# Fiscal Management of Aggregate Demand: The Effectiveness of Labor Tax Credits\*

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#### Abstract

We use quantitative heterogeneous-agent model, with nominal rigidities and unemployment risk, to analyze the effectiveness of several fiscal policies in stabilizing a demand-driven recession. The model delivers empirically-realistic distributions of marginal propensities to consume (mpc) and labor participation elasticities (lpe), and matches the cross-sectional incidence of unemployment risk over the business cycle. We consider three fiscal stabilization packages: (i) a transfer to all low-income households; (ii) an increase in unemployment benefits to unemployed households; and (iii) an increase in labor tax credits to low-income working households. The labor tax credit is the most effective package to attenuate the recession, as it targets both high-mpc and high-lpe households and thus jointly stimulates labor and consumption. This result holds despite the recession resulting in higher unemployment risk.

Keywords: Heterogeneous Agents, Fiscal Policy, Optimal Taxation, Redistribution, Business Cycle. *JEL*: E21, E62, H21, H23, H53.

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### 1 Introduction

The stabilization of business cycle fluctuations has long been a key discussion in policy debates. Ample research has analyzed the stabilization properties of monetary policy, with the policy rate as its main instrument, and on fiscal policy, with instruments such as government spending, unemployment benefits, and lump-sum checks. Less attention, however, has been devoted to the stabilization properties of labor income taxes.<sup>1</sup> This is somewhat surprising, given the large expansionary effects that empirical work finds and labor tax cuts (Mertens and Ravn 2013; Zidar 2019). In this paper, we aim to fill this gap by analyzing the effectiveness of the cross-section of labor taxes in managing aggregate demand during a recession and stabilizing business cycle fluctuations.

To this end, we develop a quantitative Heterogeneous Agents New Keynesian (HANK) model that includes a rich set of fiscal policies, including a cross-section of labor taxes. The model features an empirically realistic cross-section of marginal propensities to consume (mpc) and labor participation elasticities (lpe), which makes it suitable to analyze policies on households with heterogeneous responses to taxes. Additionally, the model features a cross-section of unemployment risk which varies with the business cycle, reflecting weak labor demand conditions during a recession. We use the model as a laboratory to evaluate different stabilization policies during a demand-driven recession. We find that labor tax cuts concentrated on low-income households is a powerful stabilization policy.

We add three features to an off-the-shelf HANK model: an extensive labor supply decision (Chang and Kim 2007), heterogeneous discount factors (Carroll et al. 2017), and an Okun's law type of relation between output and the probability of being unemployed (Okun 1973). The extensive labor supply assumption implies that *lpe* declines with income, as high-income earners have exceptional labor market opportunities and are thus less likely to exit the labor force. Similarly, high discount factor households accumulate more wealth and thus exhibit lower *mpc*. Additionally, the ad-hoc Okun's law enables to incorporate a cross-section of unemployment risk, that is higher for low-income workers as well as more responsive during a recession. As we discuss below, these cross-sectional patterns for *lpe*, *mpc*, and unemployment risk are key to assess the effects of different fiscal polices.

In this environment, we consider a demand-driven recession induced by a decline in households' willingness to consume (Huo and Ríos-Rull 2020; Smets and Wouters 2007). We evaluate three fiscal packages in response to the recession. First, a targeted transfer (TT) package, which temporarily increases transfers to all low-income households, regardless of their employment status. Second, an unemployment insurance (UI) package, which temporarily increases unemployment benefits to all unemployed workers. Third, a tax credit (TC) package, which temporarily increases labor tax credits for

<sup>&</sup>lt;sup>1</sup>We review the existing literature in Section 1.1.

low-income employed workers—that is, the TC package implements a targeted cut on labor income taxes. We design all three packages so that they amount to the same total spending, financed with a mix of government debt increases and tax adjustments.

While all three fiscal policies mitigate the recession, their effectiveness varies. The TT package mitigates the one-year cumulative output contraction by roughly a fifth; the UI package mitigates the contraction by a third, and the TC package by almost half. It is also useful to report cumulative multipliers at one year, that is, the cumulative output gain relative to no policy per each dollar spent in the package. The TT package yields a multiplier of 0.37 after one year; the UI package's multiplier is 0.60, and the TC multiplier is 0.90. Thus, the TC package is substantially more effective in stabilizing output.

The fiscal packages operate through two margins: a consumption channel and a labor supply channel. The TT package operates through the consumption channel only, targeting low-income households with high mpc. In fact, the TT package may have a detrimental labor supply channel effect, as wealth effects on workers receiving a check may lead contract labor supply. The UI package also operates through the consumption channel only. However, as unemployed workers feature higher mpc than working households, the consumption response to the fiscal stimulus is larger than in the TT package. The TC package is the only one to operate through, both, the consumption channel and a labor supply channel. The tax cuts target low-income workers who exhibit the larger lpe, thus providing strong labor supply channel effects. At the same time, these low-income workers have higher mpc, thus stimulating consumption channel effects. In turn, the TC package results the more potent option we consider.

The potency of the TC package may raise concerns about the strength of the *labor supply channel* in our model. We argue this is not the case: the model-implied *lpe* distribution is conservative, and the unemployment dynamics well empirically founded. In particular, the benchmark calibration implies a moderate *lpe*: an average *lpe* of 0.30, ranging between 0.45 for the bottom quartile and 0.2 for the top quartile. Additionally, we replicate the labor tax cuts experiments of Mertens and Ravn (2013) and Zidar (2019) in our model, and obtain aggregate effects of labor tax cuts smaller than what they empirically estimate. An alternative calibration with an average *lpe* of 0.50 brings the model closer to the aggregate evidence on labor tax cuts, and generates TC multipliers well above unity

Similarly, the calibration features empirically realistic dynamics of unemployment risk over the business cycle. Although in an ad-hoc manner, the Okun's law relation in our model captures the business cycle properties of unemployment risk, and in particular the cross-sectional incidence of unemployment risk over the business cycle (Mueller 2017). Still, we find the TC to be the most potent fiscal policy to stabilize a recession. Thus, we think the strength of the *labor supply channel* is well disciplined by

empirical evidence.

Finally, we also compare the three packages to two other stabilization packages often explored in the literature: a one-time lump-sum check to all households, labeled T package, and increase in government spending, labeled G package. The T package has a small capacity to stabilize the recession, as it fails to target low-*mpc* workers. The G package has large effects on output but crowds out private consumption, a shortcoming that the TC package does not have.

Overall, our findings contribute to the understanding of the macroeconomic implications of fiscal policy interventions in New Keynesian models with heterogeneity, a framework increasingly used for policy analysis. We argue that labor taxes should be included in the policy maker toolkit to fight recessions. Unlike other policies typically sued, labor tax cuts can stimulate, both, demand and supply, thus making it an attractive alternative.

### 1.1 Literature Review

This paper contributes to the rapidly growing literature using HANK models to analyze the effects of monetary policy and government spending—see Kaplan, Moll, and Violante (2018), Bilbiie (2020), Auclert, Rognlie, and Straub (2023), Ferriere and Navarro (2024), among many others. Optimal fiscal and monetary policy using quantitative HANK setup has been considered in Bhandari et al. (2021), Le Grand and Ragot (2022), McKay and Wolf (2023)—all of which discuss the stabilizing properties of fiscal policy. The work in McKay and Reis (2021) analyzes the optimal time-invariant progressivity of the t&T system in the presence of business cycle fluctuations.

A recent literature has used quantitative HANK models to discuss the expansionary effects of unemployment benefits extensions—see Kekre (2022) for a rich model with search frictions on the labor market; Gorn and Trigari (2024) for a tractable model with analytical characterization of stabilizing and destabilizing effects of unemployment benefits extensions; or Bardoczy and Guerreiro (2023) for a focus on the role of expectations on that question.

Two recent papers point out at the importance of labor taxes to stimulate the economy. In a HANK setup with search-and-matching frictions but exogenous labor supply, Broer et al. (2024) show that a temporary labor subsidy to firms can be more expansionary than a temporary extension of UI benefits. Closer to our paper, Le Grand, Ragot, and Bourany (2024) argue that time-varying flat labor taxes are a powerful instrument to stabilize demand shocks in a standard HANK environment.

To the best of our knowledge, our work contributes to the literature by focusing on labor taxes that may vary over the business cycle in a targeted manner. In this sense, our quantitative analysis echoes the analytical work in Bilbiie, Monacelli, and Perotti (2021), who explicitly consider changes in the distribution of taxes in a two-agent New-Keynesian

environment.

An additional contribution of our paper is to make progress in reconciling micro estimates of labor elasticities and the larger macro estimates of tax multipliers (Mertens and Ravn 2013; Zidar 2019).

Section 2 describes the model and its calibration. Section 3 quantifies the effects of fiscal stabilizers in this environment. Section 4 considers various robustness exercises. Section 5 concludes.

### 2 Model

In this section, we develop a HANK model to study the effects of various fiscal polices in the context of a recession. We introduce heterogeneity in discount factors and an extensive labor supply decision, to generate heterogeneity in mpc and lpe in line with the data. We also introduce unemployment risk, with unequal incidence in the distribution. We describe the model environment and its calibration. We finish the section discussing how the model-implied distributions of lpe and mpc compare with their empirical counterparts, as well as how the model-implied aggregate responses to tax changes compare with empirical estimates in Mertens and Ravn (2013) and Zidar (2019).

#### 2.1 Environment

Time is discrete and indexed by  $t = 0, 1, 2, \ldots$  The economy is populated by a continuum of households, intermediate-good producers, a final-good producer, a monetary authority, and a fiscal authority. Households supply labor to intermediate-good producers, who sell their goods to final-good producers. Intermediate-good producers are under monopolistic competition and face a cost of adjusting prices as in Rotemberg (1982). For simplicity, we consider deterministic transition dynamics and use time t to denote the aggregate state of the economy.

Households.—Households value consumption and leisure and face idiosyncratic labor income and unemployment risk. Their labor productivity x follows an exogenous stationary Markov process with transition probabilities  $\pi_x(x'|x)$ . Their unemployment status  $\eta$  follows an exogenous time-varying Markov process  $\pi_{\eta,t}(\eta'|\eta,\cdot)$ . A household with  $\eta = \ell$  faces an indivisible labor supply choice: they can either work  $\bar{h}$  hours or zero (Chang and Kim 2007). A household with  $\eta = u$  is unemployed and faces no labor supply decision.

Households also have differences in their discount factor  $\beta$ , which evolves stochastically following a Markov chain  $\pi_{\beta}(\beta'|\beta)$  (Krusell and Smith 1998). Labor productivity, unemployment, and discount factor shocks are uninsurable: Households can only trade a one-period risk-free bond to self-insure, subject to a nonborrowing limit.

Let  $V_t(a, x, \eta, \beta)$  be the maximal attainable value in period t to a household with assets a, idiosyncratic productivity x, unemployment status  $\eta$  and discount factor  $\beta$ . We first describe the value function of a household with employment status  $\eta = \ell$ .

$$V_{t}(a, x, \ell, \beta) = \max_{c, h, a'} \{ \log(c) - Bh + \beta \mathbb{E}_{t} [V_{t+1}(a', x', \eta', \beta') | x, \beta, \ell) ] \}$$
(1)  
subject to  

$$c + a' \leq a + y^{\ell} + y^{k} - \mathcal{T}_{t}(y^{\ell}, y^{k}) + T_{t} + \tilde{d}_{t}(x),$$
  

$$y^{\ell} = w_{t}xh, \quad h \in \{0, \bar{h}\},$$
  

$$y^{k} = r_{t}a, \quad a' \geq 0,$$

where c and h denote consumption and hours worked,  $w_t$  denotes wages perceived by households, and  $r_t$  denote the real return on households' savings. Households face a distortionary tax  $\mathcal{T}_t(y^\ell, y^k, e)$ —which depends on labor income  $y^\ell = w_t x h$  and capital earnings  $y^k = r_t a$ —and receive a lump-sum transfer  $T_t$ . Finally,  $\tilde{d}_t(x)$  represents the dividend payments received from firms in the economy, which we discuss in more detail below.

As often in discrete choice models, we add a preference shock  $\epsilon_h$  for each possible level of working hours:  $h \in \{0, \bar{h}\}$  hours. The preference shock follows a Gumbel distribution with variance  $\varrho$ .<sup>2</sup> Let  $\mathbb{h}_t^h(a, x, \ell, \beta)$  be the probability of working h hours at time t, and let  $c_t^h(a, x, \ell, \beta)$  and  $a_t^{h'}(a, x, \ell, \beta)$  denote a household's optimal policies conditional on working h hours. Finally, denote  $h_t(a, x, \ell, \beta) = \sum_h h \mathbb{h}_t^h(a, x, \ell, \beta)$ ,  $c_t(a, x, \ell, \beta) = \sum_h c_t^h(a, x, \ell, \beta) \mathbb{h}_t^h(a, x, \ell, \beta)$ , and  $a_t'(a, x, \ell, \beta) = \sum_h a_t^{h'}(a, x, \ell, \beta) \mathbb{h}_t^h(a, x, \ell, \beta)$  the expected policies.

We now turn to the value function of the unemployed household, given as:

$$V_{t}(a, x, u, \beta) = \max_{c, a'} \left\{ \log(c) - B\bar{h} + \beta \mathbb{E}_{t} \left[ V_{t+1}(a', \eta', s', \beta') | x, \beta, u \right] \right\}$$
subject to
$$c + a' \leq a + y^{\ell} + y^{k} - \mathcal{T}_{t}(0, y^{k}) + \mathcal{B}_{t}(w_{t}x) + T_{t} + d_{t}^{h}(x),$$

$$y^{k} = r_{t}a, \quad a' \geq 0.$$
(2)

While unemployed, the household faces labor disutility  $B\bar{h}$ ; this assumption, akin to a disutility cost of searching a job, is irrelevant for business cycle dynamics as there is no endogenous search decision in the model. The household receives unemployment benefits of the form:

$$\mathcal{B}_t(w_t x) = \zeta \max(\rho w_t^h x \bar{h}, \bar{u}i) + \chi w_t^h x \bar{h}. \tag{3}$$

 $<sup>^2</sup>$ Rust (1997) initially proposed using a Gumbel preference shock in dynamic discrete-choice models. See Ferriere and Navarro (2024) for a more detailed discussion.

The first part of the unemployment benefit function mimics the standard statutory benefit, with  $\zeta$  the eligibility rate for unemployment benefits,  $\rho$  the replacement rate, and ui the maximum benefit level. We assume that unemployment benefits are exempt of taxation. We follow Kekre (2022) and allow for an additional transfer proportional to the labor income received if employed. As discussed in Kekre (2022), modeling non-UI income as a transfer offers a parsimonious way to capture the earnings of other household members without extending the framework to model dual-income households. We calibrate  $\chi$  to match the ratio of average consumption of households with  $\eta = u$  to the average consumption of households with  $\eta = \ell$ . Denote  $c_t^h(a, x, u, \beta) = c_t(a, x, u, \beta)$ , and  $a'_t^h(a, x, u, \beta) = a'_t(a, x, u, \beta)$  the consumption and savings policies of unemployed households, and  $h_t^h(a, x, u, \beta) = h_t(a, x, u, \beta) = 0$ . Finally, let  $\mu_t(a, x, \eta, \beta)$  be the measure of households with state  $(a, x, \eta, \beta)$ .

Unemployment Risk.—We model unemployment risk  $\pi_{\eta}(\cdot)$  as a function that depends on, both, idiosyncratic productivity, x, and total output,  $Y_t$ . Guided by empirical evidence presented in Mueller (2017), we make four key assumptions about unemployment risk. First, we assume that, regardless the state of the economy, low-productivity workers are more likely to become unemployed: that is,  $\partial \pi_{\eta}(u|\ell_{-}, x, Y_{t})/\partial x < 0 \ \forall Y_{t}$ . Second, we assume that unemployment is more likely during a recession: that is,  $\partial \pi_{\eta}(u|\ell_{-}, x, Y_{t})/\partial Y_{t} <$  $0 \ \forall x$ . Third, we assume that unemployment duration is independent of the idiosyncratic productivity: that is,  $\pi_{\eta}(\ell|u_{-}, x, Y_{t}) = \pi_{\eta}(\ell|u_{-}, Y_{t})$ . Finally, we assume that unemployment duration is longer during recessions: that is,  $\partial \pi_{\eta}(\ell|u_{-}, Y_{t})/\partial Y_{t} > 0$ . Section 2.3 discusses how we calibrate  $\pi_{\eta}(\cdot)$  to match the evidence in Mueller (2017). To ease notation, we define  $\pi_{\eta,t}(\eta|\eta_{-}, x) \equiv \pi_{\eta}(\eta|\eta_{-}, x, Y_{t})$ .

Final-Good Producers.—A competitive representative final-good producer combines a continuum of intermediate goods—indexed by  $j \in [0,1]$ —to produce the final good  $Y_t$ . Production technology is  $Y_t = \left(\int_0^1 y_{jt}^{\frac{\epsilon-1}{\epsilon}}\right)^{\frac{\epsilon}{\epsilon-1}}$ , where  $\epsilon > 0$  is the elasticity of substitution across intermediate inputs. Profit maximization for the final-good producers reads

$$\max_{\{y_{jt}\}_j} \left\{ P_t Y_t - \int_0^1 P_{jt} y_{jt} dj : \quad Y_t = \left( \int_0^1 y_{jt}^{\frac{\epsilon - 1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon - 1}} \right\}$$
 (4)

where  $P_t$  and  $P_{jt}$  stand for the nominal price of the final good and the intermediate good, respectively. Optimal demand reads

$$y_{jt}^d = \left(\frac{P_{jt}}{P_t}\right)^{-\epsilon} Y_t. \tag{5}$$

<sup>&</sup>lt;sup>3</sup>We assume unemployment benefits are not taxable to simplify the interpretation of our results, with labor-taxes policies targeted to employed workers, and unemployment-benefit policies targeted to unemployed workers. The function  $\mathcal{B}_t(\cdot)$  could thus be interpreted as after-tax unemployment benefits. Similar assumptions are made in Gorn and Trigari (2024).

Intermediate-Good Producers.—The intermediate good is produced with a linear production function in effective labor  $n_{jt}$ . Intermediate-good producers set prices subject to a quadratic price adjustment cost. Let  $J_t(P_{jt-1})$  be the maximal attainable value at time t to an intermediate-good producer that posted prices  $P_{jt-1}$  last period:

$$J_{t}(P_{jt-1}) = \max_{P_{jt}, y_{jt}, n_{jt}} \left\{ d_{jt} + \frac{1}{1 + r_{t+1}} J_{t+1} \left( P_{jt} \right) \right\}$$
subject to
$$d_{jt} = \frac{P_{jt}}{P_{t}} y_{jt} - w_{t} n_{jt} - \Theta_{t}(P_{jt}, P_{jt-1}) - \Phi$$

$$y_{jt} = \left( \frac{P_{jt}}{P_{t}} \right)^{-\epsilon} Y_{t}$$

$$y_{jt} = n_{jt}$$

$$\Theta_{t}(P_{jt}, P_{jt-1}) = \frac{\Theta}{2} \left( \frac{P_{jt}}{P_{jt-1}} - \bar{\Pi} \right)^{2} Y_{t}$$

$$(6)$$

where  $w_t$  is the wage paid to the households and  $\Phi$  is a fixed operating cost. The cost of adjusting prices is  $\Theta_t(\cdot)$ , where  $\bar{\Pi}$  is the inflation target of the monetary authority. All firms discount flows at the real rate  $r_t$ , which is justified by an arbitrage argument in this economy without aggregate uncertainty.

Intermediate-goods producers are all identical, so we focus on a symmetric equilibrium with  $P_{jt} = P_t \ \forall j, t$ . Optimal decisions yield the usual New Keynesian Phillips curve:

$$\left(\Pi_t - \bar{\Pi}\right)\Pi_t + \frac{\epsilon - 1}{\Theta} = \frac{\epsilon}{\Theta}w_t + \frac{1}{1 + r_{t+1}}\left(\Pi_{t+1} - \bar{\Pi}\right)\Pi_{t+1}\frac{Y_{t+1}}{Y_t}.$$
 (7)

Fiscal Authority.—The government's budget constraint is given by

$$G_t + (1+r_t)D_t + T_t + \int \mathcal{B}_t(w_t x)d\mu_t(a, x, u, \beta) = \dots$$

$$D_{t+1} + \int \mathcal{T}_t(w_t x h_t(a, x, \eta, \beta), r_t a)d\mu_t(a, x, \eta, \beta)$$
(8)

where  $D_t$  is the government's debt. As we discuss in detail below, the tax function  $\mathcal{T}_t(\cdot)$  will incorporate a flat component on capital income and a progressive component on labor income.

Monetary Authority.—Monetary policy is fully described by a Taylor rule that sets the short-term nominal interest rate as

$$\ln\left(\frac{1+i_{t+1}}{1+\bar{i}}\right) = \phi_{\Pi} \ln\left(\frac{\Pi_t}{\bar{\Pi}}\right),\tag{9}$$

where  $\phi_{\Pi} > 1$  and  $\bar{i}$  is the steady state of the nominal interest rate. Given inflation and

the nominal interest rate, the real return  $r_t$  is determined by the Fisher equation as

$$1 + r_t = \frac{1 + i_t}{\Pi_t}. (10)$$

We assume that the returns on government bonds and household deposits are determined in real terms. Expressing returns in real or nominal terms is irrelevant in an economy with perfect foresight, except at the first period of the realization of an unexpected shock.

### 2.2 Equilibrium

We discuss market clearing for labor, assets, and goods markets.

The labor market between households and intermediate-good producers—that is,

$$L_t \equiv \int x h_t(a, x, \ell, \beta) d\mu_t(a, x, \ell, \beta) = \int n_{jt} dj \equiv N_t, \tag{11}$$

where  $L_t$  is households' effective labor supply, and  $N_t$  is the labor demand by intermediategoods producers in a symmetric equilibrium. Market clearing in the assets markets requires that government's debt equates households' savings, that is,

$$D_t = \int ad\mu_t(a, x, \eta, \beta). \tag{12}$$

Market clearing in the goods market reads

$$Y_t = G_t + C_t + \Theta_t + \Phi, \tag{13}$$

where  $C_t \equiv \int c_t(a, x, \eta, \beta) d\mu_t(a, x, \eta, \beta)$  is the consumption of all households and  $\Theta_t$  is the price adjustment costs by intermediate-goods producers. Finally, firms' dividends are distributed across all households:  $\int \tilde{d}_t(x) d\mu_t(a, x, \eta, \beta) = \int d_{jt} dj$ .

Let  $\mathbb{A}$  be the space for assets a,  $\mathbb{X}$  be the space for productivities x,  $\mathbb{E} = \{\ell, u\}$  be the space of employment status, and  $\mathbb{B}$  be the space for discount factors  $\beta$ . Define the state space  $\mathbb{S} = \mathbb{A} \times \mathbb{X} \times \mathbb{E} \times \mathbb{B}$ , with typical element  $\mathbf{s} \in \mathbb{S}$ , and let  $\mathcal{S}$  be the Borel  $\sigma$ -algebra induced by  $\mathbb{S}$ . A formal equilibrium definition for the economy is provided next.

Definition 1 Given sequences for government policies  $\{G_t, T_t, D_t, \mathcal{T}_t(\cdot), \mathcal{B}_t(\cdot)\}_t$ , an equilibrium in this economy is given by: sequences of prices  $\{r_t, w_t, i_t, \Pi_t\}_t$ ; sequences of households' values  $\{V_t(s)\}_t$ , policies  $\{h_t^h(s), c_t^h(s), a_t^{\prime h}(s)\}_{ht}$ , and measures  $\{\mu_t(s)\}_t$ ; intermediate-good producers' policies  $\{n_{jt}\}_{jt}$ ; such that (i) households' policies solve their problem and achieve values  $V_t(s)$ ; (ii) intermediate-goods producers' policies solve their problem; (iii) the government's budget constraint is satisfied; (iv)  $i_t$  and  $r_t$  satisfy equations (9)-(10); (v) labor, assets, and goods markets clear as in (11)-(13); and (vi) the measure evolves consistently with the households' policies:  $\mu_{t+1}(S_0) = \int Q_t(s, S_0) d\mu_t(s) \ \forall S_0 \in S$ ,

**Table 1:** Wealth Distribution and Employment by Wealth Quartile

	Wealth quartile			
	1	2	3	4
Share of wealth	0.00	0.03	0.12	0.84
Employment rate	0.87	0.81	0.78	0.70

Notes: Households are sorted by wealth. Employment includes working and unemployed workers.

where  $Q_t(\cdot)$  is a transition function given as  $Q_t(s, S_0) = \mathbb{I}(a'_t(s) \in S_0) \sum_{(x', \eta', \beta') \in S_0} \pi_x(x'|x)$  $\pi_{\beta}(\beta'|\beta')\pi_{\eta,t}(\eta'|\eta, x).$ 

### 2.3 Calibration

A period in the model is a quarter. We calibrate the model in steady state and denote X—suppressing time indexes—as the steady-state value of variable  $X_t$ . We then discuss unemployment risk and fiscal policy in response to output fluctuations. Table 2 summarizes the parameter values.

Households' Parameters.—We set the level of hours when employed to  $\bar{h}=1/3$ . We follow Chang, Kim, and Schorfheide (2013) and set the idiosyncratic labor productivity x shock to follow an AR(1) process in logs:  $\log(x') = \rho_x \log(x) + \varepsilon_x'$ , where  $\varepsilon_x \sim \mathcal{N}(0, \sigma_x)$ , with  $\sigma_x = 0.287$  and  $\rho_x = 0.939$ . We calibrate the dis-utility of working B to match an employment rate of 78% including unemployment, as in Jang, Sunakawa, and Yum (2023). We set the variance of the working preference shock to  $\varrho = 0.256$  as to match an average lpe of 0.30, as we discuss in more detail below. As shown in Table 1, a variance above 0 also helps to flatten employment rates per wealth, making the model closer to the data (Ferraro and Valaitis 2024; Jang, Sunakawa, and Yum 2023).

We calibrate heterogeneity in discount factors  $\beta$  to match the households' wealth distribution. We assume  $\beta$  can take three values:  $\beta \in \{\beta_{\text{low}}, \beta_{\text{mid}}, \beta_{\text{high}}\}$ . We follow Krusell and Smith (1998) and assume a persistence of  $\pi_{\beta}(\beta, \beta) = 0.995$ , corresponding to an average duration of 50 years, and, conditional on switching,  $\beta$  can only move to an adjacent value on the grid. Additionally, we assume  $\Delta\beta = \beta_{\text{high}} - \beta_{\text{mid}} = \beta_{\text{mid}} - \beta_{\text{low}}$ . We set  $\beta_{\text{high}} = 0.993$  to match an annualized interest rate of r = 3.5% and  $\Delta^{\beta} = 0.045$  to match the wealth concentration of the top quartile. As shown in Table 1, the model generates a wealth share of 84% for the top quartile, close to its empirical counterpart in the Survey of Consumer Finance (SCF).

Unemployment Risk.—We calibrate unemployment risk as:

$$\pi_{\eta}(u|\ell,x) = \phi_0 x^{\phi_1},$$

<sup>&</sup>lt;sup>4</sup>These numbers are estimated using the whole sample of Panel Study of Income Dynamics (PSID) ages 18 to 65 from 1979 to 1992.

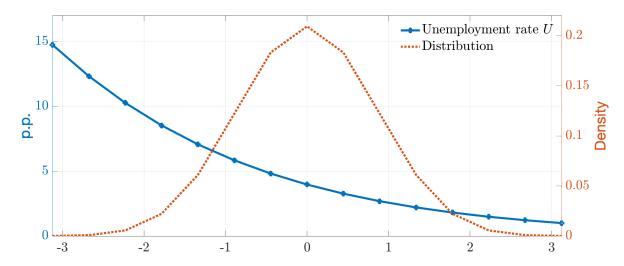


Figure 1: Steady State Cross-Sectional Unemployment Rate

**Note:** The blue curve plots steady state unemployment rate by level of labor productivity x in log. The red curve plots the mass of household by level of labor productivity x.

where  $\phi_0 > 0$  and  $\phi_1 < 0$  are calibrated to match separation rates that decrease by wage group. Using using US data from 1980 to 2012, Mueller (2017) estimates monthly separation rates equal to 0.014 for workers below the median hourly wage and equal to 0.007 for workers below the median hourly wage. We set  $\phi_0$  and  $\phi_1$  to match these separation grates by wage groups.

While unemployed, we assume a job finding rate independent of x, in line with estimates in Mueller (2017):

$$\pi_{\eta}(\ell|u,x) = \phi_2.$$

Mueller (2017) estimate a monthly finding rate of 0.32, which disciplines  $\phi_2$ . This calibration generates a steady state unemployment rate U equal to 4.3%. Unemployment rates per labor productivity x are reported in Figure 1.

Technology Parameters.—We set  $\epsilon = 7$ , which is a standard value in the literature. We set  $\Theta = 200$  to match a Phillips curve slope,  $\epsilon/\Theta$ , of 0.035, in the midrange of estimates provided in Galí and Gertler (1999). We set the fixed cost of production  $\Phi$  so that intermediate producers make zero profits in steady state.

Distribution of Profits.—Intermediate-good producers may make profits, which are paid out as dividends. Let  $d_t = \int_0^1 d_{jt} dj$  be the dividends paid in period t. We follow Farhi and Werning (2020) and assume these dividends are rebated to households in proportion to their labor productivity; that is,  $\tilde{d}_t(x) = \bar{d}_t x$ . The value of  $\bar{d}_t$  is pinned down such that all profits are distributed:  $d_t = \bar{d}_t \mu_x$ , where  $\mu_x = \mathbb{E}[x]$  is the unconditional mean of idiosyncratic productivity x. This rule realistically implies that profits are more heavily concentrated in high-income households, which are typically wealthier. As such, it limits aggregate consequences of profit redistribution.

Unemployment Benefit.—We follow Kekre (2022) to calibrate the unemployment ben-

efits, and set the fraction of households receiving UI benefits to  $\zeta = 0.4$ , the replacement rate to  $\rho = 0.5$ , and the maximum UI benefit ui to 60% of mean income. We calibrate the parameter  $\chi$  to match an average consumption of unemployed to employed households equal to 70%, as discussed in Gorn and Trigari (2024). Given the calibration of the statutory part of UI benefits, this implies that consumption falls by about 10% when a household falls into unemployment, a number in line with empirical estimates provided in Saporta-Eksten (2014) and Ganong and Noel (2019).

Tax Function.—We assume a tax function  $\mathcal{T}(wxh, ra)$  with a flat tax on capital income  $\tau_k$ , and a non-linear tax rate  $\tau_{\ell}(\cdot)$  on labor income wxh:  $\mathcal{T}(wxh, ra) = \tau_k ra + \tau_{\ell}(w^hxh)w^hxh$ . The capital tax rate  $\tau_k$  is set to 35%, following Chen, Imrohoroglu, and Imrohoroglu (2007). This number primarily reflects two flat taxes: corporate income taxes and property taxes.

For the labor tax, we assume a log-linear tax on labor income  $y_{\ell}$  as  $\tau_{\ell}(y_{\ell}) = 1 - \lambda y_{\ell}^{-\gamma}$ . With only two parameters, this tax function features a remarkable fit to the U.S. federal income tax system.<sup>5</sup> The first parameter,  $\gamma$ , measures the progressivity of the taxation scheme. When  $\gamma = 0$ , the tax rate is constant, while a positive (negative)  $\gamma$  describes a progressive (regressive) taxation scheme. The second parameter,  $\lambda$ , measures the level of taxation. An increase in  $1 - \lambda$  raises tax rates for all levels of income, while an increase in  $\gamma$  makes tax rates higher for high-income and lower for low-income households. We set  $\gamma = 0.1$ , a value in line with tax estimates in the literature. The value of  $\lambda$  is pinned down by the government's budget constraint.

Fiscal and Monetary Authority Parameters: Steady State.—We calibrate transfers T to match a transfers-to-output ratio of 8.2%, the historical average for the post-WWII period, and G to match a spending-to-output ratio of 10%, a number within the range of what is typically used in the literature.<sup>6</sup> Public debt D is set to match a debt-to-output ratio of 100% annually. Finally, we assume an inflation target of  $\bar{\Pi} = 1$ , and a monetary authority that responds with  $\phi_{\Pi} = 1.5$  to inflation deviations from its target.

#### 2.3.1 Unemployment Risk Over the Business Cycle

We model the business-cycle component of the unemployment risk process,  $\pi_{\eta,t}(\eta|\eta_-,x)$ , to target an empirically realistic Okun's law type of relation between output and unemployment, with a semi-elasticity coefficient of  $c^{Ok} = 0.5$ . That is, when output falls by 1% with respect to its steady-state level, unemployment increase by 0.5 p.p. with respect to its steady-state value. We want unemployment to potentially play a non-negligible role in the model dynamics, and thus target this value for  $c^{Ok}$  which is on the upper end of empirical estimates in the literature (Ball, Leigh, and Loungani 2017).

<sup>&</sup>lt;sup>5</sup>See Feldstein (1969), Heathcote, Storesletten, and Violante (2014) and Ferriere et al. (2023), among others.

<sup>&</sup>lt;sup>6</sup>Typical numbers go from about 6% (Brinca et al. 2016) to 18% (Smets and Wouters 2007).

**Table 2:** Parameter Calibration

Steady State			
Labor supply	$\bar{h} = 1/3$	B = 0.654	$\varrho = 0.256$
Income risk	$\rho_x = 0.939$	$\sigma_x = 0.287$	
Unemployment risk	$\phi_0=0.03$	$\phi_1 = -0.45$	$\phi_2 = 0.69$
Discount factors	$\beta_{\text{high}} = 0.993$	$\Delta_{\beta} = 0.045$	$\pi_{\beta}(\beta,\beta) = 0.995$
Taxes	$\tau_k = 0.35$	$\gamma = 0.1$	$\lambda = 0.71$
Other fiscal variables	T = 0.03	G = 0.04	D = 1.55
UI benefits	$\zeta = 0.4$	$\rho = 0.5$	$ui = 0.65\mathbb{E}[y]$
Additional UI transfer	$\chi = 0.15$		
Nominal rigidities	$\epsilon = 7$	$\Theta = 200$	
Response to the Cycle			
Monetary and fiscal policy	$\phi_{\Pi} = 1.5$	$\phi_D = 0.75$	
Unemployment: job finding rates	$\bar{\phi}_{\ell} = 0.6$	$\phi_{\ell,o} = 11.81$	
Unemployment: separation rates	$\bar{\phi}_u = 0.33$	$\phi_{u,x} = 0$	

We assume that separation rates fluctuate over the business cycle with an additive component relative to its steady-state value:

$$\pi_{\eta,t}(u|x,\ell) = \pi_{\eta}(u|x,\ell) - \bar{\phi}_u \Delta Y_t x^{-\phi_{u,x}}$$

where  $\Delta Y_t$  is the log-change of output relative to steady state. The parameter  $\bar{\phi}_u$  captures the average response of separation rates to a change in output  $\Delta Y_t$ , while the parameter  $\phi_{u,x}$  allows for the separation responses to be heterogeneous depending on the worker's productivity x. A positive value of  $\bar{\phi}_u$  means that lower output  $\Delta Y_t$  leads to higher separation rates. A positive value  $\phi_{u,x}$  means a lower pass-though of  $\Delta Y_t$  to separations as workers' productivity x increases.

We model the response of job finding rates to the business cycle to target a constant elasticity to aggregate unemployment rate, which we obtain with the following function form:

$$\log \pi_{\eta,t}(\ell|u,x,Y_t) = \log \pi_{\eta}(\ell|u,x) - \bar{\phi}_{\ell} \log(1 - \phi_{\ell,o}\Delta Y_t).$$

The value of  $\phi_{\ell,o}$  translates an output change into a change in unemployment rate, so that the value of  $\bar{\phi}_{\ell}$  captures the elasticity of job finding rates to unemployment rate. Note that we assume a homogenous response of finding rates to  $\Delta Y_t$  over idiosyncratic productivity x, consistent with estimates in Mueller (2017).

We then jointly calibrate  $\{\bar{\phi}_u, \phi_{u,x}, \bar{\phi}_\ell, \phi_{\ell,o}\}$  to match an Okun's coefficient of  $c^{Ok} =$ 

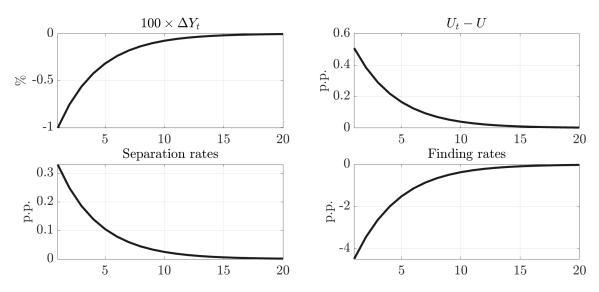


Figure 2: Dynamics of Unemployment After A Recession: Aggregates

**Note:** The top right panel reports the response of aggregate unemployment to the output fall reported in the top left panel. The bottom left panel reports the increase in separation rates resulting from the output fall, while the bottom right panel reports the associated decrease in job finding rates.

0.5, as well as the cross-sectional cyclicality of separations and finding rates as estimated in Mueller (2017). In particular, we set  $\phi_{\ell,o} = c^{Ok}/U$  to translate an output change into unemployment change, consistently with our Okun's law; we then set  $\bar{\phi}_{\ell} = 0.6$  to match the elasticity of finding rates of -0.6 estimated in Mueller (2017). Regarding separation rates, Mueller (2017) finds that the elasticity of separation rates is larger for high-wage workers. Since high-wage workers have a lower average separation rate, the larger estimated elasticity implies that the change in the level of separation rates is rather flat across workers. As such, we set we set the parameter  $\phi_{\ell u,x} = 0$ , and  $\bar{\phi}_u = 0.33$  to match our target of the Okun's law coefficient.

Figures 2 and 3 report dynamics of unemployment after an output fall of 1%. In line with the targeted Okun's law, unemployment increases by about 0.5 percentage points when output falls by 1%. This increase in unemployment is generated by a strong fall in job finding rates (bottom right graph of Figure 2), together with a moderate increase in separation rates (bottom left of Figure 2). Note that, while separation rates and job finding rates move homogeneously in the distribution in a recession, it does not imply that overall unemployment increases in a homogeneous way in the cross-section. Indeed, because steady state unemployment is larger for low-productivity households, the increase in unemployment is also larger at the bottom of the wage distribution, as shown in Figure 3.

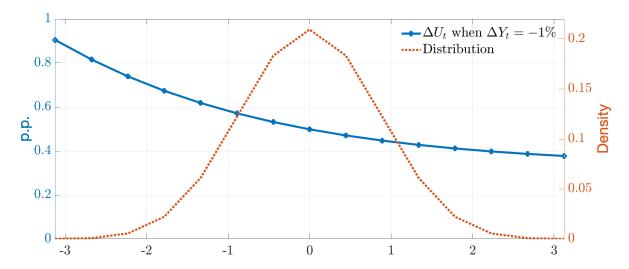


Figure 3: Dynamics of Unemployment After A Recession: Cross-Section

**Note:** The blue curve plots the change in unemployment rate after an output fall of 1% by level of labor productivity x in log. The red curve plots the mass of household by level of labor productivity x.

#### 2.3.2 Debt Financing over the Business Cycle

We assume that debt follows a rule in the spirit of Uhlig (2010). In particular,

$$D_{t+1} = (1 - \phi_D)D + \phi_D \left(\hat{G}_t - \tau^k r_t A_t - \mathcal{R}_t^{\ell}\right)$$

where

$$\hat{G}_t = G_t + T_t + \mathcal{U}_t + (1 + r_t)D_t$$

captures total government expenditures and

$$\mathcal{R}_t^{\ell} = w_t L_t - \lambda \int (w_t x h_t(a, x, \eta, \beta))^{1-\gamma} d\mu_t(a, x, \eta, \beta),$$

captures the fiscal revenues the government would have raised from labor taxes if the labor tax schedule was kept at its steady-state value. When  $\phi_D=0$ , debt remains constant, and the government only adjusts the level of the labor tax  $\lambda_t$  to meet its budget constraint. A higher  $\phi_D$  translates into a larger utilization of debt, with a limiting case of  $\phi_D=1$  where labor taxes remain constant at  $\lambda$ . We use  $\phi_D=0.75$  as a benchmark—that is, most adjustment in the cycle is done with public debt.

In practice, debt will moderately increase when the economy goes into recession, because the tax base will contract, and thus  $\mathcal{R}_t^{\ell}$  decreases. Debt will increase more when the government adopts various fiscal stabilization packages to fight the recession, as we will see in Section 3.

**Table 3:** Marginal Propensities to Consume.

	Wealth quartile			
	1	2	3	4
$\overline{mpc}$	0.19	0.15	0.07	0.03

Notes: Households are sorted by wealth. The mpc are computed out of a \$500 rebate and at the quarterly level.

### 2.4 Heterogeneity in *lpe* and *mpc*

The calibrated model generates a rich heterogeneity of mpc and lpe across households, which we next compare with data counterparts. Distributions of mpc and lpe are key to the response of the fiscal stimuli that we explore in Section 3.

Marginal Propensities to Consume.—We report mpc in Table 3. We compute in the model the consumption response to an unexpected one-time rebate of \$500. The average mpc amounts to 0.13 at the quarter level, that is, 0.45 at the annual level—see Crawley and Theloudis (2024) for an overview of the empirical literature estimating mpc.<sup>7</sup> The mpc also declines in wealth, with an mpc close to 0.20 for the bottom quartile and falling to 0.03 for the top quartile. Another important dimension of heterogeneity is the unemployment status: the average mpc is 0.12 for employed households and 0.32 for unemployed households.

Labor Participation Elasticities.—We compute lpe using two approaches. First, we simulate a 1% transitory increase in after-tax rates and compute lpe using labor responses to the tax change. In particular, we assume a 1% increase in  $\lambda$  the tax level parameter, imposed for four consecutive quarters to mimic a typical change in the tax code. Then, the parameter  $\lambda$  returns to steady-state at a persistence 0.75, the shock persistence we use in Section 3. We compute the annual response of hours worked and obtain an aggregate lpe of 0.30, a standard number in the literature. We also sort households by their annual income and compute lpe by income quartile, which we report in the first line of Table 4. The lpe decline with income, at 0.44 for the bottom quartile and slightly above 0.22 for the top quartile. This distribution is in line with a large body of evidence showing larger labor supply responsiveness for lower-income earners—and often well above 0.5—as discussed in Blundell (1995), Keane (2011), and Meghir and Phillips (2010) among many others.<sup>8</sup>

As a robustness, we also measure *lpe* using a steady-state simulation and regressing hours worked on after-tax hourly wages (Altonji 1986; Blundell, Duncan, and Meghir 1998; MaCurdy 1981). Most empirical studies use annual data, thus we simulate a panel of households at a quarterly frequency and then time-aggregate to an annual frequency. We

<sup>&</sup>lt;sup>7</sup>The annual  $mpc^y$  can be obtained as  $mpc^y = 1 - (1 - mpc)^4$ . A more accurate measurement of the annual mpc can be obtained by quasi simulation—see Ferriere and Navarro (2024) for a discussion.

<sup>&</sup>lt;sup>8</sup>See Ferriere and Navarro (2024) for an extensive discussion of this literature.

**Table 4:** Labor Participation Elasticities.

	Income quartile			
	1	2	3	4
lpe [1]	0.44	0.34	0.25	0.22
lpe [2]	0.56	0.59	0.50	0.26

**Notes:** Households are sorted by income. The *lpe* are computed at the annual frequency. Line [1] reports *lpe* out of a simulated temporary tax change. Line [2] reports *lpe* computed using simulated steady-state data. See text for more details.

then estimate the following regression:

$$\log h_{in} = b_0 + b_1 \log \tilde{w}_{in} - b_2 \log c_{in} + \varepsilon_{in},$$

where  $h_{in}$ ,  $\tilde{w}_{in}$  and  $c_{in}$  denote hours worked, after-tax hourly wage, and consumption of household i in year n.<sup>9</sup> We report the parameter  $b_1$ , which is typically referred to as the micro-Frisch labor supply elasticity. While this approach delivers lpe which are more sensitive to model details, it is also closer to the empirical literature on labor elasticities.

The average model-implied *lpe* amounts to 0.45, a number larger than the 0.30 obtained by simulating a tax shock, but which remains well in line with the micro literature. The distribution of *lpe* follows the pattern of our previous *lpe* estimates, with higher elasticity for bottom-income groups. Overall, while this approach delivers larger elasticities, the heterogeneity in *lpe* across income groups remain moderate, ranging from 0.26 to 0.59.

#### 2.5 Tax Shocks

The key new policy we analyze in this paper is labor tax cuts. In turn, we compare the model-implied aggregate responses to labor tax cuts with the empirical estimates in Mertens and Ravn (2013) and Zidar (2019). As we argue, the model responses broadly align with evidence. If at all, the model understates the potency of labor tax cuts.

Mertens and Ravn (2013) use postwar U.S. data to estimate tax multipliers out of changes in personal income tax rates. In their benchmark estimate, they find that a personal income tax cut leads to a multiplier above 2. That is, personal income increases by more than \$2 for each \$1 of revenue lost by the tax cut.

We replicate Mertens and Ravn (2013) exercise in our model. In particular, we assume an unexpected and transitory decline in labor taxes for all workers. We implement the labor tax cut by unexpectedly increasing the tax level parameter  $\lambda$ , which then returns to steady state with a persistence rate of 0.75. We perform our exercise in partial equilibrium and assume that other prices are constant. Model-implied multipliers are moderate, at

<sup>&</sup>lt;sup>9</sup>We drop observations with annual hours equal to 0.

around 0.6 on impact.

Zidar (2019) further investigates the impact of personal income tax changes across different income groups, using postwar U.S. data. They find that tax cuts for the bottom 90% of the income distribution leads to higher employment, whereas tax cuts for the top 10% have no significant effect on either employment nor output. Specifically, a tax cut of 1% of output for the bottom 90% income group results in approximately a 3 percentage points increase in employment over a two-year period.

We replicate Zidar (2019) exercise and implement a change in labor taxes to either the bottom 90% of income distribution or the top 10% of the income distribution. As before, we implement the tax change in partial equilibrium with an unexpected and transitory change in the tax-level parameter  $\lambda$ . The model-implied response broadly aligns Zidar (2019): the tax cut for the top 10% income group has minimal effects on employment, increasing employment by only 0.16% on impact, while the tax cut for the bottom 90% income group has a more substantial effect, raising employment by slightly more than 1% on impact. Again, model-implied responses are more moderate than their empirical counterpart.

One caveat should be raised. While the model-implied level of employment responses are modest relative to evidence, the timing of the response is faster. In particular, the model response peaks on impact while it takes 3 quarters in Mertens and Ravn (2013) estimates and almost two years in Zidar (2019) estimates. This absence of a delayed response is common in models without richer features, such as costly capital adjustments—see Section 3.4 for a further discussion.

Overall, we see our calibration of the *labor supply channel* as conservative. Aggregate *lpe* is 0.3, heterogeneity in *lpe* is moderate, and the macroeconomic effects of tax changes are small compared to their empirical counterparts. Yet, as we show next in Section 3, labor tax cuts are a potent instrument to stabilize a recession.<sup>10</sup>

# 3 Quantitative Experiment

We model a demand-driven recession as a sudden decline in households' willingness to consume, and first analyze responses of macroeconomic variables to this contractionary aggregate demand shock. We then introduce three fiscal stabilization packages, which amount to the same total spending, but have very different effects on the macroeconomy: a targeted transfer (TT) package, which temporary increase transfers for all low-income households; an unemployment insurance (UI) package, which temporary increase UI ben-

<sup>&</sup>lt;sup>10</sup>Section 4 presents an alternative calibration with larger and steeper *lpe*, which generate macroeconomic effects of tax cuts closer to estimates found in Mertens and Ravn (2013) and Zidar (2019). In this calibration, which remains broadly aligned with the data, the effectiveness of temporary tax credits is even further enhanced.

efits for all unemployed households; and a tax-credit (TC) package, which temporary increases tax credit for low-income working households. We conclude this section with a comparison to other standard fiscal stabilization packages: a transfer (T) package, that is, a one-time lump-sum check to all households; and a government spending (G) package, that is, a temporary increase in public spending.

### 3.1 Recession

We engineer a demand-driven recession with a preference shock  $\omega_t$  multiplying the instantaneous utility function. In particular, we assume that, from  $\omega = 1$  in steady state, the preference shock unexpectedly falls in t = 0 and reverts to its steady-state value with a quarterly persistence of  $\rho_{\omega} = 0.75$ . We calibrate the initial fall to generate an output contraction of about 12 basis points on impact. We assume the economy was at steady state before the preference shock and that there is perfect foresight after the shock.

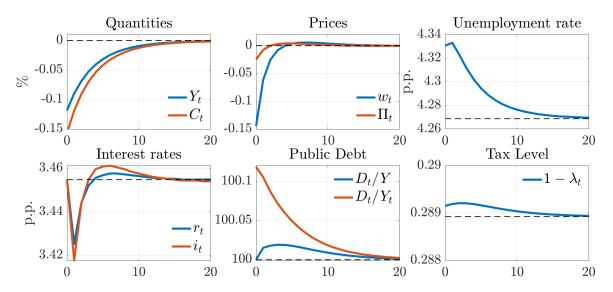


Figure 4: Impulse Responses to a Negative Demand Shock

Note: Impulse responses of a demand-driven recession engineered as a temporary shock to instantaneous utility.

Figure 4 presents impulse responses of macroeconomic variables to a demand-driven recession engineered as a temporary shock  $\{\omega_t\}$ . Output contracts by 0.12% on impact, with moderate persistence: after 10 quarters, the economy has almost returned to steady state. Consumption also contracts, by about 0.15% on impact. Unemployment increases by about 5 basis points, consistent with an Okun's coefficient of 0.5. As standard with an aggregate demand shock, wages and inflation drop. On the fiscal side, public debt increases moderately, as the tax base of the labor income tax decreases in recession.

### 3.2 Fiscal packages

We explore the aggregate response of the economy to three alternative fiscal stabilization packages. All packages amount to a total spending equivalent to giving a one-tome check of \$200 to all households. We describe the implementation of each program, as well as their effects on output, consumption, and prices.

**The TT package.** The first fiscal stabilization package implements a temporary transfer to all low-income households.

We build on Ferriere et al. (2023) and model transfers that phase out with income through the means of logistic functions. In particular, for a given income y, the temporary transfer is defined as:

$$\hat{T}_t(y) = m_t \frac{2 \exp(-\xi y/\bar{y})}{1 + \exp(-\xi y/\bar{y})},$$

where  $m_t$  is the amount of transfers received at no income y = 0, and  $\xi$  is the phase-out rate, capturing the speed at which transfers phase out with income relative to steady-state mean income  $\bar{y}$ .

Such checks have been implemented in the last decades, a well-known example being during the 2008 crisis. In that example, the dollar amount of the checks were determined by the level of income reported by each household to the IRS during the previous fiscal year. As such, apart from their wealth effect, the checks did not feature any direct distortionary effect on household behaviors. To mimic this design, we assume that a household with states  $(x, \eta, \beta)$  is eligible to the transfer based on  $\tilde{y}(x, \eta, \beta)$  the mean steady-state pre-tax income of a household with productivity x, employment status  $\eta$  and discount factor  $\beta$ , which is a good proxy for assets:

$$\tilde{y}(x,\eta,\beta) = \int \{ wxh(a,x,\eta,\beta) + ra\} d\mu(a,x,\eta,\beta).$$

Such a design ensures that the transfer does not directly distort labor or savings decisions, as the amount of transfer received by a household only depends on its exogenous states.

To give this program an automatic stabilizer flavor, we assume that transfers phase out in time at the same rate as the economy returns to steady state. That is, we fix an initial transfer  $m_0$  and assume that  $m_t = \rho_{\omega} m_{t-1}$ , where  $\rho_{\omega} = 0.75$ . The transfer is designed to phase out rather quickly over income, with a phase-out rate of  $\xi = 12$ . We compute  $m_0$  such that the total cost of this program equates a one-time check of \$200 to all households. The program features a transfer of about \$900 at  $\tilde{y} = 0$ , and is well targeted at the bottom of the income distribution with only 20% of households receiving more than \$50 in the first period of the recession.

The UI package. The second fiscal stabilization package implements a temporary transfer to unemployed households:

$$\hat{T}_t(\eta) = m_t$$
 if  $\eta = u$ .

We assume the same persistence  $\rho_{\omega}$  as in the previous package and find the initial transfer  $m_0$  such that the cost of this second package is equivalent to giving one check of \$200 to all households. This procedure yields a transfer of about \$1,100 to all unemployed households in the first period, which then phase out over time with a persistence rate of 0.75.

The TC package. The third fiscal stabilization package implements a temporary transfer to working-poor households. Again, we model the transfer using logistics functions, but makes three assumptions which depart from the TT package: (1) the transfer depends on current income; (2) the transfer depends on labor income only, and (3) the transfer can only be received if labor income is positive:

$$\hat{T}_t(y_\ell) = m_t \frac{2 \exp(-\xi y_\ell/\bar{y})}{1 + \exp(-\xi y_\ell/\bar{y})}$$
 if  $\eta = e \& y_\ell > 0$ .

The transfer is akin to a non-refundable labor tax credit, and as such implements a temporary labor tax cut targeted to low-income working households.

Again, we assume that  $m_t$  phase out over time with a persistence of  $\rho_{\omega} = 0.75$ , and we pick  $m_0$  to equate the total cost to the one of giving one check of \$200 to all households. We also assume a slower phase-out rate at  $\xi = 6$ , which maximizes the efficiency of this instrument. This procedure yields a maximum transfer of \$800 for the poorest working household in the first quarter of the recession.

**Comparison.** Figure 5 reports responses of quantities, prices, and fiscal variables, for each experiment. Figure 6 reports cumulative multipliers, computed as the sum of spending in the fiscal package over the sum of output under the fiscal stimulus package minus the output without any fiscal package:

$$M_j = \frac{\sum_{t=0}^{j} (Y_t^f - Y_t^b)}{\sum_{t=0}^{j} \hat{T}_t},$$

where  $Y_t^f$  denotes the path for output when a fiscal package  $\hat{T}_t$  is adopted while  $Y_t^b$  denotes the path for output under no fiscal package.

The TT package stabilizes the economy and reduces the one-year cumulative output contraction by 20%. Consumption decreases less than in the benchmark without fiscal stabilization, and unemployment does not increase as much. The TT package also has

marked inflationary effects.

The UI package appears more efficient than the TT package to stabilize the economy, with a reduction of the one-year cumulative output contraction by 32%. It is also associated with a lower increase in wages and inflation. However, two points should be noted regarding the model measurement of the efficacy of the UI package. First, the model abstracts from endogenous search, and thus does not account for the distortionary effects of the transfer on job finding rates. As such, the model overstates the efficacy of the UI package to stabilize the economy. Second, the model abstracts from the heterogeneity across unemployed households, between recipients and non-recipients of UI benefits. The consumption response of the average unemployed household that we measure in the model may be smaller than the average consumption response across recipients and non-recipients in the data. As such, the model may also understate the efficacy of the UI package to stabilize the economy.<sup>11</sup>

The TC package is by far the most efficient fiscal stabilization package. It reduces the one-year cumulative output contraction by 48%. It is also associated with significantly less inflation, related to the effect of the fiscal package on incentives to work. In the TT package, wages increase as compared to the benchmark, to incentivize households to work despite the transfer. In the TC package, instead, incentives to work are enhanced by the tax credit itself. Wages remain low, which dampens inflation.

The efficiency of tax credits is particularly visible when computing cumulative multipliers in Figure 6. The multiplier is at 0.9 at 4 quarters for the TC package, while it is only equal to 0.6 for the UI package and 0.37 for the TT package.

**Decomposition.** All packages operate through two margins: a consumption channel, and a labor-supply channel. To quantify each channel, we compute responses of supply and demand output at the equilibrium paths for prices and taxes of the benchmark experiment without fiscal intervention. That is, for each fiscal package, we compute what would have been the households' policies  $\{\hat{c}_t, \hat{h}_t\}$  and the associated measure  $\{\hat{\mu}_t\}$ , should the fiscal package have been implemented but all equilibrium sequences follow their benchmark path, denoted by a subscript b:  $\{r_t^b, w_t^b, \pi_{\eta,t}^b, d_t^b, \lambda_t^b\}$ . We then use these counterfactual household policies to compute supply output  $\{\hat{Y}_t^s\}$  and demand output  $\{\hat{Y}_t^d\}$  as follows:

$$\hat{Y}_t^s = \int x \hat{h}_t(a, x, \eta, \beta) d\hat{\mu}_t(a, x, \eta, \beta)$$

$$\hat{Y}_t^d = \int \hat{c}_t(a, x, \eta, \beta) d\hat{\mu}_t(a, x, \eta, \beta) + G_t + \Theta_t^b + \Phi,$$

<sup>&</sup>lt;sup>11</sup>See for instance Ganong and Noel (2019) for an empirical discussion of consumption levels of recipients vs. non-recipients unemployed households, and Kekre (2022) and Broer et al. (2024) for a quantitative discussion of transfers targeted to non-recipients unemployed households only.

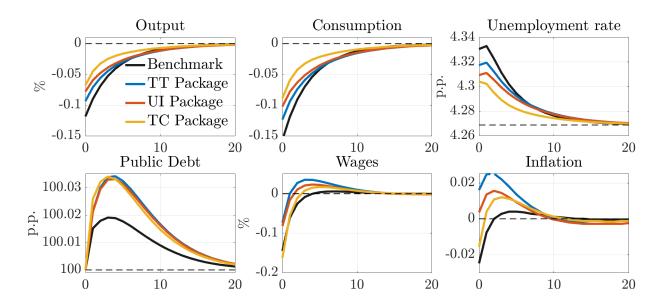


Figure 5: Impulse Responses for Three Stabilization Packages

**Note:** Impulse responses of a demand-driven recession. The Benchmark depicts the case with no fiscal stabilization package. The TT package implements targeted transfers to low-income households; the UI package implements a transfer to unemployed households; the TC package implements a tax credit to working-poor households.

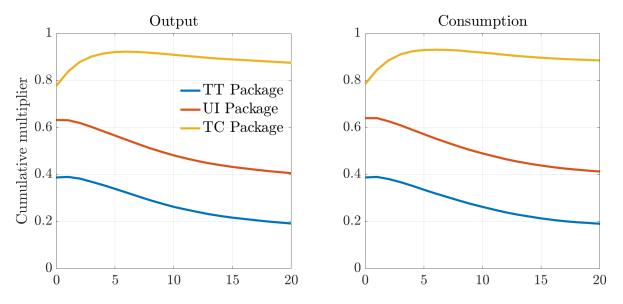


Figure 6: Cumulative Multipliers for Three Stabilization Packages

**Note:** Impulse responses of a demand-driven recession. The Benchmark depicts the case with no fiscal stabilization package. The TT package implements targeted transfers to low-income households; the UI package implements a transfer to unemployed households; the TC package implements a tax credit to working-poor households.

where  $\{\Theta_t^b\}$  denotes the output cost of adjusting prices under the benchmark inflation sequence. Figure 7 plots the impulse response functions.

The left panel in Figure 7 plots supply output for the three experiments. The labor-supply channel is small but negative for both the TT and the UI packages. For the TT case, transfers to low-income households are associated with negative wealth effects. For the UI case, there is no direct effect on labor supply as the recipients of the transfers

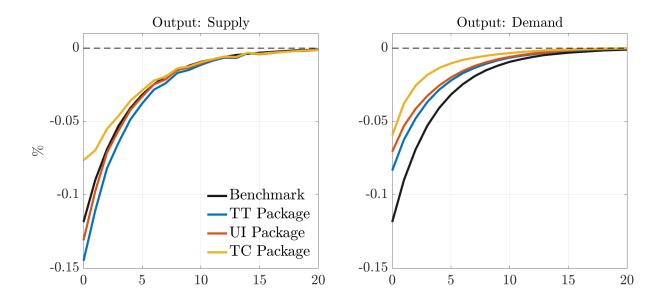


Figure 7: Decompositions

 ${\it Note:}\,$  IRF at prices of the recession without any stabilization package.

are unemployed, and we abstract from the effects of transfers on search incentives. Yet, larger future UI benefits reduce current precautionary motives, and thus, labor supply, of working households. In contrast, the labor-supply channel is strongly positive for the TC package. This is because tax credits incentivize labor supply of low-income working households, who feature high *lpe*. This positive labor-supply channel materializes despite the larger unemployment risk associated with the recession.

The right panel in Figure 7 plots demand output for the three experiments. As expected, the consumption channel is positive in all three experiments. It is larger for the UI package than for the TT one as mpc of unemployed workers is large. Interestingly, the consumption channel is the largest for the TC package. A tax credit that increases labor supply induces a positive response of labor income, and therefore, of consumption. Thus, the magnitude of the consumption channel hinges on, both, the high lpe and the high lpe of low-income working households.<sup>12</sup>

Overall, our results, derived in an off-the-shelf HANK model, suggest that temporary tax credits, that is, labor tax cuts, are an efficient fiscal instrument to stabilize the economy. These findings are noteworthy for two reasons. First, the TC package stabilizes the economy despite unemployment being more prevalent at the bottom of the income distribution and increasing during the recession. Second, we use a relatively conservative calibration of *lpe*, as discussed in Section 2.5. In Section 4.2 we build an alternative calibration with a steeper profile of *lpe* aggregating to 0.5, a number that remains within the bounds of standard labor elasticities in the literature. In that alternative calibration,

<sup>&</sup>lt;sup>12</sup>See Ferriere and Navarro (2024) for an analytical characterization of this interaction in the context of public spending shocks.

tax credits are even more potent, with multipliers well above unity.

### 3.3 Stabilization Through Higher Labor Tax Progressivity

The labor tax cuts implemented in TC package have an *intertemporal* component, as the loss of fiscal revenue is initially financed with debt but repaid with higher taxes in the future. They also have an *intratemporal* component, as labor tax credits are targeted towards low-income households and financed by future taxes on all households, which redistributes the tax burden from the bottom towards the top of the distribution. In this section we aim to disentangle the stabilization effectiveness of the *intertemporal* and *intratemporal* components of the TC package.

To do so, we conduct a new experiment in which we set the debt adjustment parameter  $\phi_D$  to zero. In turn, public debt remains constant and tax credits at the bottom of the distribution are entirely financed with a contemporaneous uniform increase in the level of labor taxes,  $\lambda_t$ . For completeness, we also analyze the stabilization properties of the UI package under this constant-debt scenario. Figure 8 reports responses of quantities, prices, and fiscal variables, while Figure 9 reports cumulative multipliers.

There are two main results of this exercise. First, multipliers are lower, especially on impact, when the government does not resort to public debt to finance the stabilization packages. This finding is not surprising, as the expansionary role of public debt has been well established in the literature in an environment in which Ricardian equivalence does not hold (Heathcote 2005).

Second, and more interestingly, the TC multiplier remains high, at almost 0.8 after 4 quarters. Notice that, when public debt is not used, the TC package is akin to a budget-neutral temporary increase in labor income tax progressivity, with a decline in tax payments for low-income households and an increase of tax payments for higher-income households. Thus, this exercise shows that a temporary increase in labor tax progressivity is a quantitatively efficient policy to boost output and stabilize a recession.

#### 3.4 Discussion

Among the alternatives we analyze, labor tax cuts implemented in the TC package are the most effective policy to stabilize a recession. Yet, there are two potential concerns with this policy: implementation and timing of responses. We briefly discuss these two concerns below.

Implementing changes in income taxes can be an arduous task, with multiple rounds of discussions among several branches of government. As such, changing income taxes at business cycle frequency seems unfeasible. Additionally, full awareness of the tax change may develop slowly, especially if tax credits are refunded towards the end of the

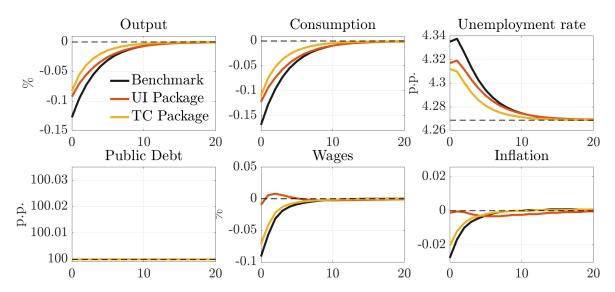


Figure 8: Impulse Responses with Constant Debt

**Note:** Impulse responses of a demand-driven recession. The Benchmark depicts the case with no fiscal stabilization package. The UI package implements a transfer to unemployed households; the TC package implements a tax credit to working-poor households. Public debt remains constant:  $\phi_D = 0$ .

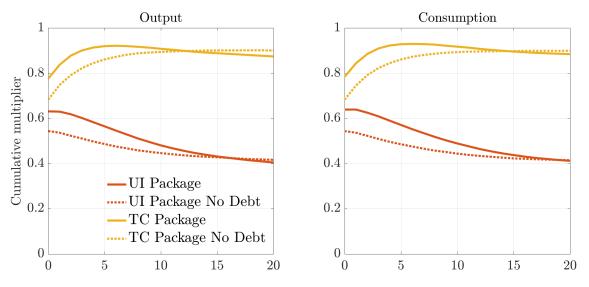


Figure 9: Cumulative Multipliers with Constant Debt

 $m{Note:}$  Cumulative multipliers for the UI package and the TC package under constant public debt:  $\phi_D=0$ .

fiscal year. However, a feasible alternative would be to implement legislations such that labor taxes respond systematically to the state of the economy. A current example of such legislation is unemployment benefits, which generosity and duration responds to the total unemployment level. Implementing this systematic component on taxes with a simpler structure—such as payroll taxes which are collected by firms on a monthly basis—could be further convenient, as workers would perceive their additional income as they receive their paychecks.

A second concern with labor tax cuts is about the time it may take for the policy to have an effect. While our model implies an immediate peak effect of labor tax cuts, the empirical work in Mertens and Ravn (2013) and Zidar (2019) suggest that effects are more backloaded. Delayed responses may attributable to the delayed awareness about the tax changes, or because of further labor and capital adjustment frictions we don't currently have in our model. Addressing this issue would necessitate a richer model of the labor market and of formation of expectations.

Beyond implementation and timing considerations, our findings suggest that labor tax cuts are a potent policy that deserves more attention in policy debates.

### 4 Robustness

This section presents several robustness exercises. First, we analyze other standard fiscal stabilization packages frequently implemented or discussed in the literature. Second, we present an alternative calibration with larger *lpe*. Finally, we discuss the importance of sticky prices vs. sticky wages in our environment.

# 4.1 Other fiscal packages

Transfers and public spending. To put our results into perspective, we compare our three fiscal stabilization packages to two packages frequently discussed in the policy debate. First, we model a one-time lump-sum transfer of \$200 given to all households—we refer to this case as the T package. Second, we model an increase in government spending, with persistence  $\rho_{\omega}=0.75$ , again so that its total cost is comparable to all other packages—we refer to this case as the G package. The left panel of Figure 10 reports output multipliers for these two cases, together with the multiplier of the TC package to ease comparison.

The T package is not very efficient to stimulate output, despite an average quarterly mpc equal to 0.13. The output multiplier barely reaches 0.1. Targeting transfers to low-income households is important to maximize the efficiency of the fiscal stimulus package. In contrast, the G package does stimulate the economy, with an output multiplier even larger than the tax credit, at least on impact. Yet, this output expansion

comes together with a large crowding-out of private consumption: in our calibration, the consumption multiplier is negative at all horizons in the case of the G package.

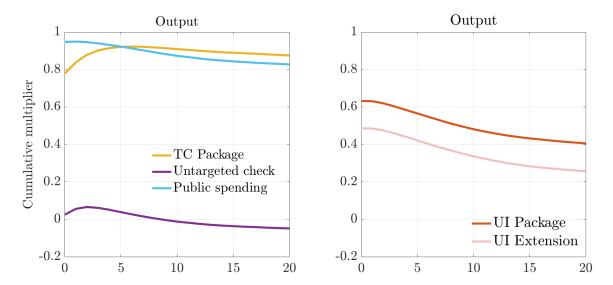


Figure 10: Cumulative Multipliers for Three Additional Stabilization Packages

**Note:** The left panel presents cumulative output multipliers for two new packages: the T package, a one-time lump-sum check of \$200; and the G package, a temporary increase in public spending. For comparison we also report the case of the TC package. The right panel presents cumulative output multipliers for an extension of the UI benefits. For comparison we also report the case of the UI package.

UI extension. We also compare our UI package to another fiscal stimulus package: the UI extension. We model the UI extension as an increase in  $\zeta$  the fraction of unemployed who receive unemployment benefits. We find  $\zeta_0$  such the total cost of this package is equivalent to the other ones, given a persistence  $\rho_{\omega}$ . The right panel of Figure 10 plots cumulative output multipliers and compares it to the UI case. A fiscal stimulus package in the form of a UI extension delivers multipliers slightly smaller than the UI package, but of a comparable magnitude. Transfers are equal across all unemployed in the UI package, while they are increasing in productivity for the UI extension. Lower-productivity households also feature higher mpc, which explains why the UI package is more expansionary. Yet, the quantification of the UI extension remains imprecise in the model, as we do not differentiate explicitly between recipients and non-recipients of the UI benefits, and do not allow for endogenous job search when unemployed.

### 4.2 Alternative Calibration

This subsection investigates an alternative calibration, which primarily differs in the calibration of the variance of the Gumbel shock  $\rho_w$ —the rest of the parameters are calibrated to match the same targets. This economy features a larger average lpe, at 0.45 when computed using a simulated transitory tax shock. The profile of lpe also gets steeper, from 0.94 for the bottom income quartile to 0.25 for the top income quartile. This economy

also features a larger mpc, at 0.19 at the quarterly level. As a consequence, the aggregate effects of tax shocks are larger: we obtain a tax multiplier approaching 1, closer to the 2 to 2.5 estimates in Mertens and Ravn (2013). When replicating the tax cut exercise by income group, we find that the tax cut on the bottom-90 group increases employment by 1.7%, a magnitude also closer to the estimates of about 3% reported in Zidar (2019). Overall, this calibration comes closer but still underestimates the aggregate effects of tax shocks, with lpe which remain moderate, at 0.45 in average and below unity for the bottom quartile.

In that calibration, the TC package is even more powerful to stimulate the economy. Figure 11 reports the multipliers for both the UI package and the TC package. Multipliers for the UI package are comparable to the benchmark calibration. Instead, multipliers for the TC package are well above unity.

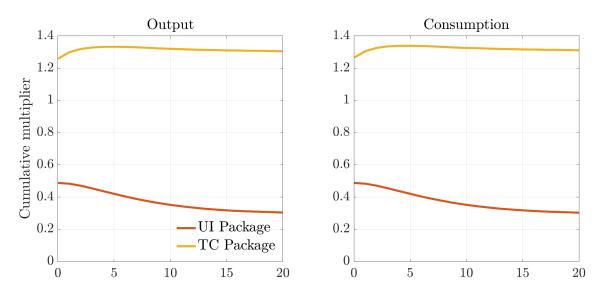


Figure 11: Cumulative Multipliers for an Alternative Calibration

Note: Alternative Calibration with larger and steeper lpe. Cumulative multipliers for the UI package and the TC package.

# 4.3 Nominal Rigidities

This subsection investigates the robustness of our results to our modeling of nominal rigidities. To do so, we replace price rigidities with wage rigidities. In particular, we borrow on Ferriere and Navarro (2024) and extend Erceg, Henderson, and Levin 2000 to an environment with heterogeneous households. As we explain next, a key advantage of our modeling is to generate labor market outcomes which depend not only on firms' labor demand but also on the distribution of individual labor supply decisions.

Wage rigidities. We model the labor market with two layers, with a labor packer and a labor union, ans we accommodate households heterogeneity by introducing a market

between unions and households.

The labor packer produces a final labor bundle by combining the differentiated labor  $n_{kt}$  from each union  $k \in [0, 1]$ . The labor bundle is produced as

$$N_t = \left(\int_0^1 n_{kt}^{\frac{\epsilon_w - 1}{\epsilon_w}}\right)^{\frac{\epsilon_w}{\epsilon_w - 1}},$$

and optimal labor demand for each variety reads

$$n_{kt}^d = \left(\frac{W_{kt}}{W_t}\right)^{-\epsilon_w} N_t \tag{14}$$

where  $W_{kt}$  is the nominal wage paid to union k and  $W_t = w_t P_t$  is the wage paid by intermediate-goods producers in nominal terms.

Labor unions are under monopolistic competition and set wages subject to a quadratic adjustment cost. They hire households labor in a competitive market at wage rate  $w_t^h$  and use it to produce their union-specific labor with a one-to-one technology. Let  $J_t^w(W_{kt-1})$  be the maximal attainable value at time t to a labor union that posted wages  $W_{kt-1}$  last period:

$$J_{t}^{w}(W_{kt-1}) = \max_{W_{kt}, n_{kt}} \left\{ d_{kt}^{w} + \frac{1}{1 + r_{t+1}} J_{t+1}^{w}(W_{jt}) \right\}$$
subject to
$$d_{kt}^{w} = \left( \frac{W_{kt}}{P_{t}} - w_{t}^{h} \right) n_{kt} - \Theta_{t}^{w}(W_{kt}, W_{kt-1}) - \Phi^{w}$$

$$n_{kt} = \left( \frac{W_{kt}}{W_{t}} \right)^{-\epsilon_{w}} N_{t}$$

$$\Theta_{t}^{w}(W_{kt}, W_{kt-1}) = \frac{\Theta^{w}}{2} \left( \frac{W_{kt}}{W_{kt-1}} - \bar{\Pi} \right)^{2} N_{t}$$
(15)

where  $n_{kt}$  is the total efficient hours demanded from households.

In a symmetric equilibrium, the unions' optimal decisions yield the wage Phillips curve:

$$\left(\Pi_{t}^{w} - \bar{\Pi}\right)\Pi_{t}^{w} + \frac{\epsilon^{w} - 1}{\Theta^{w}}w_{t} = \frac{\epsilon^{w}}{\Theta^{w}}w_{t}^{h} + \frac{1}{1 + r_{t+1}}\left(\Pi_{t+1}^{w} - \bar{\Pi}\right)\Pi_{t+1}^{w}\frac{N_{t+1}}{N_{t}}$$
(16)

where  $\Pi_t^w = W_t/W_{t-1}$  is wage inflation.

An equivalence result. We compare our benchmark setup with sticky prices, technology parameters  $(\epsilon, \Theta)$ , and flexible wages, to an alternative setup featuring sticky wages, technology parameters  $(\epsilon^w, \Theta^w)$  and flexible prices. Under linear technology, one can show that an equilibrium sequence in the benchmark sticky-price setup will also be

an equilibrium sequence in the alternative sticky-wage setup as long as  $(\epsilon^w, \Theta^w)$  in the sticky-wage setup are set to the same values as  $(\epsilon, \Theta)$  in the sticky-price setup. Intuitively, when output equals labor, it is equivalent to consider that output is demand-driven or labor is demand-driven. As such, our results are robust to modeling nominal rigidities with sticky wages rather than sticky prices.<sup>13</sup>

### 5 Conclusion

We developed a HANK model to analyze the effectiveness of different policies in response to a demand-driven recession. The model features an empirically realistic distribution of mpc and lpe, and also matches the cross-sectional incidence of unemployment risk over the business cycle. We find that the targeted labor-tax credits implemented in the TC package is the most efficient policy we consider in stabilizing a recession. The TC package is effective because it operates on, both, the consumption channel, as it provides income to low-income workers with high mpc, and the supply channel, as it lowers taxes on low-income workers with high lpe. The other policies we consider, such as targeted transfers or more generous unemployment benefits, operate through consumption channel only.

We argued that the strength of the *labor supply channel* in our calibration is conservative relative to available empirical estimates. Furthermore, the model includes empirically founded unemployment risk dynamics, restricting workers labor supply decisions in a realistic manner. As such, we think our model captures a realistic response of labor supply to tax cuts.

Fiscal stabilization packages based on temporary labor tax cuts could rise concerns regarding their implementation and the time it takes to have an effect. Nonetheless, the substantial potential of the tax cut package we finds warrants further discussion in policy debates.

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<sup>&</sup>lt;sup>13</sup>Formal proof to be added.

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