}, X_1 - X_{ss}, \dots]$. The sequences of the household transfer policies and government consumption are collected in $\boldsymbol{h} = \left[\boldsymbol{g}, \boldsymbol{t}, \overline{\boldsymbol{\phi}}, \overline{\boldsymbol{u}}\right]'$ and the sequence of firm transfer policies are collected in $\boldsymbol{f} = [\boldsymbol{hs}, \boldsymbol{rs}]'$. The sequences of the variables that determine the household income, i.e. the job-separation rate, the job-finding rate, and dividends are collected in $\boldsymbol{inc} = [\boldsymbol{\delta}, \boldsymbol{\lambda^u}, \boldsymbol{div}]'$.

In the following proposition, we define a block, indexed by i, as a set of N^i equations in $N^i + N^i_{input}$ unknowns, where N^i variables are endogenous to the block and N^i_{input} variables are exogenous to the block (but may be endogenous to the full system). In addition, we say that a block satisfies *local block determinacy* if there exists a unique bounded solution to its associated system of equations.

Proposition 1. ***(A directed cycle graph)*** *The model equations can be organized as belonging to one of three blocks, an HA block, an NK block, and a SAM block, that are ordered in a circle and map sequences of input variables to sequences of output variables that are inputs to the following block. The*

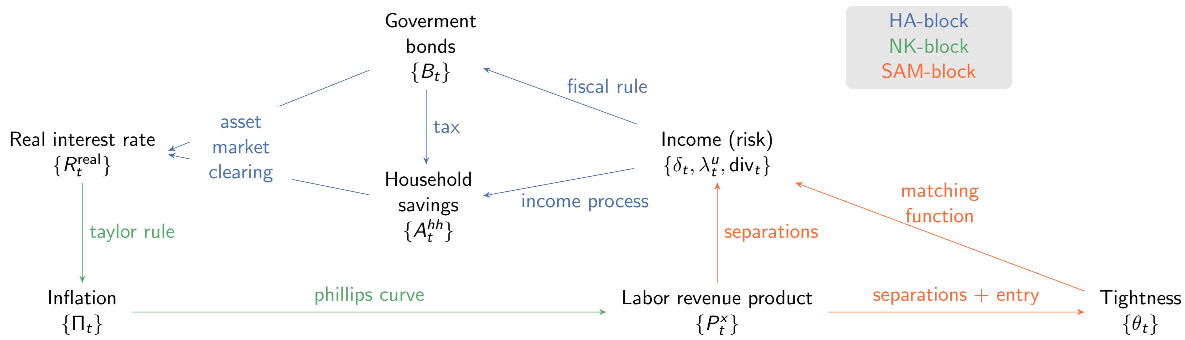

Figure 1: Equilibrium as a *directed cycle graph*.

input sequences to the HA block consist of policy variables and income components $\boldsymbol{inc}$ *determined in the SAM block. The input sequences to the SAM block consist of firm subsidies* $\boldsymbol{f}$ *and the intermediate-goods price* $\boldsymbol{p^x}$ *determined in the NK block. The inputs to the NK block consist of the real interest rate* $\boldsymbol{r^{real}}$ *determined by asset-market clearing in the HA block. Assuming local block determinacy, there exist unique matrices* $M_{HA}, M_{h,r}, M_{f,r}, M_{NK}, M_{SAM}, M_{f,inc}$ *such that a first-order approximation of the equilibrium of our model can be written as*

$$\boldsymbol{r^{real}} = M_{HA}\boldsymbol{inc} + M_{h,r}\boldsymbol{h} + M_{f,r}\boldsymbol{f}, \tag{33}$$

$$\boldsymbol{p^x} = M_{NK}\boldsymbol{r^{real}}, \tag{34}$$

$$\boldsymbol{inc} = M_{SAM}\boldsymbol{p^x} + M_{s,inc}\boldsymbol{f}. \tag{35}$$

Proof. See Appendix C. □

According to Proposition 1, each block provides a partial-equilibrium mapping from its inputs to the inputs of exactly one following block. These mappings thus form the vertices of a DCG that is illustrated in Figure 1. The HA block contains the equations describing household and government behavior. It maps sequences of labor-market flows and dividends ($\boldsymbol{inc}$), household transfer policies ($\boldsymbol{h}$) and firm transfer policies ($\boldsymbol{f}$) (that raise taxes on households) to the real interest rate that clears the market for government bonds. These mappings correspond, respectively, to the operators M_{HA}, $M_{h,r}$and $M_{f,r}$ in Equation (33).

The NK block consists of the new-Keynesian Phillips curve (13) and the Taylor rule (28). It maps the sequence of marginal costs, or intermediate-goods prices ($\boldsymbol{p^x}$), via that of inflation rates (π), to real interest rates ($\boldsymbol{r^{real}}$). Inverting this mapping provides a mapping from the sequence of the real interest rate to the intermediate-goods prices.[8] This mapping corresponds to the operator M_{NK} in Equation (34).

The SAM block consists of the equations determining vacancy creation and separation decisions of intermediate goods firms. It maps sequences of the intermediate-goods price and of firm transfer policies ($\boldsymbol{f}$) to sequences of labor-market flows and dividends ($\boldsymbol{inc}$). These mappings correspond, respectively, to the operators M_{SAM} and M_f in Equation (35).

The assumption of local block determinacy is, from a quantitative-applied perspective, weak. For example, the HA block is, in isolation, an equilibrium transition back to the stationary distribution in a Huggett (1993) model with an exogenous sequence of income components. Local block determinacy thus holds as long as a small perturbation of the exogenous income components is consistent with a unique bounded path of other endogenous variables. Correspondingly, the SAM block exhibits local block determinacy if a sequence of intermediate-goods price $\boldsymbol{p^x}$ and firm transfers $\boldsymbol{f}$ uniquely determines the dynamics of the labor market. Proving that local block determinacy holds is challenging (see, e.g., Cheridito and Sagredo (2016); Cao (2020); Pröhl (2024)) but can be verified numerically.[9]

3.2 Policy transmission through direct and general-equilibrium effects

Different shocks directly affect different blocks in Figure 1. The DCG representation means that they share a common circular transmission. This simplifies the analysis and comparison of different fiscal stimulus shocks. We provide a sufficient condition for *general-equilibrium determinacy*, and show how this implies an intuitive decomposition of the transmission of fiscal shocks.

Proposition 2. ***(Policy impulse responses)*** *Let $||\cdot||$ denote the operator norm. If $||M_{SAM}M_{NK}M_{HA}|| <$ 1, there is a unique solution to the system (33)-(35) given by*

[8] The intermediate-goods firms also delivers profits to the households. However, by Equation (15), total profits can be calculated knowing only the output of the SAM block, and we do therefore not need to consider the direct profit link from the NK block to the HA block

[9] The NK block trivially satisfies local block determinacy and the proof of Corollary 1 provides an explicit description of M_{NK} such that M_{NK}^{-1} can be explicitly constructed.

$$
\boldsymbol{inc} = \underbrace{\mathcal{G}}_{GE} \times \left(\underbrace{M_{SAM} M_{NK} \underbrace{M_{h,r} \boldsymbol{h}}_{direct}}_{\text{first round, household transfer policy}} + \underbrace{M_{SAM} M_{NK} \underbrace{M_{f,r} \boldsymbol{f}}_{direct} + \underbrace{M_{f,inc} \boldsymbol{f}}_{direct}}_{\text{first round, firm transfer policy}} \right), \tag{36}
$$

where $\mathcal{G}$ is defined by

$$
\mathcal{G} = (I - M_{SAM} M_{NK} M_{HA})^{-1}.
$$

Proof. $||M_{SAM} M_{NK} M_{HA}|| < 1$ is a sufficient condition for the inverse $\mathcal{G} = (I - M_{SAM} M_{NK} M_{HA})^{-1}$ to exist. Given its existence, Equation (36) follows from rearranging Equations (33)-(35). □

The condition $||M_{SAM} M_{NK} M_{HA}|| < 1$ implies that the geometric sum $I + M_{\text{SAM}} M_{\text{NK}} M_{\text{HA}} + (M_{\text{SAM}} M_{\text{NK}} M_{\text{HA}})^2 + \ldots$ is bounded and converges to $\mathcal{G}$. We may thus think of the equilibrium as the product of a first-round policy-specific effect on the income vector $\boldsymbol{inc}$, and a policy-invariant repeated feedback loop through the three blocks. The condition $||M_{SAM} M_{NK} M_{HA}|| < 1$ can be interpreted as this circular feedback loop not being too strong.

The first-round effect may in turn be decomposed into a direct partial-equilibrium effect and indirect effects. The direct effect is given by the partial equilibrium within the blocks where the policy variable enters directly. The indirect effects consist of the responses in the blocks that follow. Household transfers and government consumption directly affect the demand for bonds, which is contained in the HA block. Firm transfer policies have a direct effect in the SAM block due to the implied changes in hiring and firing incentives. All policies have a direct effect in the HA block because they require tax or bond financing.

For example, consider the transmission of a positive shock to government consumption, G_t, which we will use as benchmark for comparing the output effects of policies. By increasing spending, the government levies taxes on households and issues bonds. The tax sequence affects the households' demand for bonds. The shifts in the demand and supply curves for bonds result in a sequence of the real interest rate that clears the asset market. The NK block maps this partial-equilibrium real interest rate sequence to a sequence of intermediate-goods prices $\boldsymbol{p^x}$, which move more strongly whenever monetary policy is less reactive (requiring larger movements in inflation to move rates) or prices are more sticky (requiring larger movements in marginal costs to move inflation). The SAM block, in turn, maps $\boldsymbol{p^x}$ to sequences of dividends paid by intermediate goods firms, as well as to job-finding and separation rates, the response of which depends on the separation and hiring elasticities ψ and ξ. This sequence of household income determinants again affects taxes and bond issuance, as well as household savings decisions, giving us a new sequence of the real interest rate. From there onward, the general equilibrium cycle repeats until convergence, contained in the operator $\mathcal{G}$.

Finally, note the close connection between the determinacy condition in Proposition 2 and the standard result from the New-Keynesian literature that determinacy is achieved if the monetary policy reaction coefficient is strong enough. The condition $||M_{SAM}M_{NK}M_{HA}|| < 1$ is satisfied if $||M_{SAM}|| \cdot ||M_{NK}|| \cdot ||M_{HA}|| < 1$, which holds if $||M_{NK}||$ is small enough, which in turned is satisfied if the reaction coefficient ϕ_π is large enough. We formalize this in the following corollary.

Corollary 1. ***(Taylor Principle)*** *Assume that M_{SAM} and M_{NK} are bounded operators. Then there is a unique solution to the system (33)-(35) if the monetary policy reaction coefficient ϕ_π is sufficiently large.*

Proof. See Appendix C. □

3.3 The determinants of relative fiscal stimulus

To compare stimulus effects across policies, we restrict the set of potential policy paths by requiring each policy to achieve the same path of output $\boldsymbol{y}$. This implies that we can compare the fiscal stimulus effects on the basis of total cumulative fiscal costs ($\mathbf{1}'\boldsymbol{taxes}$) alone. For any fiscal spending shock, we define the cumulative fiscal multiplier as the ratio of the cumulative changes in output and tax revenue,

$$\mathcal{M} = \text{cumulative fiscal multiplier} = \frac{\mathbf{1}'\boldsymbol{y}}{\mathbf{1}'\boldsymbol{taxes}}.$$

We first consider household-transfer policies, which change the asset demand and supply in the HA block. To achieve an identical equilibrium sequence of output in general equilibrium, these policies must imply an identical sequence of the real interest rate in the partial equilibrium of the HA block, since the further transmission of that sequence, depicted in Figure 1, is common across policies. In turn, this implies that we can rank cumulative fiscal multipliers on the basis of the direct fiscal costs alone, and that this is ranking is invariant to parameter changes outside the HA block.

Proposition 3. ***(The fiscal costs of household-transfer and government-consumption policies)*** *Consider two sequences of household-transfer policies $\boldsymbol{h}^0$ and $\boldsymbol{h}^1$ chosen to imply the same direct partial-equilibrium real interest rate sequence, so*

$$M_{h,r}\boldsymbol{h}^0 = M_{h,r}\boldsymbol{h}^1.$$

The output sequences are then the same $\boldsymbol{y}^0 = \boldsymbol{y}^1$, and the difference in total cumulative fiscal cost in general equilibrium is the same as the difference in the cumulative direct partial-equilibrium fiscal cost,

$$\mathbf{1}'\boldsymbol{taxes}^0 - \mathbf{1}'\boldsymbol{taxes}^1 = \mathbf{1}'M_{h,taxes}\boldsymbol{h}^0 - \mathbf{1}'M_{h,taxes}\boldsymbol{h}^1,$$

where $M_{h,taxes}$ maps any transfer policy sequence to its associated sequence of direct fiscal cost. Furthermore, the cumulative fiscal multiplier is largest for the policy with the lowest cumulative direct partial-equilibrium fiscal cost,

$$\mathcal{M}_{h^0} \lesseqgtr \mathcal{M}_{h^1} \iff \mathbf{1}'M_{h,taxes}\boldsymbol{h}^0 \lesseqgtr \mathbf{1}'M_{h,taxes}\boldsymbol{h}^1. \tag{37}$$

Proof. When the direct partial-equilibrium real interest rates are the same, then Corollary 2 implies identical income and output sequences ($\boldsymbol{inc}^0 = \boldsymbol{inc}^1 = \boldsymbol{inc}$, $\boldsymbol{y}^0 = \boldsymbol{y}^1 = \boldsymbol{y}$) because the operators M_{SAM}, M_{NK}, and M_{HA} are all policy independent. The total tax cost is the sum of the taxes implied by the change in household income in equilibrium and the direct tax cost $\boldsymbol{taxes}^j = M_{\text{inc,taxes}}\boldsymbol{inc}^j + M_{h,taxes}\boldsymbol{h}^j$, which implies the result. $\square$

Proposition 3 simplifies the mapping from our model to practical policy analysis: for a given desired output stimulus, the difference in the total fiscal costs of household-transfer policies does not depend on parameters outside the HA block. To assess which policy is more cost-effective in stimulating output, a policy maker only needs to take a stance on the direct partial equilibrium effects on the demand and supply for assets contained in the HA block. These can in principle be constructed using only micro data on consumption-saving behavior and estimates of the fiscal rule.

For our model, there is no equivalent result to Proposition 3 for firm transfer policies: hiring and retention subsidies typically affect separation and job-finding rates, and thus the income process $\boldsymbol{inc}$, differently even when they achieve identical paths of output and employment. This implies that their relative stimulus effects depend on the structure of the HA block. Having data-consistent responses of labor-market transition rates to fiscal policies is thus important in the quantitative analysis: data-consistency in employment responses is not enough to identify heterogeneous fiscal effects of policies.

An interesting analytical benchmark for the quantitative analysis, however, is when incomplete-markets frictions are absent, such that the HA block consists of a representative household who collects all income. In this case, the relevant output from the SAM block is the vector of total income $\boldsymbol{y}$, which is shared by all policies. In this case, relative fiscal costs of different firm transfer policies are similarly independent of HA and NK blocks.

Proposition 4. ***(Relative fiscal costs of firm transfer policies.)*** *. Consider a version of the model where the HA block consists of a representative agent whose consumption and savings behavior is described by an Euler equation $y_t^{-\sigma} = \beta(1+r_t)y_t^{-\sigma}$ and a standard budget constraint. Consider two sequences of firm-transfer policies $\boldsymbol{f}^0$ and $\boldsymbol{f}^1$ chosen to imply the same direct partial-equilibrium output sequence*

$$M_{f,inc}\boldsymbol{f}^0 = M_{f,inc}\boldsymbol{f}^1.$$

The difference in total cumulative fiscal cost in general equilibrium is the same as the difference in the cumulative direct partial-equilibrium fiscal cost,

$$\mathbf{1}'\boldsymbol{taxes}^0 - \mathbf{1}'\boldsymbol{taxes}^1 = \mathbf{1}'M_{f,taxes}\boldsymbol{f}^0 - \mathbf{1}'M_{f,taxes}\boldsymbol{f}^1.$$

Furthermore, the cumulative fiscal multiplier is largest for the policy with the lowest cumulative direct partial-equilibrium fiscal cost,

$$\mathcal{M}_{h^0} \lesseqgtr \mathcal{M}_{h^1} \iff \mathbf{1}'M_{f,taxes}\boldsymbol{f}^0 \lesseqgtr \mathbf{1}'M_{f,taxes}\boldsymbol{f}^1 \tag{38}$$

Proof. When the direct partial-equilibrium output path is identical across the policies, $M_{f,inc}\boldsymbol{f}^0 = M_{f,inc}\boldsymbol{f}^1$, then Corollary 2 implies identical income and output sequences ($\boldsymbol{inc}^0 = \boldsymbol{inc}^1 = \boldsymbol{inc}$, $\boldsymbol{y}^0 = \boldsymbol{y}^1 = \boldsymbol{y}$) since Ricardian equivalence implies $M_{f,r} = 0$ and because the operators M_{SAM}, M_{NK}, and M_{HA} are all policy independent. The total tax cost is the sum of the taxes implied by the change in household income in equilibrium and the direct tax cost $\boldsymbol{taxes}^j = M_{\text{inc,taxes}}\boldsymbol{inc}^j + M_{f,taxes}\boldsymbol{f}^j$, which implies the result. □

Relation to Wolf (2023) Our analysis is related to Wolf (2023), who, within a HANK framework, establishes conditions such that government consumption and household transfer policies have the same general-equilibrium output effects. In that case, stimulus effects of transfer policies can be deduced from their micro-effects on consumption demand and data on government consumption responses without estimating a full structural model. Here, we characterize the differences in tax costs across policies that achieve a common output path but are financed through a common standard fiscal rule that allows different tax sequences and fiscal multipliers, while Wolf (2023)'s analysis assumes equal tax sequences of the two policies, implying identical multipliers.

Relation to Auclert et al. (2021) The DCG representation of our equilibrium is related to, but not the same, as the directed acyclical graph (DAG) representation familiar from Auclert et al. (2021). The latter is a mapping from a number of input sequences via equilibrium relations to an identical number of equation errors that can be used to update guesses for inputs or calculate sequence-space Jacobians. Our model can, as most equilibrium models, also be written as a DAG, using an input sequence to any of its blocks as a guess. Our analytical results follow from the more particular feature of our model that its equilibrium can be written as a DCG consisting of one circle between three blocks.

4 Calibration

In line with the characterization of the model in Section 3, we group the model parameters as belonging to one of three blocks: the Heterogeneous-Agent (HA) block, the New-Keynesian (NK) block and the Search-And-Matching (SAM) block. We calibrate the model in two steps. First, we set standard model parameters to conventional values used in the macroeconomic literature, or to match the conventional moments in post-war U.S. data to the steady state of the economy. Given these parameters, we then calibrate the parameters of the HA block and the SAM block that are key to the relative strength of the fiscal policies under consideration. Specifically, because the dynamics of savings and consumption are at the heart of transmission, we calibrate the parameters of the HA block to match micro-level consumption profiles upon unemployment shocks, similar to Kekre (2023). Because time-variation in unemployment risk is another central determinant of policy effectiveness, we choose the parameters of the SAM block to match the dynamics of unemployment risk (job-finding and job-separation rates) at the macro level, following our earlier work (Broer et al., 2023).

A time period in the model is one month. Tables 1-3 summarize the parameters of our model.

Parameter	Value	Source / Target
Substitution elasticity, ϵ_p	6	Standard
Rotemberg cost, φ	355	Standard
Taylor rule parameter, ϕ_π	1.5	Standard

Table 1: NK parameters.

4.1 NK block

The parameters of the NK block are displayed in Table 1. The Rotemberg adjustment cost is set so that the implied slope of the Phillips curve is the same as with a Calvo model with average price duration of 9 months.[10]

4.2 HA block

We choose the parameters governing individual income risk and consumption-savings behavior to match average statistics from U.S. micro data in the steady state of our model.

Following Kekre (2023), we target a structure of unemployment insurance that captures the temporary nature of unemployment benefits, and the observed income drops during unemployment, in U.S. micro data. Specifically, individuals who become unemployed receive unemployment benefits equivalent to 76 percent of their last wage for 6 months, after which the replacement rate drops to 55 percent. These replacement ratios are higher than the statutory ones, but in line with observed drops in household income (accounting for, e.g., the presence of a second earner). To capture that only 39 percent of unemployed individuals receive unemployment benefits (Chodorow-Reich and Karabarbounis, 2016), 51 percent of newly unemployed individuals immediately receive the low replacement rate. Finally, average search efficiency in steady state S_{ss} is normalized to 1 and we set the relative search efficiencies $s(u_{it-1})$ to match the documented decline of job-finding rates with increasing unemployment duration reported in Eubanks and Wiczer (2016), see Appendix B for details.

The parameters that govern consumption-savings behavior are set to replicate the observed consumption profile after unemployment shocks. We choose this strategy, as opposed to targeting moments of the observed wealth distribution, because the degree of consumption in-

[10]The implied relation between inflation and real marginal costs—the Phillips curve—with our adjustment cost specification has a slope of $(\epsilon_p - 1)/\varphi$. With a Calvo survival probability θ_p, the slope is instead $(1-\theta_p)(1-\beta\theta_p)/\theta_p$. The two are the same when $\varphi = (\epsilon_p - 1)\theta_p/((1-\theta_p)(1-\beta\theta_p))$. We set φ consistent with a Calvo survival probability of $\theta_p = 8/9$, which implies an average price duration of 9 months.

HA Parameters	**Value**	**Source / Target**
Discount factor β^{12}	0.971	Relative consumption drop of unemployed, -20%
Share of HtM agents Θ	0.374	Consumption drop at UI expiration, -43%
CRRA coefficient, σ	2	Standard
High UI, $\overline{\phi}$	0.76	Kekre (2023)
Low UI, $\underline{\phi}$	0.55	Kekre (2023)
UI duration, $\overline{u}$	6.0	UI duration in the US
UI prob, π^{UI}	0.488	UI recipients / unemployed = 39 percent
Relative search effectiveness, $s(u_{it-1})$	(See Figure B.1)	Eubanks and Wiczer (2016)
Tax-smoothing parameter, ω	0.05	Two-year deficit government consumption shock
Bond maturity, δ_q	$59/60 \cdot R_{ss}^{\text{real}}$	Bond maturity of 5 years
Tax rate, τ	0.30	Standard
Value of bonds, $\frac{q_{ss}B_{ss}}{Y_{ss}^{hh}}$	2.10	Steady state interest rate at 2 percent

Table 2: HA parameters.

surance, which determines the precautionary-savings motive and the marginal propensity to consume (MPC), is a key determinant of the transmission in our model.

We calibrate the share of hand-to-mouth households, the discount factor and the supply of government bonds to match (i) an annual steady-state real interest rate of 2 percent per year, (ii) an average consumption level of the unemployed relative to the employed of 80 percent (Chodorow-Reich and Karabarbounis, 2016), and (iii) a percentage drop in consumption upon expiration of unemployment benefits that equals 43 percent of the drop in income (Ganong and Noel, 2019). With a fraction of hand-to-mouth households just under 40 percent, a bond supply equal to 210 percent of monthly post-tax income, and a discount factor $\beta = 0.971$, the model matches these moments well.

The implied average quarterly MPC is 40.6 percent, which is line with empirical estimates (see, e.g., Johnson et al. (2006)). Since profits are distributed equally and lump sum to all households, this also implies that the average quarterly MPC out of profit income is 40.6 percent, which is higher, but still roughly in line with the evidence presented in Di Maggio et al. (2020). In Section 5, we consider a different profit distribution arrangement.

Following Auclert et al. (2020), we set the bond maturity parameter δ so that average bond maturity is 5 years and the tax-smoothing parameter ω to target that the government runs a deficit for two years following an $AR(1)$ government consumption shock with a monthly autocorrelation of $0.90^{\frac{1}{3}}$.[11] We set the labor income tax rate to a standard value of 30 percent,

[11] This is in line with what is typically used in the literature, see Ferriere and Navarro (2024) and Christiano et al. (2014).

Parameter	Value	Source / Target
Firm discount factor, β^{firm}	$0.98^{\frac{1}{12}}$	Standard
Matching function elasticity, α	0.60	Petrongolo and Pissarides (2001)
Separation rate, δ_{ss}	0.027	Broer et al. (2023)
Tightness, θ_{ss}	0.60	Hagedorn and Manovskii (2008)
Separation elasticity, ψ	2.960	EU share of unemployment volatility w.r.t TFP shock from Broer et al. (2023)
Entry elasticity, ξ	0.010	UE lag relative to EU w.r.t TFP shock from Broer et al. (2023)
Wage level, W_{ss}	0.671	Unemployment var. w.r.t. TFP shock from Broer et al. (2023)

Table 3: SAM parameters.

and choose the level of government consumption such that the supply of government bonds is equal to households' demand for government bonds.

4.3 SAM block

To calibrate the SAM block, we first set a number of parameters to standard values in the literature or to match a set of standard steady state moments, such as steady state tightness and separation rates. In addition, the model contains a scale parameter in the idiosyncratic entry cost function.

We choose the wage level and the elasticities of separations and entry to capture three key features of the response of U.S. labor-market variables to macroeconomic shocks, namely the size of the unemployment response, the share of the response accounted for by separation vs. job-finding, and the lead-lag relation of the two. Specifically, as we show in Broer et al. (2023), in response to a one percent innovation to total factor productivity with estimated monthly autocorrelation of $0.907^{1/3}$, the overall size of the unemployment response corresponds to a conditional standard deviation of 0.88 percentage points, the separation rate accounts for about 45 percent of the total response in unemployment, and the peak of the job-separation rate response leads the peak of the job-finding rate response by 9 months, with similar responses to other macroeconomic shocks. As we also show in Broer et al. (2023), the delayed response of the job-finding rate identifies the sluggishness of vacancy creation, the contribution of the separation rate to unemployment volatility identifies the separation elasticity, and the overall unemployment volatility identifies the wage level (which determines the *fundamental surplus* as in Ljungqvist and Sargent (2021)).

5 Comparing the stimulus effects of fiscal policies

In this section, we quantitatively investigate the fiscal multipliers associated with different fiscal transfer policies, and their determinants.

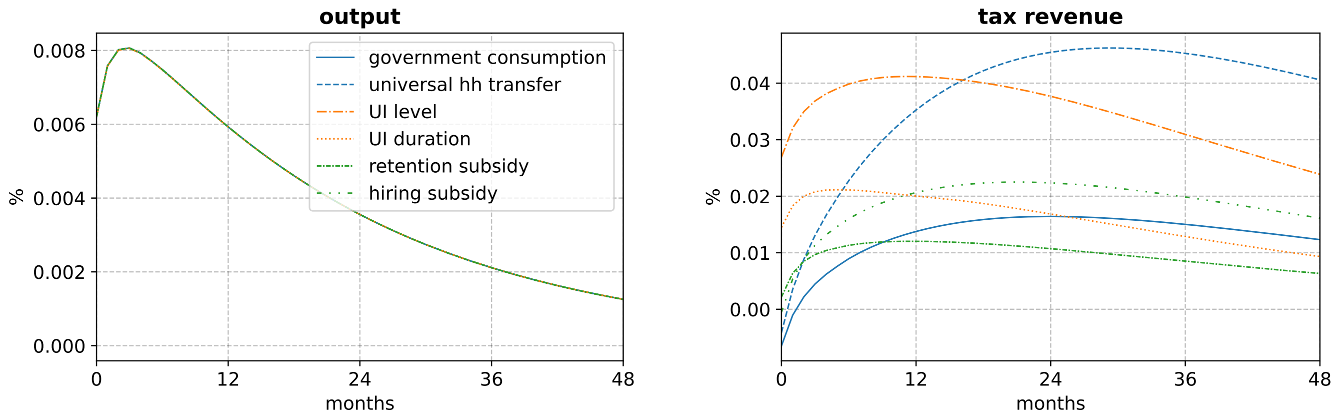

Figure 2: Tax revenue responses with different policies.

Notes: The figure shows the sequences of output (in the left-hand panel) and tax revenues (right-hand panel) for different policies in the baseline calibration of the model. The expenditure sequences are chosen to achieve the same output sequence as the benchmark policy of increased government consumption.

5.1 Fiscal multipliers of different policies in the baseline model

Our benchmark policy is government consumption, which we assume to follow an $AR(1)$ with standard persistence $\rho_G = 0.90^{\frac{1}{3}}$. We discipline the remaining policy sequences to imply the same sequence of unemployment and output in general equilibrium, depicted in the left panel of Figure 2. The right panel shows the sequences of tax revenues required to achieve this path.[12]

In row 1 of Table 4, we display the multipliers associated with the different transfer policies, normalized by the multiplier of the government consumption shock, with its absolute size in square brackets. We make two observations. First, the absolute size of the government consumption multiplier is around 1. This was not targeted in our calibration, but is in line with empirical evidence on military spending shocks, see, e.g., Ramey 2011). Second, the multipliers associated with the different transfer policies differ greatly, ranging from 0.28 to 1.64.

In row 2, we display the cumulative increase in taxes associated with each policy, as a fraction of output (the inverse of the fiscal multiplier). In row 3 and 4, we decompose this total tax response into the partial equilibrium increase in expenditures from the policy, and a general equilibrium contribution from changing government outlays on unemployment insurance.

For the household-transfer and government consumption policies, their identical general-equilibrium

[12] The implied policy sequences are shown in Appendix Figure D.1.

		Household transfers			Firm transfers	
	G [level]	**Transfer**	**Level**	**Duration**	**Retention**	**Hiring**
1. Relative fiscal multiplier	1.0 [0.99]	0.28	0.44	1.03	1.64	0.72
2. Relative tax response	1.00	3.64	2.29	0.97	0.61	1.39
3. PE relative tax response	1.47	4.11	2.77	1.45	0.57	1.56
4. GE relative tax response	-0.47	-0.47	-0.47	-0.47	0.04	-0.17

Table 4: Relative cumulative fiscal multipliers, and the relative tax response decomposed in to the partial-equilibrium response and general-equilibrium response.

Notes: The relative cumulative fiscal multipliers are cumulative fiscal multipliers of each policy relative to the cumulative fiscal multiplier of government consumption (with the absolute level of the cumulative fiscal multiplier for government consumption shown in brackets). The expenditure sequences are chosen to achieve the same output sequence as the benchmark policy of increased government consumption. In the second row, the relative cumulative tax responses for all policies are shown. Since the output path is shared across policies, this is the inverse of the relative cumulative fiscal multiplier. The partial-equilibrium tax response is the cumulative partial equilibrium fiscal cost of all policies, while the general equilibrium tax response is the additional tax response as a result of general equilibrium feedback. The numbers in row 3 and 4 are normalized with cumulative total tax response for the government spending shock. Therefore, for each policy, they sum to the total tax response in row 2.

transmission (from Proposition 3) immediately implies an identical general equilibrium contribution to tax expenditures, which is negative because these policies stimulate demand and thus reduce government outlays.

An increase in firm transfers, in contrast, directly increases both the supply of government bonds and demand for them (by temporarily lowering unemployment and unemployment risk). This implies smaller pressure on the real interest rate, and smaller general-equilibrium effects, so the bulk of the fiscal multiplier is directly determined by the partial-equilibrium tax cost.

5.2 What determines fiscal multipliers?

To understand the large differences in fiscal multipliers in Table 4, we now show how stimulus effects of different policies depend on particular model features. For this, Table 5 shows cumulative fiscal multipliers associated with different versions of our environment, keeping the policy paths unchanged from the baseline model (where they achieved an identical output stimulus). In all cases, we hold the other parameters of the model constant, and do not recalibrate the model.

		Household transfers			Firm transfers	
	G [level]	**Transfer**	**Level**	**Duration**	**Retention**	**Hiring**
1. Baseline	1.0 [0.99]	0.28	0.44	1.03	1.64	0.72
2. Less sticky prices ($\phi = 178$)	1.0 [0.61]	0.30	0.47	1.03	3.43	1.15
3. More reactive mp ($\delta_\pi = 2$)	1.0 [0.64]	0.30	0.47	1.03	3.33	1.13
4. Representative agent	1.0 [0.54]	0.00	0.00	0.00	1.92	0.57
5. Fewer HtM (17.4%)	1.0 [0.80]	0.19	0.41	1.11	1.80	0.69
6. More tax financing ($\omega = 0.10$)	1.0 [0.84]	0.19	0.40	1.10	1.70	0.67
7. Exo. separations ($\psi = 0$)	1.0 [0.13]	0.35	0.52	1.02	1.39	3.38
8. Free entry ($\xi = \infty$)	1.0 [0.54]	0.31	0.47	1.03	1.50	1.21
9. Wage rule ($\eta_e = 0.50$)	1.0 [0.73]	0.29	0.46	1.03	1.55	0.74
10. 95% of div. to PIH	1.0 [0.82]	0.28	0.43	0.99	0.72	0.16

Table 5: Cumulative fiscal multipliers relative to the fiscal multiplier of government consumption.

Notes: For different versions of the model (along the row dimension), the table shows the cumulative fiscal multipliers associated with different policies (along the column dimension) relative to the fiscal multiplier of government consumption, presented in square brackets. The expenditure sequences are chosen to achieve the same output sequence as the benchmark policy of increased government consumption in the baseline calibration, and then unchanged when considering alternative specifications of the model.

5.2.1 Determinants of the government-spending multiplier

The numbers in square brackets in the first column of Table 5 show how government-spending multipliers are affected by changing the key features of our baseline model, namely nominal rigidities and the degree of market incompleteness, and the labor market frictions particular to our baseline model. These results are very much in line with the literature on government spending multipliers (see, e.g., Hagedorn et al. (2019) and Auclert et al. (2024) for similar comparisons in alternative HANK environments).

Row 2-3 illustrate the effects of changes to the NK block. With more flexible prices or a more reactive monetary policy rule (rows 2 and 3 respectively), the benchmark multiplier falls towards its flexible-price value, which, given the absence of wealth effects on labor supply, is zero in our model.

Rows 4-6 illustrate the effect of changes to the HA block. With a representative household who receives all income and abides by the permanent-income hypothesis (PIH), a higher average marginal propensity to save lowers excess bond supply and upward pressure on interest rates in the first round, reducing the general-equilibrium multiplier by about half (row 4). The multiplier also declines when reducing the share of hand-to-mouth households, which lowers the average marginal propensity to consume (row 5)., or when stronger current-tax financing reduces consumption of the non-Ricardian households (row 6).

Rows 7-10 illustrate the effect of changes to the SAM block: with exogenous and constant separations (row 6), the multiplier declines to an eighth of its baseline value, as one of the key transmission channels through endogenous separations is broken. With free entry to vacancy posting (or an infinite elasticity of vacancy creation, row 7), time variation in separations does not lead to vacancy depletion, as pointed out by Coles and Kelishomi (2018). Job-finding rates are thus less procyclical, weakening the transmission of fiscal policies, and reducing the benchmark multiplier by half. When we allow wages to respond to the level of unemployment,[13] the revenue product of labor is less procyclical, reducing the cyclicality of separations and job finding. This dampens the benchmark multiplier by one fourth. The multiplier is also lower when the bulk of profit income is distributed to a new set of PIH households (row 10).[14] This

[13]Specifically, we allow the wage to depend on employment through the following *wage rule*,

$$W_t = W_{ss} \left(\frac{1 - u_t}{1 - u_{ss}} \right)^{\eta_e}.$$

[14]In particular, we replace 5 percent of households, non-hand-to-mouth, by PIH households and assume that these

change effectively reduces the average MPC out of profit income to a very small number.

5.2.2 Relative fiscal multipliers of household transfer policies

The first four columns of Table 5 show the cumulative fiscal multipliers associated with household transfer policies scaled by that of the benchmark government consumption policy, in different versions of the model.

According to Proposition 3, the stimulus achieved by household transfers and government consumption is affected by model changes outside the HA block in exactly the same way. This result can be used to characterize the effect that a parameter change outside the HA block has on relative fiscal multipliers. Since a parameter change outside of the HA block (i) affects the output path of the two policies in the same way and (ii) affects the general-equilibrium component of tax expenses in the same way, the relative multipliers of household transfer policies after the parameter change can be computed as a function of relative multiplier prior to the parameter change and the effect that the parameter change has on tax expenses associated with government consumption. Explicitly, we have the following proposition.

Proposition 5. *Consider two sequences of household-transfer policies $\boldsymbol{h}^0$ and $\boldsymbol{h}^1$ chosen to imply the same direct partial-equilibrium real interest rate sequence. Let $\mathcal{M}_{h^1}/\mathcal{M}_{h^0}$ denote the relative fiscal multiplier of policy $\boldsymbol{h}^1$ relative to $\boldsymbol{h}^0$. A parameter change outside of the HA block generates a change in the relative fiscal multiplier given by*

$$\frac{\mathcal{M}_{h^1}^{new}}{\mathcal{M}_{h^0}^{new}} = \frac{1+\frac{\mathbf{1}'\boldsymbol{taxes}^{0,new}-\mathbf{1}'\boldsymbol{taxes}^{0}}{\mathbf{1}'\boldsymbol{taxes}^{0}}}{1+\frac{\mathbf{1}'\boldsymbol{taxes}^{0,new}-\mathbf{1}'\boldsymbol{taxes}^{0}}{\mathbf{1}'\boldsymbol{taxes}^{0}}\frac{\mathcal{M}_{h^1}}{\mathcal{M}_{h^0}}}\frac{\mathcal{M}_{h^1}}{\mathcal{M}_{h^0}}$$

where $\frac{\mathbf{1}'\boldsymbol{taxes}^{0,new}-\mathbf{1}'\boldsymbol{taxes}^{0}}{\mathbf{1}'\boldsymbol{taxes}^{0}}$ is the percent change in total tax expenditures for policy $\boldsymbol{h}^0$.

Proof. To be filled in. □

In particular, the relative fiscal multiplier is unchanged if either tax expenditures associated with government consumption remains unchanged or if the relative fiscal multiplier initially

collect 95 percent of the profits. This change also constitutes a slight alteration to the HA block, as we adjust the share of buffer-stock households. With this change in the income process, we effectively dampen the MPC out of firm profit income drastically, but leave the average MPC and the precautionary-savings motive to labor income close to unaffected.

was equal to 1. Quantitatively, the relative fiscal multipliers of household transfer policies (in the first four columns of Table 5) are close to constant across rows 1-3 and 7-10.

Changes in the structure of the HA block (in rows 4-6), in contrast, change the stimulus from household transfers relative to the benchmark policy. In particular, transfers leave output unaffected with a representative agent (implying zero multipliers in row 3), as demand is neither affected by fiscal redistribution, nor by bond issuance due to Ricardian equivalence. The relative multiplier of universal transfers is particularly sensitive to the fraction of hand-to-mouth households (row 5), as it strongly depends on the average marginal propensity to consume. Transfers to the unemployed, who have a high MPC regardless, are less affected. In fact, because fewer hand-to-mouth consumers increase the role of precautionary savings, unemployment duration extensions, which insure against a particularly averse contingency of long-term unemployment, become more effective relative to government consumption. Increased current-tax financing (row 6) dampens fiscal multipliers in proportion to the policy's total financing needs, thus increasing the dispersion of relative multipliers.

Overall the efficacy of all transfer policies thus hinges on the limited insurance against unemployment risk. Universal transfers are substantially more sensitive to the average MPC than transfers to the unemployed, which are more sensitive to the strength of the precautionary-savings motive.

5.2.3 Relative fiscal multipliers of firm transfer policies

While the relative size of fiscal multipliers associated with the two firm transfer policies is only mildly affected by parameters outside the SAM block (implying that Proposition 4 holds approximately also with incomplete markets and for fiscal multipliers), their size increases substantially compared to the benchmark policy when nominal rigidities are weaker (rows 2 and 3 of Table 5). This is because their stimulus effects rely much less on general equilibrium effects, relative to government consumption, such that their absolute multipliers are less affected by the degree of nominal rigidity.

Changes in the SAM block, by contrast, strongly affect the relative fiscal stimulus from firm transfers. With constant separations (row 7) the ordering of their fiscal multipliers switches: hiring subsidies are substantially more stimulative than retention subsidies that waste resources on inframarginal matches. Similarly, with free entry to vacancy posting (row 7), the relative efficacy of hiring subsidies increases and that of retention subsidies decreases, simply because vacancy creation responds more strongly to a given change in the value of a vacancy. While the wage rule has limited effect on the relative multipliers, the marginal propensity to consume out of dividends matters greatly: when we lower it (row 10), the relative multipliers of the firm transfer policies, which directly raise profit income for the equity owners, fall dramatically.

Overall, our baseline result of firm transfers being relatively effective stimulus policies compared to household transfer policies thus rely on two features of the baseline model: First, that the transmission from real interest rates to intermediate-goods prices in the NK block is not overly strong, in the sense that monetary policy is sufficiently reactive and prices sufficiently flexible to limit the general-equilibrium amplification that boosts stimulus effects of household relative to firm transfers. Second, that the MPC out of profit income is significantly larger than what is implied by the permanent-income hypothesis. This assumption has support in the data (Di Maggio et al., 2020), but the uncertainty surrounding this number is large. Moreover, our baseline result that retention subsidies are more effective than hiring subsidies primarily depends onthe relative sensitivity of job creation and job destruction to economic conditions, that where chosen to target the observed lead-lag relation of separations and job-finding in U.S. data, implying that vacancy creation is relatively sluggish and separations are relatively elastic compared to the standard DMP benchmark.

6 Conclusion

In this paper, we have studied fiscal stimulus effects in an environment where a multitude of frictions gives common transfer policies output effects. Incomplete markets empower government transfers (through heterogeneous and declining intertemporal marginal propensities to consume) and public insurance (through its effect on precautionary savings). Frictional labor markets with endogenous separations and realistic flow dynamics give public subsidies for new or existing job matches an effect on hiring and firing. Nominal rigidities make output demand determined in the short run.

Despite the complexity of the framework, we showed how the environment is analytically tractable in sequence space as a directed cycle graph: different model blocks interact in a circle through output sequences that are inputs to the next block. This allowed us to show how relative fiscal multipliers are determined by differences in first-round, within-block effects of policies, and to characterize the subsequent common general-equilibrium transmission of fiscal policies as a circular interaction of model frictions. In our benchmark calibration, long-run fiscal multipliers differ strongly, ranging from 0.3 to 1.6. The relative stimulative potential of demand-side policies, like transfers or unemployment insurance policies, hinges on the degree of partial insurance (that governs marginal propensities to consume and the response of precautionary savings), but is approximately unaffected by the precise specification of the labor market SAM block or the degree of nominal frictions. The stimulative potential of firm subsidies mainly hinges on the elasticities of hiring and firing to the match revenue product, and the marginal propensity to consume out of dividend income, but not on the degree of market incompleteness or nominal rigidities.

We think these results are useful for policymakers as they add transparency to comparative fiscal policy analysis in HANK models with a state-of-the-art labor market. In particular, they guide discussions about the relative potency of stimulus policies toward relevant sufficient statistics, such as intertemporal MPCs, or revenue elasticities of separations and hiring, which policymakers may have their own views about.

Given the complexity of the model, we have kept several dimensions of the analysis intentionally simple. While we have focused on steady-state policy interventions, future research should study the state-dependence of relative fiscal multipliers. For example, unemployment insurance policies may gain comparative edge during recessions when unemployment levels and risk are high. To the extent that anticipation effects partially determine the efficacy of fiscal policies, expectational biases (e.g., of workers with respect to their unemployment risk) should be taken seriously and the disincentive effects of policies on the unemployed deserve more attention. Finally, this paper has a narrow focus: we study the stimulus effect of different fiscal transfer policies. As such, we do not make normative statements and, in particular, we do not study the welfare properties of the policies under consideration. For a complete assessment of the policies, welfare evaluation is of course also central, something we leave for future research.

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A Appendix to Section 2

A.1 Separation decision

In Equation 8, we assume that G is a mixture of a point mass at 0 and a Pareto distribution with location parameter $\Upsilon > 0$ and shape parameter ψ,

$$G(\chi_t) = \begin{cases} 0 & \chi_t < 0, \\ 1-p & 0 \leq \chi_t < \Upsilon, \\ (1-p) + p(1-(\chi_t/\Upsilon)^{-\psi}) & \chi_t \geq \Upsilon, \end{cases} \tag{39}$$

This implies

$$\begin{aligned} \delta_t &= \int_{V_t^j}^{\infty} G(\chi_t) d(\chi_t) \\ &= \begin{cases} p & \text{if } V_t^j \leq \Upsilon \\ p\left(\frac{V_t^j}{\Upsilon}\right)^{-\psi} & \text{else} \end{cases} \end{aligned} \tag{40}$$

and

$$\begin{aligned} \mu_t &= \int_0^{V_t^j} \chi_t dG(\chi_t) \\ &= \frac{\mathbb{E}[\chi_t] - \text{Prob.}[\chi_t > V_t^j]\mathbb{E}[\chi_t | \chi_t > V_t^j]}{1 - \text{Prob.}[\chi_t > V_t^j]} \\ &= \begin{cases} 0 & \text{if } V_t^k \leq \Upsilon \\ \frac{p\frac{\psi\Upsilon}{\psi-1} - p\left(\frac{V_t^j}{\Upsilon}\right)^{-\psi}\frac{\psi V_t^j}{\psi-1}}{(1-p)+p(1-(\chi_t/\Upsilon)^{-\psi})} & \text{else} \end{cases} \\ &= \begin{cases} 0 & \text{if } V_t^k \leq \Upsilon \\ \frac{p\frac{\psi}{\psi-1}\Upsilon\left[1-\left(\frac{V_t^j}{\Upsilon}\right)^{1-\psi}\right]}{1-p\left(\frac{V_t^j}{\Upsilon}\right)^{-\psi}} & \text{else} \end{cases} \\ &= \mu(V_t^j) \end{aligned} \tag{41}$$

We always choose $Y = \left(\frac{\delta_{ss}}{p}\right)^{\frac{1}{\psi}} V^j_{ss}$ which implies Equation (9) in the main text. Furthermore, with $p = \delta_{ss}$ we have $Y = V^j_{ss}$ which implies $\delta_t = \delta_{ss}$ when $V^j_t \leq V^j_{ss}$. Instead we set $p = (1+\Delta_\delta)\delta_{ss}$ where $\Delta_\delta > 0$ is a small positive number. This implies that δ_t can rise above δ_{ss} when V^j_t falls below V^j_{ss}. It also implies that μ_{ss} is a small positive number.

B Appendix to Section 4

B.1 Steady state

From Table 3, we have the externally calibrated parameters (β, ρ, ϑ,ϵ_p, ϕ, δ_π, α), the steady targets (δ_{ss}, λ^u_{ss}, θ_{ss}), and the internally calibrated parameters ($\tilde{m}_{ss}$, ψ, ξ). Together with the two auxiliary parameters that are set to a value close to zero ($\kappa_0 = 0.1$, $\Delta_\delta = 0.1$; see Footnote 7 and Appendix A, respectively), the remaining model parameters can be deduced. From the matching function, we directly have

$$A = \frac{\lambda^u_{ss}}{\theta^\alpha_{ss}}.$$

This implies that the steady states of labor markets stocks and flows can be found by,

$$\begin{aligned}
\lambda^v_{ss} &= A\theta^{-\alpha}_{ss}, \\
u_{ss} &= \frac{\delta_{ss}(1-\lambda^u_{ss})}{\lambda^u_{ss} + \delta_{ss}(1-\lambda^u_{ss})}, \\
\tilde{u}_{ss} &= \frac{u_{ss}}{1-\lambda^u_{ss}}, \\
\tilde{v}_{ss} &= \tilde{u}_{ss}\theta_{ss}, \\
v_{ss} &= (1-\lambda^v_{ss})\tilde{v}_{ss}, \\
\iota_{ss} &= \tilde{v}_{ss} - (1-\delta_{ss})v_{ss}.
\end{aligned}$$

We can now also calculate both the value of a job and the value of a vacancy,

$$\begin{aligned}
V^j_{ss} &= \frac{\tilde{m}_{ss}}{1-\beta(1-\delta_{ss})}, \\
V^v_{ss} &= \kappa_0.
\end{aligned}$$

Hereby, we can infer p, F, κ, Υ and W_{ss} by

$$
\begin{aligned}
p &= (1+\Delta_\delta)\delta_{ss} \\
F &= \iota_{ss}(V^v_{ss})^{-\xi} \\
\kappa &= \lambda^v_{ss} V^j_{ss} - (1-\beta(1-\lambda^u_{ss})(1-\delta_{ss}))V^v_{ss} \\
\Upsilon &= \left(\frac{\delta_{ss}}{p}\right)^{\frac{1}{\psi}} V^{ss}_j \\
\mu_{ss} &= \frac{p\frac{\psi}{\psi-1}\Upsilon\left[1-\left(\frac{V^j_{ss}}{\Upsilon}\right)^{1-\psi}\right]}{1-p\left(\frac{V^j_{ss}}{\Upsilon}\right)^{-\psi}} \\
M_{ss} &= \tilde{m}_{ss}P^x_{ss}Z_{ss} + \beta\mu_{ss} \\
W_{ss} &= P^x_{ss}Z_{ss} - M_{ss}
\end{aligned}
$$

Hereafter the steady state values of all other variables can be found as well.

B.2 Details on the calibration of search efficiency

Figure B.1: Relative job-finding rates during unemployment

Notes: Shows the average job-finding rate conditional on unemployment duration relative to the initial job-finding rate.

We set the relative search efficiency, as a function of months of unemployment, to match the duration dependence of job-finding rates as reported in Eubanks and Wiczer (2016) and shown in Figure B.1.

B.3 Scale parameter ???

To calibrate the SAM block, we first set a number of parameters to standard values in the literature or to match a set of standard steady state moments, such as steady state tightness and separation rates. In addition, the model contains a scale parameter in the idiosyncratic entry cost function. We choose this to satisfy to ensure that our model converges to the standard free-entry model when the elasticity of vacancy creation with respect to vacancy values tends to infinity, details are given in Appendix B.

C Appendix to Section 3

C.1 Proof of Proposition 1

The model can be decomposed into three blocks in the following manner.

The SAM block contains the 16 endogenous variables $\tilde{v}_t, v_t, \iota_t, \theta_t, S_t, u_t, \lambda_t^v, \lambda_t^u, \delta_t, V_t^j, W_t, \chi_{c,t}, V_t^v, X_t, div_t, Y_t$ and exogenous (to the SAM system) P_t^x from the NK block, policy variables rs_t, hs_t, and productivity Z_t.

The SAM block consists of Equations (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), (11), (12), (14), and (15). Further, $\chi_{c,t}$ is determined by

$$\chi_{c,t} = V_t^j$$

and S_t is the average search intensity

$$S_t = \frac{\sum_{k>0} s(k) u_{k,t-1}}{\sum_{k>0} u_{k,t-1}}$$

where $s(k)$ is the exogenous search intensity of agents unemployed for k periods. These equations constitute 16 equations in 16 endogenous variables, which together with the law of motion for the distribution of unemployment duration constitute the complete SAM block. The law of motion for the distribution of unemployment duration is given by

$$u_{0,t} = \sum_{k>1} \lambda^u_{kt} u_{k-1,t-1} + (1-\delta_t) u_{0,t-1},$$
$$u_{1,t} = \delta_t u_{0,t-1},$$
$$u_{k,t} = (1-\lambda^u_{k,t}) u_{k-1,t-1}, k > 1,$$

where $u_{0,t}$ are the share of employed workers, $u_{k,t}$, $k > 0$, is the share of unemployed workers who have been unemployed for k periods, and $\lambda^u_{kt} = A\theta_t^{1-\alpha} s(k)$.

The NK block contains the 3 endogenous variables P^X_t, Π_t, R_t and exogenous (to the NK system) R^{real}_t from the HA block. The NK block contains Equations (13), (28), and (29). The nonlinear Phillips curve also contains Y_t but it drops out under a linearization. These equations constitute 3 equations in 3 endogenous variables, which determine the NK block.

The HA block contains the 11 endogenous variables $A^{hh}_t, q_t, B_t, \text{taxes}_t, \text{expenses}_t, \tilde{\tau}_t, \tau_t \tilde{Y}^{hh}_t, Y^{hh}_t, R^{real}_t$, and exogenous (to the HA system) $\delta_t, \lambda^u_t, \theta_t, W_t, div_t$ from the SAM block as well as all the policy variables. The HA block consists of Equations (18), (19), (23), (24), (25), (26), (27), (30), (31), as well as the heterogeneous-agent consumption-saving problem.

The heterogeneous-agent consumption-saving problem described by Equations (16), (17), (20), (21), and (22) generate aggregate household savings A^{hh}_t taking as input the endogenous variables R^{real}_t, τ_t, the exogenous variables from the SAM block determining the income process, $\delta_t, \lambda^u_t, W_t, div_t$, and the exogenous policy variables $\bar{\phi}_t, \bar{u}_t, T_t$. In effect, the consumption-saving problem provides an additional equation, determining A^{hh}_t. These equations thus constitute 10 equations in 10 unknowns. The goods market clearing condition, Equation (32), is redundant by Walras' law.

Under local block determinacy, each block has a unique solution near a steady state given inputs. A linearization of the HA block thus generates $\boldsymbol{r}^{real}$ as a linear function of the SAM block inputs $\boldsymbol{inc}$, demand policies $\boldsymbol{d}$ and supply policies $\boldsymbol{s}$, which gives us Equation (33). Equations (34) and (35) are derived by a similar argument.

C.2 Proof of Corollary 1

The NK block is simply the composition of a Taylor rule and a Phillips curve, and M_{NK} can be written down explicitly. Under a log-linearization, the Taylor rule and the Phillips curve are given by $i_t = \phi_\pi \pi_t$ and $\pi_t = \beta \pi_{t+1} + \phi^{-1} p^x_t$ which, together with $r^{\text{real}}_t = i_t - \pi_{t+1}$, yield the explicit description $p^x_t = \frac{\phi}{\phi_\pi - 1}\left(\left(1-\phi_\pi^{-1}\right)\sum_{k=0}^{\infty} \phi_\pi^{-k}\left(r^{\text{real}}_{t+k} - \beta r^{\text{real}}_{t+k+1}\right)\right)$ of the linear mapping

M_{NK} from the sequence of the real interest rate to the sequence of the intermediate-goods price. Since $p_s^x = \frac{\phi}{\phi_\pi}(r_s^{real} - (\beta\phi_\pi - 1)\sum_{k=1}^{\infty} \frac{r_{s+k}^{real}}{\phi_\pi^k})$, it is immediate that $||M_{NK}|| = \sup_{||\boldsymbol{v}||=1} ||M_{NK}\boldsymbol{v}|| = \frac{\phi}{\phi_\pi}(1 + \frac{|\beta\phi_\pi - 1|}{\phi_\pi - 1})$ with $v = [1, -1, -1, -1, \ldots]$ as maximizer if $\beta\phi_\pi > 1$, else with $v = [1, 1, 1, \ldots]$ as maximizer.Let the threshold ϕ_π^* be implicitly defined by $\frac{\phi}{\phi_\pi^*}(1 + \frac{\beta\phi_\pi^* - 1}{\phi_\pi^* - 1}) = ||M_{SAM}|| \cdot ||M_{HA}||$. Then, for $\phi_\pi > \max(1/\beta, \phi_\pi^*)$, we have $||M_{SAM}M_{NK}M_{HA}|| < 1$ and we obtain local equilibrium determinacy. .

D Appendix to Section 5

D.1 Policy paths

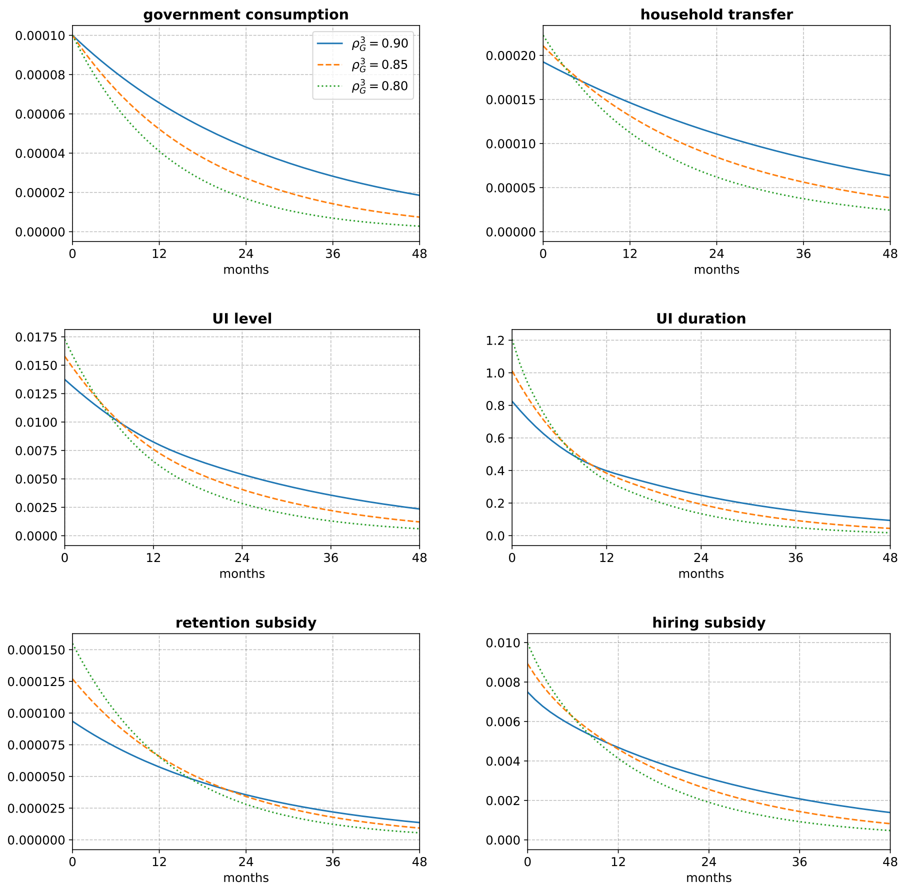

Figure D.1: Policy sequences

Notes: The baseline policy sequence is for government consumption, which is varied exogenously. The other policies are chosen to imply the same general equilibrium unemployment path.

	G [level]	Household transfers: Transfer	Level	Duration	Firm transfers: Retention	Hiring
1. Baseline	1.0 [0.99]	0.28	0.44	1.03	1.64	0.72
2. Wage rule ($\eta_e = 0.50$)	1.0 [0.73]	0.29	0.46	1.03	1.55	0.74
3. Bargained wage ($\eta_{EG} = 0.10$)	1.0 [0.88]	0.28	0.45	1.03	1.85	0.78

Table 6: Relative cumulative fiscal multipliers: the role of the distribution of dividends, persistence of policies, wage setting, endogenous search, and firm heterogeneity.

Notes: For different specifications of the model (along the row dimension), the table shows the cumulative fiscal multipliers associated with different policies (along the column dimension) normalised by that associated with government consumption, whose multiplier is presented in square brackets. The expenditure sequences are chosen to achieve the same output sequence as the benchmark policy of increased government consumption, and then unchanged when considering alternative model specifications.

D.2 Wage bargaining

The wage bargaining protocol of Elsby and Gottfries (2022) implies wage dynamics as follows:

$$W_t = \eta_{\text{EG}} P_t^X + \left(W_{ss} - \eta_{\text{EG}} P_{ss}^X \right).$$

With this protocol, our theoretical results are valid and we continue to be able to analyze the model as a directed cycle graph. The effects of endogenous wages on fiscal multipliers are shown in row 2 and 3 of Table 6. In both cases, the multipliers decrease almost uniformly across the different policies, such that relative multipliers are unchanged, with the exception of firm subsidies, which with bargained wages are somewhat more effective.