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Assessing the Stabilizing Effects of Unemployment Benefit Extensions†

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We study the stabilizing role of benefit extensions. We develop a tractable quantitative model with heterogeneous agents, search frictions, and nominal rigidities. The model allows for a stabilizing aggregate demand channel and a destabilizing labor market channel. We characterize each channel analytically and find that aggregate demand effects quantitatively prevail in the United States. When feeding in estimated shocks, the model tracks unemployment in the two most recent downturns. We find that extensions lowered unemployment by a maximum of 0.36 pp in the Great Recession, while the joint stabilizing effect of extensions and benefit compensation peaked at 1.12 pp in the pandemic. (*JEL* E24, E32, E43, E52, J64, J65)

Due to both automatic and discretionary extensions, the duration of benefits in the US unemployment insurance system is strongly countercyclical. In most states, unemployed individuals can collect unemployment benefits for up to 26 weeks in normal times, but this maximum duration can be extended at times of high unemployment. During the Great Recession, it reached a record of 99 weeks. Countercyclical benefit duration results in a share of unemployed workers receiving unemployment insurance that is also countercyclical, typically fluctuating between 30 percent in booms and 50 percent in recessions. Nearly seven in ten (68 percent) unemployed workers were receiving jobless benefits in 2010 (see McKenna 2015). Instead, benefit compensation is typically not a cyclical dimension of US policy. An exception is the policy response to the COVID crisis, which entailed both dimensions. This paper studies both compensation and extensions, with a focus on the latter and the Great Recession, but also considers an application to the pandemic downturn.

Whether countercyclical unemployment insurance provides a stabilization mechanism that can smooth economic fluctuations and reduce unemployment in recessions is largely debated in academic and policy circles, but still unsettled. One

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reason for this is that empirical studies of the stabilizing effect of benefit policy often come to contradicting conclusions.[1] Existing empirical studies use different methodologies to identify the effects of changes in unemployment insurance and may or may not account for all the transmission mechanisms. Further, they rely on different assumptions when extrapolating the results of micro or regional-level analyses to aggregate implications of the policy changes, making it difficult to interpret the results of such aggregations. A structural macro model is then needed to sort out the various forces and capture general equilibrium effects.

In this paper, we develop a model that includes the most salient transmission mechanisms of unemployment benefits. First, a literature has emphasized the discouraging effect of unemployment insurance either on the search effort of unemployed workers or on the job creation of firms through higher outside options of workers when bargaining wages. We label these supply-side effects the "labor market" channel of unemployment insurance. A different literature has highlighted an "aggregate demand" channel of benefits, working via the heterogeneous responsiveness of individual consumption to unemployment benefits in presence of idiosyncratic risk and liquidity-constrained agents. While countercyclical benefit policy destabilizes the economy through labor market effects, it stabilizes it via aggregate demand forces. Moreover, as we later show, the workings of each channel are affected by the presence of the other channel. This makes a unified general equilibrium framework necessary to study the net stabilizing effect of unemployment insurance. Existing works, however, have mostly focused on either one transmission mechanism or the other. Further, studies of the aggregate demand channel have mainly framed unemployment insurance policy in terms of a time-invariant benefit level, while historically the most relevant policy dimension has been the cyclicality of benefit extensions.

We fill this gap in the literature by studying theoretically and quantitatively the effects of cyclical benefit policy on labor market dynamics within a model that includes both a labor market and an aggregate demand channel. We characterize analytically both transmission mechanisms of unemployment insurance and identify the determinants of their strength. We demonstrate quantitatively that benefits on balance stabilize unemployment fluctuations—i.e., the aggregate demand channel prevails. Benefit extensions and compensation raise consumption of liquidity-constrained unemployed workers and reduce motives for precautionary saving for employed workers. With nominal price frictions, the increase in aggregate demand raises labor demand and job creation, which in turn results in a reduction in idiosyncratic unemployment risk, which further decreases precautionary motives via a feedback loop between endogenous unemployment risk and aggregate demand effects. Under our calibration, these mechanisms overpower the amplifying pressure exerted by benefits via labor market effects. Even so, we later show that the net contribution of benefit policy to US cyclical fluctuations has not been large relative to other driving forces. During the Great Recession, in particular, benefit extensions had a modest net stabilizing effect. We also quantify the separate contribution of the

[1] We extensively review related studies, both empirical and theoretical, at the end of the introduction.

automatic extensions embedded in the US system and the discretionary extensions implemented in 2008. The tractability of the model further permits to quantify the separate contribution of the two transmission channels by closing each in turn. We show that the model's predictions are consistent with the relevant estimates from the empirical literature. We finally assess the impact of benefit duration versus compensation during the pandemic recession.

To capture both channels, we first model a labor market with search frictions. Within this framework, the decision of firms to create jobs and the decision of households to exert search efforts are the key drivers of labor market outcomes. The wage in each match is determined through Nash bargaining and is subject to wage rigidity. Bargaining brings in a role for unemployment benefits, via the opportunity cost of employment, to affect equilibrium wages and hiring, referred to as the "macro effect" of unemployment benefits on labor markets; real wage rigidity contributes to determining the power of this effect. In turn, unemployment insurance also has a "micro effect," via the direct impact that the opportunity cost has on the search effort exerted by the unemployed.

Second, we introduce an aggregate demand channel via heterogeneous agents (HAs) and incomplete markets, as well as price rigidities. Specifically, workers face liquidity constraints during a single period but pool their assets at the end of the period. Workers can be employed, unemployed receiving benefits, or unemployed not receiving benefits. The labor market status of each worker is i.i.d. and determined each period by the evolution of aggregate rates of employment and benefit recipiency. Employed workers have enough income to optimize their consumption, while unemployed workers are borrowing-constrained. This structure enables both a redistribution channel and a motive for precautionary saving, but keeps the model tractable while at the same time preserving its suitability for quantitative analysis, as we extensively discuss.[2]

We capture benefit extensions via the share of unemployed workers receiving the benefits. There are two reasons for this. First, benefit extensions naturally increase the recipiency rate and drive its cyclicality. Second, what matters to the transmission channels of unemployment insurance policy, via aggregate consumption and average wages, is the share of workers receiving the benefits, not the maximum benefit duration of individual workers. We thus directly model policy in terms of the recipiency rate.[3] Then, to account for the two key features of the US unemployment insurance system, we model automatic extensions as a policy rule where the share of recipients depends on the unemployment rate (to proxy for extensions automatically activated at certain unemployment thresholds) and model discretionary extensions as an exogenous shock to the recipiency rule (and later estimate it from the data).

To study the workings and the quantitative implications of our model, we proceed in three steps. We first assess whether countercyclical unemployment insurance

[2] See the calibration section and the dedicated Section IVC.

[3] Recipiency is also determined by eligibility and take-up rates, which are also cyclical and push recipiency up in downturns. Maximum duration is, however, the key determinant of cyclicality, as demonstrated by the fact that recipiency for regular programs, which have a fixed duration, is only mildly cyclical. At the same time, by using recipiency we capture the contribution of these factors to benefit policy transmission, despite not explicitly modeling them.

policy, in terms of both benefit compensation and duration, stabilizes or destabilizes the unemployment rate when fluctuations are driven by a variety of alternative driving forces that can be accommodated by our framework. Within a calibrated version of the model, we show that with both channels active, countercyclical unemployment insurance stabilizes unemployment in response to all shocks considered. We show that the same policy has a destabilizing effect if we switch off the aggregate demand channel by either relaxing liquidity constraints (as in a representative agent (RA) model) or abstracting from nominal rigidities (as in a flexible price model).[4]

As a second step, we inspect analytically the mechanisms of each channel. We derive equations that characterize the direct impact of unemployment insurance on the decision of households to search and the decision of firms to hire, via both the labor market and the aggregate demand channel. Benefit compensation and duration directly impact the opportunity cost of employment of the worker, which in turn affects incentives to search and to post vacancies. As we said, the aggregate demand channel works via a redistribution effect toward liquidity-constrained unemployed and a precautionary motive effect on employed, which in presence of nominal price frictions affect labor demand and job creation. We show analytically that the difference in consumption of benefit recipients and nonrecipients is a key determinant of both channels of benefit extensions. We also characterize the direct impact of benefit compensation, for which a key driver is the difference in consumption of employed and benefit recipients.

Finally, we turn to the ability of the model to account for actual unemployment dynamics. We estimate automatic and discretionary extensions and a number of aggregate shocks, and feed them into the model. We first focus on the Great Recession. In line with both the economic literature and the narrative of the 2007–2009 downturn, we estimate two labor market shocks (separations to unemployment and transitions to long-term unemployment (LTU)) and a shock to the household borrowing capacity. We show that with these shocks, the (untargeted) unemployment rate from the model closely tracks the actual rate during the Great Recession.[5] We next show that benefit extensions had a mild stabilizing effect during the Great Recession and quantify the contribution of each channel. We find that without extensions, the unemployment rate would have been higher by a maximum of 0.36 pp. Discretionary extensions alone lowered unemployment by a peak effect of 0.16 percentage points, with the macro labor market channel contributing to a peak increase of 0.32 pp, the micro channel to a peak increase of 0.07 pp, and the aggregate demand channel to a peak decrease of 0.42 percentage points. We then turn our attention to the pandemic recession and evaluate the impact of changes in benefit duration versus compensation. We find that absent extensions, unemployment would have been higher by

[4] For example, with an elasticity of benefit duration to unemployment of 0.6613 that we estimate in US data, the standard deviation of unemployment decreases by 14.11 percent if fluctuations are driven by separation shocks. Under the same policy, absent aggregate demand effects, the relative volatility now increases by 3.67 percent.

[5] That the model can track actual unemployment with shocks directly estimated from the data, rather than with arbitrary shocks estimated to target unemployment dynamics, is important for two reasons. First, it externally validates our model as a suitable framework to study unemployment. Second, given that the effects of extensions differ depending on the driving force of fluctuations, it gives us confidence on the quantification of the impact of extensions.

0.79 pp at its peak effect. Higher benefit compensation instead lowered unemployment by a maximum of 0.80 pp.

We now turn to reviewing the related empirical and theoretical literature.

Related Literature.—A number of quantitative works have studied the effects of unemployment insurance on aggregate outcomes, via either supply-side or aggregate demand mechanisms. Mitman and Rabinovich (2020) focus on the labor market channel and emphasize, in particular, the macro effect that arises in the standard search and matching model via equilibrium bargained wages. They find that benefit extensions played a major role in driving the dynamics of unemployment in the postwar period.[6] Concentrating instead on aggregate demand effects are McKay and Reis (2016), who study unemployment insurance within a model with HAs, uninsurable exogenous idiosyncratic risk, and nominal rigidities. Their focus is on the automatic stabilization of a time-invariant level of benefits.[7] Closer to our paper, Kekre (2022) studies countercyclical unemployment insurance within a model with incomplete markets and search frictions. While he considers richer heterogeneity on the demand side that allows for a distribution of assets, our more tractable setup captures comparable channels of extensions and is similarly suitable to study their quantitative impact on aggregate demand. At the same time, our setup is more transparent and more functional to decompose transmission channels.[8] Importantly, we also differ in our strategy for the quantitative evaluation of actual benefit policy. We feed in a set of relevant shocks estimated from external data and show that our model closely tracks (untargeted) unemployment during the Great Recession. In doing that, we quantify the distinct impact of automatic and discretionary extensions. Finally, we also apply our model to the pandemic recession and assess the separate effect of extensions and benefit compensation.

On the empirical side, a few studies focus on estimating the impact of benefit extensions on aggregate outcomes, such as employment and unemployment. Chodorow-Reich, Coglianese, and Karabarbounis (2018) exploit the fact that extensions of benefit duration during the Great Recession were based on real-time unemployment data, which are subject to measurement error. Using data revisions, they show that exogenous changes in benefit duration played a limited role for macroeconomic outcomes. Importantly, the predictions of our model with both channels active fall into their range of estimates.[9] Hagedorn et al. (2019) develop a different empirical strategy exploiting a policy discontinuity at border counties across states. They find that benefit extensions raised equilibrium wages and caused a sharp contraction in vacancy creation and employment. They interpret these results as evidence of supply-side effects of unemployment insurance, working via higher equilibrium

[6] See also Faig, Zhang, and Zhang (2016) for an earlier contribution.

[7] In related work, McKay and Reis (2021) characterize the optimal time-invariant benefit level. While they make idiosyncratic risk endogenous, they do not allow for a direct effect of benefits on equilibrium wages and hiring.

[8] Accordingly, we characterize analytically both channels and their interaction, for both compensation and duration. In our study of the Great Recession, we use these analytical expressions to quantify the channels' separate contribution.

[9] They estimate an effect of benefit extensions between -0.5 and 0.3 pp of unemployment at the 90 percent confidence level. We find that extensions stabilized unemployment by a peak net effect of -0.36 pp.

wages and reduced job creation.[10] Boone et al. (2021) and Dieterle, Bartalotti, and Brummet (2020) use a similar identification strategy but different estimation techniques, and find smaller effects of extensions on unemployment. Interestingly, the predictions of our model, absent aggregate demand effects, fall within their range of estimates.[11] A related study by Marinescu (2017) uses state-level data from an online job board and estimates a negligible impact of benefit extensions on vacancy posting. Her findings are in line with our results of a small net effect of benefits on equilibrium vacancies, in turn arising from contrasting aggregate demand and labor market effects of about equal strength.

Other empirical studies consider the impact of extensions on individual labor market outcomes, including Rothstein (2011); Farber and Valletta (2015); and Johnston and Mas (2018). These works mostly find small effects, suggesting in turn limited effects of extensions on incentives to search.[12] Accordingly, we find that the micro effect of extensions on labor markets, which we calibrated on the basis of the micro evidence, is not quantitatively important. There is also a sizeable literature studying the effects of permanent reforms of benefit duration or compensation on individual outcomes. Closest to our study, Krueger and Mueller (2010) find that while the time spent on search by the eligible unemployed is lower with higher benefit compensation, it is instead higher for the ineligible. These findings are consistent with spillovers due to lower congestion that improve job market outcomes of ineligible workers, as documented by Lalive, Landais, and Zweimüller (2015) in response to increased benefit duration in Austria.[13]

Finally, hardly any paper studies the expansion of unemployment insurance during the most recent COVID-19 recession. Two exceptions are Ganong et al. (2021), concentrating on individual consumption and job search, and Marinescu, Skandalis, and Zhao (2020), focusing on job applications and vacancy posting.[14] Instead, to the best of our knowledge, there is no other quantitative analysis of the effects of benefit policy on unemployment dynamics during the pandemic.

The remainder of the paper is organized as follows. Section I describes the model. Section II describes the calibration of the model. Section III quantitatively evaluates the net stabilizing effects of countercyclical unemployment insurance. Section IV inspects the mechanisms analytically and discusses the intuition. Section V evaluates the ability of the model to account for unemployment dynamics during the

[10] Consistently with this interpretation, aggregate demand effects may spillover across counties—as individuals working in one county may live or shop in a border county—and, hence, not be reflected in border counties' differences.

[11] Dieterle, Bartalotti, and Brummet (2020), for example, find that extensions raised unemployment by 0.2 or 0.5 pp depending on the specification, but their confidence bounds are wide. We find that absent aggregate demand effects, discretionary extensions would have raised unemployment by a peak value of 0.45 pp during the Great recession.

[12] Specifically, Rothstein (2011) finds small negative effects of extensions on the unemployment-to-employment transition rate, but concentrated among the long-term unemployed. Farber and Valletta (2015) instead find no negative effect on this transition rate but a small positive effect on the unemployment-to-inactivity transition rate. Johnston and Mas (2018) find a small negative effect of a cut in benefit duration on nonemployment duration.

[13] See also a review of related empirical evidence in Landais, Michaillat, and Saez (2018).

[14] Ganong et al. (2021) find that the expanded benefits resulted in a 2–2.6 percent increase in aggregate consumption between April and July 2020 and that the reduction in job search lowered employment by 0.2–0.4 percent. Marinescu, Skandalis, and Zhao (2020) find no evidence that the benefit expansion reduced the ability of firms to find job applicants.

two most recent US downturns. It also quantifies the contribution of benefit extensions, via both transmission channels, in the Great Recession, and the contribution of benefit extensions versus compensation in the pandemic recession. Section VI concludes.

I. The Model

There is a continuum of identical households/families, each with a continuum of members of measure one. Household members face idiosyncratic unemployment risk. Unemployment risk is endogenous, resulting from the job creation decision of firms and the search intensity decision of households. Unemployment risk is uninsurable. The family has assets and can borrow up to a certain limit. At the start of each period, after borrowing, the family allocates a share of the assets to each member in the form of cash. Only after the cash is allocated, a lottery among family members determines who is employed and receives a wage, and who is unemployed; the lottery also determines who among the unemployed can receive unemployment insurance. Firms are of three types: final goods, retailers, and wholesale firms. A competitive final good sector combines varieties of intermediate goods into final goods. A measure one of monopolistically competitive retailers facing nominal price rigidities differentiate a wholesale good into varieties and sell them to the final good firms. A continuum of wholesale firms hire workers in a frictional labor market to produce wholesale goods and sell them to the retailers in competitive markets. The government sets the nominal interest rate according to a Taylor rule. It also collects taxes on labor and profit income and pays unemployment insurance and safety net transfers. The level and the duration of unemployment insurance respond to the economy's aggregate state according to distinct policy rules.

Summing up, the model includes search frictions, price rigidity, and incomplete markets. Labor market frictions allow for the labor market channel of unemployment benefit extensions, while market incompleteness together with price rigidities for the aggregate demand channel. Despite the complexity of the channels, the i.i.d. nature of idiosyncratic unemployment risk makes the model analytically tractable.

A. *Timing*

The intraperiod timing is the following: (i) aggregate shocks are realized; (ii) the family borrows and allocates cash to its members; (iii) firms post vacancies and unemployed workers search, matches are formed, wages are bargained, and separations realize; (iv) i.i.d. employment shocks and benefit recipiency shocks are realized; and (v) firms produce and family members consume and save.

B. *Unemployed, Vacancies, and Matching*

Firms with open vacancies and unemployed workers searching for jobs meet randomly. The aggregate number of matches, m_t, is a function of the number of efficiency units of search, s_t, and the number of vacancies, v_t, according to a standard Cobb-Douglas matching function,

$$m_t = \alpha_m s_t^{\alpha} v_t^{1-\alpha}, \tag{1}$$

where α is the elasticity of matches to efficiency units of search and α_m is matching efficiency.

Unemployed workers can be either short-term unemployed or long-term unemployed, with the latter searching with lower search efficiency than the former. We derive total efficiency units of search at time t as the sum of units of search intensity weighted by the search efficiency of their respective type:

$$s_t = (1 - n_{t-1})\sigma_t\left[\varphi_{t-1} + \bar{\sigma}(1 - \varphi_{t-1})\right], \tag{2}$$

where, at the start of period t, there are $(1 - n_{t-1})$ unemployed workers searching with intensity σ_t and, of these, a share φ_{t-1} is short-term unemployed and searches with search efficiency normalized to 1, while a complementary share $(1 - \varphi_{t-1})$ is long-term unemployed and searches with search efficiency $0 < \bar{\sigma} < 1$.

Given the matching function (1), the probability f_t^s that an efficiency unit of search leads to a match is given by $f_t^s = m_t/s_t = \alpha_m (v_t/s_t)^{1-\alpha}$ and the probability f_t^v that a firm fills a vacancy is given by $f_t^v = m_t/v_t = \alpha_m (v_t/s_t)^{-\alpha}$.

Employment evolves according to the law of motion

$$n_t = \rho_t n_{t-1} + m_t, \tag{3}$$

where ρ_t is the exogenous time-varying survival rate of employment relationships.

Finally, the share of short-term unemployed is given by

$$\varphi_t = \frac{u_t^{ST}}{u_t^{LT} + u_t^{ST}}, \tag{4}$$

where short-term unemployed u_t^{ST} and long-term unemployed u_t^{LT} evolve according to the following laws of motion:

$$u_t^{ST} = u_{t-1}^{ST}(1 - f_t^s \sigma_t)(1 - \delta_t) + n_{t-1}(1 - \rho_t), \tag{5}$$

$$u_t^{LT} = u_{t-1}^{LT}(1 - f_t^s \sigma_t \bar{\sigma}) + u_{t-1}^{ST}(1 - f_t^s \sigma_t)\delta_t, \tag{6}$$

where δ_t is the exogenous time-varying transition probability from being short-term to being long-term unemployed.

C. *Households*

Household members can be employed or unemployed; unemployed members can either receive unemployment insurance or not. Who is employed and unemployed, recipient of benefits and not, is decided every period by a lottery. At the start of each period, the household allocates a share of its assets to each member, in the form of cash, to be used for consumption. Since cash on hand needs to be decided before the employment status is revealed, all agents receive the same amount. After the employment status is determined, on top of cash, employed workers receive the wage, benefit recipients collect unemployment insurance, and the nonrecipients collect a safety net transfer from the government. To provide cash to the agents, the household can use the net assets from the previous period and borrow today up to a borrowing constraint. Savings for next period are determined after individual consumption takes place as the sum of all cash that wasn't spent by the agents. The household decides on aggregate borrowing and saving, cash on hand, search intensity, and individual consumption. Finally, employed members suffer a constant disutility cost from supplying labor.

Let $W_t(n_{t-1}, a_t, b_t)$ be the value function of the representative household, given beginning-of-period employment, n_{t-1}; beginning-of-period asset holdings, a_t; and beginning-of-period debt, b_t.[15] Let $u(\cdot)$ denote the period utility function, strictly increasing, strictly concave, and satisfying the Inada conditions $\lim_{c\to\infty} u'(c) = 0$ and $\lim_{c\to 0} u'(c) = \infty$. Also let $\varsigma(\cdot)$ denote the period cost of search, strictly increasing and strictly convex. The representative household chooses consumption levels of individual household members that are contingent on their employment status (c_t^n if employed, c_t^{ur} if unemployed and recipients of benefits, and c_t^{un} if unemployed and not recipients of benefits); new debt, b_{t+1}; cash to transfer to individual household members for consumption, x_t; end-of-period assets, a_{t+1}; search intensity by unemployed, σ_t; and end-of-period employment, n_t, to solve

$$(7)\quad W_t(n_{t-1}, a_t, b_t) = \max\Big\{n_t\big[u(c_t^n) - \chi\big] + (1 - n_t)\big[\nu_t u(c_t^{ur}) + (1 - \nu_t)u(c_t^{un})\big] - (1 - n_{t-1})\varsigma(\sigma_t) + \beta E_t\big[W_{t+1}(n_t, a_{t+1}, b_{t+1})\big]\Big\},$$

subject to seven constraints. These are the household budget constraint; the liquidity constraints of employed, benefit recipients, and nonrecipients; the borrowing constraint; the end-of-period asset equation; and the employment accumulation equation. In the equation above, χ denotes the disutility of work, β is the household's discount factor, and ν_t is the share of unemployed receiving the unemployment benefits at period t. We also refer to ν_t as the recipiency rate.

The household budget constraint at the start of the period states that

$$(8)\quad x_t = \frac{b_{t+1}}{p_t} + (1 + i_t)\frac{a_t}{p_t} - (1 + i_t)\frac{b_t}{p_t}.$$

In words, the amount of cash that the household transfers to its members for consumption at the start of the period equals the value of new borrowings, plus the

[15] We use the time subscript t to capture the dependence of the value function from the aggregate state, $\mathbf{s}_t$; that is, we write $W_t(n_{t-1}, a_t, b_t)$ instead of $W(n_{t-1}, a_t, b_t; \mathbf{s}_t)$. We will use this convention throughout the paper.

value of assets it owns, with interest income, minus the repayment of debt including interest payments.

Since employment is randomly allocated within the period, cash x_t is identically (and optimally) allocated to each household member. Further, intraperiod transfers are ruled out. Then, household members face liquidity constraints that are specific to their employment status, given by

$$c_t^n \leq x_t + (1 - \tau_t) w_t + (1 - \tau_t) d_t, \tag{9}$$

$$c_t^{ur} \leq x_t + \tau_t^u, \tag{10}$$

$$c_t^{un} \leq x_t + \tau^s. \tag{11}$$

On top of the cash transfer, employed individuals can finance consumption with wage income w_t and dividend income d_t, net of taxes τ_t. Unemployed individuals, instead, also collect unemployment insurance τ_t^u, if benefit recipients, and a safety net transfer τ^s, if nonrecipients.

We assume a borrowing constraint that limits the household ability to raise new debt. Specifically, the real value of new debt is limited by an exogenous time-varying borrowing limit, $\bar{b}_t$:

$$b_{t+1} \leq p_t \bar{b}_t. \tag{12}$$

Household's end-of-period assets are the unspent funds of individual household's members,

$$\begin{aligned} \frac{a_{t+1}}{p_t} = {} & x_t + (1 - \tau_t) w_t n_t + (1 - \tau_t) d_t n_t + \tau_t^u (1 - n_t) \nu_t \\ & + \tau^s (1 - n_t)(1 - \nu_t) - \big[n_t c_t^n + (1 - n_t) \nu_t c_t^{ur} \\ & + (1 - n_t)(1 - \nu_t) c_t^{un} \big], \end{aligned} \tag{13}$$

and equal the total funds available for consumption to household's members net of their total consumption.

The household's employment accumulation equation states that

$$n_t = \rho_t n_{t-1} + f_t^s s_t, \tag{14}$$

where s_t is given in equation (2).

To sum up, households choose $\{c_t^n, c_t^{ur}, c_t^{un}, x_t, b_{t+1}, a_{t+1}, \sigma_t, n_t\}$ to solve (7) subject to (8)–(14).[16]

[16] When solving her maximization problem, the household takes total dividends $D_t \equiv d_t n_t$ as given. This comes from the assumption that households rather than individual employed workers own the firms. This assumption is more appropriate in presence of i.i.d. employment states.

Note that equations (9)–(11) assume that the households own the firms, receive the dividends, and distribute them to the employed workers. In the data, only a fraction of the population participates in the stock market. Stock market participants typically earn higher income and are wealthier. As there is no wealth distribution in our model, we assign the dividends to the workers with the highest income. Since dividend recipients decide on the intertemporal allocation of profits and firms' hiring, firms discount the future with factor

$$\Lambda_{t,t+1} \equiv \beta E_t\left[\frac{(1-\tau_{t+1})u'(c_{t+1}^n)}{(1-\tau_t)u'(c_t^n)}\right]. \tag{15}$$

D. *Hiring Firms and Wage Bargaining*

Wholesale goods firms hire workers in a frictional labor market and produce the wholesale good. We will refer for simplicity to wholesale goods firms as simply firms. To hire workers, firms must post vacancies at a per-period cost κ. Firms produce wholesale goods with a linear technology in labor. Let $F_t(n_{t-1})$ be the value function of the representative firm, given beginning-of-period employment, n_{t-1}. Firms then choose vacancies, v_t, and employment, n_t, to solve

$$F_t(n_{t-1}) = \max\left\{q_t z_t n_t - w_t n_t - \kappa v_t + E_t\left[\Lambda_{t,t+1}F_{t+1}(n_t)\right]\right\} \tag{16}$$

subject to

$$n_t = \rho_t n_{t-1} + f_t^v v_t, \tag{17}$$

where q_t is the relative price of the wholesale good in terms of the final good, z_t is aggregate productivity, and firms discount the future with factor $\Lambda_{t,t+1}$ defined in (15).

Firms and workers divide the joint match surplus via Nash bargaining. For the firm, the relevant surplus is the value of an additional worker to the firm net of current vacancy costs, $F_{n,t} \equiv \partial(F_t + \kappa v_t)/\partial n_t$:

$$F_{n,t} = q_t z_t - w_t + E_t\left[\rho_{t+1}\Lambda_{t,t+1}F_{n,t+1}\right]. \tag{18}$$

Similarly, for the household, the relevant surplus is the value of an additional employed member net of current search cost, $W_{n,t} \equiv \partial\left[W_t + (1-n_{t-1})\varsigma(\sigma_t)\right]/\partial n_t$:

$$\begin{aligned} W_{n,t} = {} & u'(c_t^n)(1-\tau_t)\left(w_t - \frac{\xi_t}{1-\tau_t}\right) \\ & + \beta E_t\left[\left(\rho_{t+1} - \left(\varphi_t + \bar{\sigma}(1-\varphi_t)\right)f_{t+1}^s\sigma_{t+1}\right)W_{n,t+1}\right], \end{aligned} \tag{19}$$

where ξ_t denotes the opportunity cost of work, defined in equation (40) in Section IVA.

Let w_t^* denote the bargained wage. The wage w_t^* is chosen to maximize the Nash product:

$$w_t^* = \arg\max \left(W_{n,t}\right)^{\eta} \left(F_{n,t}\right)^{1-\eta}, \tag{20}$$

where η denotes the workers' relative bargaining power.

Finally, we introduce real wage rigidity. We formalize it by assuming a simple wage schedule of the form

$$w_t = \gamma w_t^* + (1-\gamma)\bar{w}, \tag{21}$$

where $\bar{w}$ is the steady-state wage and $\gamma \in [0,1]$ is an index of real wage rigidity.

E. *Final Good Firms, Retailers, and Price Setting*

A competitive sector for final goods combines differentiated varieties of intermediate goods according to the production function

$$Y_t = \left(\int_0^1 y_{it}^{\frac{\epsilon-1}{\epsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}}, \tag{22}$$

where y_{it} is the input of intermediate good i at time t and ϵ is the elasticity of substitution across varieties. Final goods firms purchase intermediate good i at price p_{it} and take as given the final goods price p_t. From cost minimization, it follows that the demand for variety i is given by

$$y_{it} = \left(\frac{p_{it}}{p_t}\right)^{-\epsilon} Y_t \tag{23}$$

and the price index p_t is given by

$$p_t = \left(\int_0^1 p_{it}^{1-\epsilon} di\right)^{\frac{1}{1-\epsilon}}. \tag{24}$$

A measure one of monopolistic competitive retailers buy a wholesale good from wholesale firms, differentiate it into varieties y_{it} with a technology that transforms one unit of wholesale good into one unit of intermediate good, and sell it to the final goods producers. Retailers set prices infrequently as in Calvo (1983) with probability of revision θ. At each revision date, a retailer producing variety i chooses an optimal price p_{it}^* to maximize expected future profits, subject to the demand for its own variety. As retailers are owned by employed workers, they discount the future with factor $\Lambda_{t,t+1}$, defined in (15). The price setting problem of retailer i at each revision date t can be written as

$$\max_{p_{it}} \Pi_t(p_{it}), \tag{25}$$

with

$$\Pi_t(p_{it}) = d_t(p_{it}) + (1-\theta)\beta\Lambda_{t,t+1}\Pi_{t+1}(p_{it+1}) \tag{26}$$

and

$$d_t(p_{it}) = \left(\frac{p_{it}}{p_t} - q_t\right)y_{it}, \tag{27}$$

and subject to the demand equation (23).

Finally, the dividends from the retailers are given by

$$\int_i d_t(p_{it})di = Y_t - q_t z_t n_t, \tag{28}$$

which can be summed to the dividends from wholesale goods firms, d_t^w, given by

$$d_t^w = q_t z_t n_t - w_t n_t - \kappa v_t \tag{29}$$

to obtain total dividends, D_t, distributed to employed workers,

$$D_t \equiv d_t n_t = \int_i d_t(p_{it})di + d_t^w. \tag{30}$$

F. *Government and the Tax and Transfer System*

The government provides unemployment insurance τ_t^u to benefit recipients $(1 - n_t)\nu_t$ and a safety net transfer τ^s to nonrecipients $(1 - n_t)(1 - \nu_t)$; it also collects taxes τ_t on labor and dividend incomes to satisfy its budget constraint

$$\tau_t^u(1 - n_t)\nu_t + \tau^s(1 - n_t)(1 - \nu_t) = \tau_t w_t n_t + \tau_t d_t n_t. \tag{31}$$

We assume that benefit recipiency, ν_t, and benefit compensation, τ_t^u, are governed by distinct policy rules. Consider first benefit duration policy. We first note that the recipiency rate is the sum of two components: the share of unemployed receiving benefits under regular programs, ν_t^r, and the share of unemployed receiving benefits under extended benefits programs, ν_t^e. Regular programs have a fixed duration corresponding to a maximum of 26 weeks in most US states, but duration can be extended under extended benefits and emergency programs. Given that our focus is on the extended benefits cyclical policy component, ν_t^e, we need to separately account for the cyclical changes in recipiency under regular programs, ν_t^r.[17] These are largely determined by changes in the composition of the unemployment pool over the cycle. To do that, we formulate separate rules for the two components. We next describe the policy rule for ν_t^e and defer a description of the ν_t^r rule to Section VA.

The recipiency rule for the extended benefits programs gives the share of unemployed workers receiving benefits, ν_t^e, as a function of unemployment in the previous period, as

$$\nu_t^e = \bar{\nu}^e + \Gamma_\nu \log\frac{u_{t-1}}{\bar{u}} + \varepsilon_{\nu,t}, \tag{32}$$

[17] We thank a referee for pointing out this important measurement issue.

where $\bar{\nu}^e$ is a scale parameter, $\bar{u}$ is average unemployment, Γ_ν is a parameter governing the cyclicality of ν_t^e, and $\varepsilon_{\nu,t}$ is a policy shock. The rule in equation (32) is meant to proxy for the actual policy of extensions of benefit duration. The actual policy is implemented by increasing the maximum duration that an unemployed worker can receive benefits. In our model, whether an unemployed worker receives the benefit is independent of the duration of her unemployment spell and determined by a lottery, whereby the probability of receiving benefits is given by the share of recipients. Since benefit extensions naturally increase the share of unemployed workers receiving the benefit, this probability is a proxy in the model for the duration of unemployment benefits. When the duration of unemployment benefits is extended, each unemployed worker has a higher probability of being a recipient of unemployment insurance.

Similarly, the government sets benefit compensation according to the following rule:

$$\tau_t^u = \bar{\tau}^u + \Gamma_\tau \log \frac{u_{t-1}}{\bar{u}} + \varepsilon_{\tau,t}, \tag{33}$$

where $\bar{\tau}^u$ is a scale parameter, Γ_τ is a parameter governing the cyclicality of τ_t^u, and $\varepsilon_{\tau,t}$ is a policy shock. Since countercyclical compensation has not been a typical dimension of US policy, we use this rule mostly for counterfactual experiments. The only exception is the analysis of the pandemic recession in Section VC.

Finally, the government sets the nominal interest rate according to a Taylor rule of the form

$$1 + i_{t+1} = \left(1 + \bar{i}\right)\left(\frac{p_t}{p_{t-1}}\right)^{\phi} e^{\varepsilon_{it}}, \tag{34}$$

where ε_{it} is a monetary policy shock.

G. *Model Equilibrium*

An equilibrium is a set of policies $\left\{c_t^n, c_t^{ur}, c_t^{un}, b_{t+1}, a_{t+1}, x_t, \sigma_t, n_t, v_t, d_t^w, y_{it}, d_{it}\right\}$, prices $\{p_t, p_{it}, w_t, w_t^*, q_t\}$, aggregate quantities $\left\{s_t, \varphi_t, u_t^{ST}, u_t^{LT}, n_t, Y_t, D_t\right\}$, value functions $\left\{W_t(n_{t-1}, a_t, b_t), F_t(n_{t-1})\right\}$, and government policies $\{i_{t+1}, \nu_t, \tau_t^u, \tau_t\}$ such that (i) the households maximize (7) subject to (8)–(14); (ii) the hiring firms maximize (16) subject to (17); (iii) the final good firms behave according to (23) and (24); (iv) the retailers maximize (25) subject to (23), (26), and (27); (v) the wages are set according to (20) and (21); (vi) the labor market variables behave according to (2)–(6); (vii) the government policy is set according to (31)–(34); and (viii) the assets, dividends, and goods markets clear.[18]

[18] We have used $d_{it} \equiv d_t(p_{it})$ and n_t to denote both firm-level and aggregate employment, to save on notation.

H. *The Role of Intraperiod Borrowing*

A key element of our model is the intraperiod borrowing structure. The household can raise debt at the start of the period, up to an exogenous limit. Before the realization of idiosyncratic risk, it distributes an equal share of the new borrowing determined in (8) to its members. After that, members receive income conditional on their employment state, and consumption decisions are made. In equilibrium, the household borrows up to the limit (12), and unemployed members face binding liquidity constraints (10) and (11), while employed members face slack constraints (9) and are able to save according to (13). The intraperiod asset market equilibrium requires that beginning-of-period borrowing must equal end-of-period savings, so that both equal the borrowing limit ($a_{t+1} = b_{t+1} = p_t \bar{b}_t$). The interest rate adjusts to clear the assets market. The structure allows for short-term debt, enabling partial consumption smoothing across individual employment states, but it rules out long-term savings, avoiding the need to keep track of assets, in the aggregate and across agents.

Despite its tractability, this structure preserves a number of desirable features relative to other tractable setups present in the literature. First, it makes it possible to derive predictions for the effects of a credit tightening on households (a driver gaining prominence since the Great Recession). A tightening of the borrowing limit restrains the ability to smooth consumption across employment states and directly reduces consumption of liquidity-constrained unemployed. This prediction is similar to that of a richer model with a nondegenerate asset distribution, which would also predict a one-to-one decrease in the consumption of constrained agents. Also, the lower consumption in the unemployment state constitutes greater risk for the employed and hence will raise precautionary motives. In a richer model, unconstrained agents would likewise raise precautionary savings against higher future risk of hitting the borrowing limit. Our model thus accommodates borrowing shocks and delivers similar predictions to a model with a richer asset structure.

A second advantage of intraperiod borrowing is that it permits to match the difference in consumption of employed and unemployed workers via the calibration of the exogenous borrowing limit rather than having to rely entirely on the calibration of the government transfers to the unemployed (benefit compensation and safety net). Recall that the borrowing limit determines how much cash is distributed to the unemployed and, hence, their total income. The two government transfers can then be chosen to match other relevant moments in the data, precisely the replacement rate and the average drop in consumption associated with benefit exhaustion. The resulting calibration strategy significantly improves our confidence in the quantitative predictions of the model, specifically those related to the effects of benefit compensation and benefit recipiency.[19]

[19] The alternative most common tractable framework achieves tractability by assuming a zero borrowing limit. See, among others, Ravn and Sterk (2017) and Challe (2020). These setups rely on optimizing individual agents rather than on an household/family structure, but assume a zero debt limit, implying that agents consume their current income. While the aggregate demand structure is similar to our setup (e.g., the form of the Euler equation), such frameworks cannot accommodate borrowing shocks (obviously, given the zero debt limit) and need to rely on

Table 1—Externally Calibrated Parameters

Parameter values		
Bargaining power	η	0.5
Matching elasticity	α	0.5
Matching efficiency	α_m	1
Elasticity of substitution	ϵ	6
Relative risk aversion	ι	1

II. Calibration

We adopt a monthly calibration. We assume CRRA utility for the individual utility of household members, with relative risk aversion coefficient denoted with ι. We assume that the cost of search takes functional form given by $\varsigma(\sigma) = \left[\bar{\varsigma}/(1+\eta_\varsigma)\right]\sigma^{1+\eta_\varsigma}$, where $\bar{\varsigma}$ is a scale parameter and η_ς governs the elasticity of the search cost to search intensity σ.

There are 17 parameters in the model for which we must select values. We calibrate five of the parameters using external sources. Three are specific to the search and matching framework: the bargaining power parameter, η; the elasticity of matches to searchers, α; and the matching function constant, α_m. We calibrate them to conventional values. To maintain comparability with much of the existing literature, we set the bargaining power parameter η to be equal to 0.5. We choose the elasticity of matches to unemployment α to be equal to 0.5, the midpoint of values typically used in the literature. This choice is within the range of plausible values of 0.5–0.7 reported by Petrongolo and Pissarides (2001) in their survey of the literature on the estimation of the matching function. We then note that the parameter α_m can be normalized. A larger value of this parameter only results in a smaller value of average vacancies without affecting the steady-state properties or the dynamics of the model. The fourth parameter that we calibrate using external sources is the elasticity of substitution across varieties of intermediate goods, ϵ. This parameter is conventional in the New Keynesian literature, and we set it to 6, implying a steady-state markup of 20 percent. The last parameter is the relative risk aversion of the household members, ι. We set it to 1 to correspond to log utility. Externally calibrated parameters are summarized in Table 1.

The remaining 12 parameters are jointly calibrated to match model-relevant steady-state moments measuring the relative consumption of unemployed to employed workers; the difference in consumption of the unemployed who receive benefits and those who do not; the replacement rate; the share of unemployed receiving benefits; the separation rate; the unemployment rate; duration-dependent job finding rates; the share of short-term unemployed; the Frisch elasticity of labor supply; the nominal interest rate; and the elasticity of search intensity to the level of benefits. We calibrate the borrowing limit, $\bar{b}$; the safety net transfer, τ^s; the average benefit amount, $\bar{\tau}^u$; the average share of eligible unemployed, $\bar{\nu}$; the average

government transfers to match differences in consumption, which would be unappealing to study unemployment insurance (indeed, not a goal of these papers).

retention rate, $\bar{\rho}$; the vacancy cost, κ; the relative search efficiency of long-term unemployed, $\bar{\sigma}$; the average inflow rate to LTU, $\bar{\delta}$; the disutility of work, χ; the discount factor, β; and the search cost elasticity parameter, η_{ς}. We note that given our targets, the scale parameter of the search cost function, $\bar{\varsigma}$, can be normalized. Although there is not a one-to-one mapping of parameters to moments, there is a sense in which the identification of particular parameters is more informed by certain moments than others. We use this informal mapping to provide a heuristic argument of how the various parameters are identified.

We calibrate $\bar{b}$ to target a relative consumption expenditure of unemployed to employed workers of 0.72, from Chodorow-Reich and Karabarbounis (2016).[20] Holding everything constant, a higher $\bar{b}$ implies a higher consumption of unemployed workers, whether benefit recipients or not, and, hence, a higher ratio $\left[\bar{\nu}\bar{c}^{ur} + \left(1 - \bar{\nu}\right)\bar{c}^{un}\right]/\bar{c}^{n}$. We recover $\bar{b} = 0.4502$. We calibrate τ^{s} to target a 17 percent consumption difference of benefit recipients and nonrecipients, normalized by the consumption of the employed, from Ganong and Noel (2019).[21] The higher the safety net transfer, τ^{s}, the higher the consumption of the unemployed not receiving the benefits, $\bar{c}^{un}$, and the lower the normalized consumption difference, $\left(\bar{c}^{ur} - \bar{c}^{un}\right)/\bar{c}^{n}$. We recover $\tau^{s} = 0.1628$. We calibrate $\bar{\tau}^{u}$ to target an average replacement rate of 40.67 percent, as estimated by the United States Department of Labor (2021) for the 2001–2018 period. We set $\bar{\tau}^{u}/\left[\bar{w}\left(1 - \bar{\tau}\right)\right]$ equal to 0.4067 and recover $\bar{\tau}^{u} = 0.3224$.

We set $\bar{\nu}$ to match the empirical share of unemployment insurance recipients of 0.3956 from 1972 to 2018, from the United States Department of Labor (2022) and following McKenna (2015).[22] The parameter $\bar{\sigma}$ is chosen to match a relative job finding rate of long-term unemployed of 0.5, as estimated in Kroft et al. (2016).[23] We calibrate $\bar{\delta}$ to match an average 73.52 percent share of short-term unemployed workers from US Bureau of Labor Statistics (2022k). Given job finding and separation rates, a higher probability of becoming long-term unemployed, $\bar{\delta}$, implies a lower share of short-term unemployed workers. We recover $\bar{\delta} = 0.2905$. We calibrate $\bar{\rho}$ to match an average separation rate of 0.0354 from the US Bureau of Labor Statistics (2021) for the 2001–2018 period and recover a retention rate $\bar{\rho} = 0.9646$. The hiring cost parameter, κ, determines the resources that firms place into recruiting and hence influences the equilibrium unemployment rate. We set equilibrium unemployment to match an average unemployment rate of 6.2 percent from the US Bureau of Labor Statistics (2022n) for 2001–2018 and then calibrate κ to be consistent with it. We obtain $\kappa = 0.6036$.

[20] Our preferred estimate of 0.72 comes from the Consumer Expenditure Survey for food, clothing, recreation, vacation, over the years 1983–2012, reported in the third column of their Table 2.

[21] The consumption difference between benefit recipients and nonrecipients increases with the duration of unemployment in the nonrecipiency state. Ganong and Noel (2019) compute a range of 12 to 19 percent as a ratio of the consumption of the employed, but truncate the unemployment spell at 11 months. We then pick a value between 12 and 19 percent but toward the higher end of the range.

[22] We thank Claire McKenna for sharing the data and helping us with the construction of the series.

[23] Using Current Population Survey data from 2002 to 2007, Kroft et al. (2016) estimate that the job finding rate of the unemployed for more than six months is 47 to 53 percent of the job finding rate of the unemployed for less than a month. We pick the mean of the range.

Table 2—Internally Calibrated Parameters

	Description	Value	Target
$\bar{b}$	Borrowing limit	0.4502	Unemployed to employed cons. ratio (0.72)
τ^s	Safety net transfer	0.1628	Recipients to nonrecipients cons. diff. $(0.17c^n)$
$\bar{\tau}^u$	Benefit compensation	0.3224	Replacement rate (0.4067)
$\bar{\nu}$	Recipiency rate	0.3956	Share of recipients (0.3956)
$\bar{\rho}$	Retention rate	0.9646	Separation probability (0.0354)
κ	Flow vacancy cost	0.6036	Unemployment rate (0.062)
$\bar{\sigma}$	Search efficiency LTU	0.5	Relative LTU job finding rate (0.5)
$\bar{\delta}$	STU-LTU probability	0.2905	Share of STU (0.7352)
χ	Disutility of work	0.4167	FOC for hours worked and Frisch elasticity (1)
β	Discount factor	0.9725	Interest rate (0.003)
η_ς	Search cost elasticity	5.565	Average elasticity of search to the benefit level (−0.104)
$\bar{\varsigma}$	Search cost scale	1	Normalization

To calibrate the preference parameter χ, we proceed as follows. While the model abstracts from variation in labor at the intensive margin, we use the implicit first-order condition for the choice of hours worked evaluated at the steady state. We assume a disutility of work of the form $\chi = \left[\tilde{\chi}/\left(1 + 1/\psi\right)\right]h^{1+1/\psi}$, where $\tilde{\chi}$ is a scale parameter, h denotes hours of work, and ψ denotes the Frisch elasticity of labor supply. The implicit first-order condition equates the marginal benefit of hours to the match, qz, to the marginal cost, $\tilde{\chi}h^{1/\psi}$. (See the online Appendix for a short derivation.) Normalizing hours of work to 1 and calibrating the Frisch elasticity to 1, we recover $\chi = 0.4167$.[24,25] We calibrate β to target a monthly nominal interest rate of 0.003. The steady-state version of equation (46) determines a negative relation between the nominal interest rate and β for given consumption and population shares of the agents. We recover $\beta = 0.9725$, which is lower than what an RA model would imply, given the target. Finally, we normalize to 1 the search cost scale parameter, $\bar{\varsigma}$, and calibrate the search cost elasticity parameter, η_ς, to match the average elasticity estimated in Krueger and Mueller (2010) of the time spent on search by unemployed workers with respect to unemployment benefits.[26] We recover $\eta_\varsigma = 5.565$. The full list of internally calibrated parameter values and targeted moments is given in Table 2.

We also need to assign values to six parameters that affect the model dynamics but not the steady-state determination, and to the standard deviations and

[24] Frisch elasticity estimates vary significantly by age and gender, with values around 0.4 for young men and above 1 for older men and women. See, for example, French (2005). See also Reichling and Whalen (2012) for a summary of available estimates.

[25] The calibrated value of χ implies a relative value of nonwork, given by $\bar{\xi}/\bar{q}\bar{z}(1 - \bar{\tau})$, which is close to conventional values in the literature. We estimate 0.6455, which is only slightly below the value of 0.71 in Hall and Milgrom (2008).

[26] Krueger and Mueller (2010, 304, Table 4) report separate estimates for different regression specifications and different groups of unemployed workers. In our model, the household chooses an average search intensity for the unemployed, whether recipients or nonrecipients. We then use the estimated coefficients from the Tobit regressions for eligible and ineligible unemployed—as a proxy for recipients and nonrecipients—and compute an average elasticity using the sample weights of their respective groups. Specifically, we compute the average change in minutes of search in response to a change in the log of the average weekly benefit amount, and divide it by the average minutes of search per day. The result is an elasticity of average minutes of search with respect to the average weekly benefit amount. The corresponding elasticity in the model is computed allowing for a shock to the benefit amount that is very persistent, to parallel persistent differences in benefit compensation in the empirical analysis.

TABLE 3—CALIBRATION, DYNAMICS

	Description	Value	Target
θ	Price stickiness	0.2	Average price duration (5 months)
γ	Wage rigidity	0.0375	Wage elasticity to benefits (0.005)
ϕ	Taylor rule	2	Within range of values in the literature
Γ_{ν}	Recipiency rule, ext	0.2616	Estimated, US Depart. of Labor, 1972–2018
$\Gamma_{r,u}$	Recipiency rule, reg	0.1335	Estimated, US Depart. of Labor, 1972–2018
$\Gamma_{r,\varphi}$	Recipiency rule, reg	0.4695	Estimated, US Depart. of Labor, 1972–2018

autocorrelations of the shocks that we consider. The six parameters are the degree of price stickiness, θ; the degree of wage rigidity, γ; the parameter of the Taylor rule, ϕ; and the parameters of the recipiency rules for regular and benefit extensions programs, $\Gamma_{r,u}$, $\Gamma_{r,\varphi}$, and Γ_{ν}.[27] We set θ to be equal to 0.2, implying an average price duration of 5 months, as in Bils and Klenow (2004). We calibrate γ to 0.0375, to match an elasticity of wages to unemployment benefits of 0.005 from Jäger et al. (2020).[28] We set the Taylor rule parameter, ϕ, to 2, within the range of values standard in the literature.[29] The parameters for the recipiency rules as well as the parameters of the exogenous processes are estimated from the data, as we discuss in Section V, with the exception of the monetary shock, whose parameters are set as in McKay and Reis (2016). Table 3 reports the six model parameters that only matter for model dynamics. The parameters of the exogenous processes are presented in the online Appendix.

III. The Stabilizing Effect of Unemployment Insurance

This section assesses the stabilizing effect of cyclical unemployment insurance, taking as a metric the standard deviation of the unemployment rate. We consider insurance policy in terms of both recipiency ν_t and compensation τ_t^u. We compute the standard deviation of unemployment at different degrees of policy countercyclicality, as captured by the parameters Γ_{ν} and Γ_{τ} from equations (32) and (33). We

[27] See Section VA for the rule for regular programs.

[28] Jäger et al. (2020) report estimated wage-benefit sensitivities from their difference-in-difference regression design that range from negative 1.4 to positive 2.4 cents on the dollar after one and two years (p. 1936). We then pick as a target the middle value of this range, equal to positive 0.5 cents on the dollar. This value is well within their reported confidence intervals for all specifications in Table III (p. 1942). The corresponding elasticity in the model is computed allowing for a persistent shock to benefit compensation. Further, to validate our calibration strategy, we compute the implied elasticity of wages to productivity in the model, a common target in the literature (e.g., Hagedorn and Manovskii 2008), and recover 0.2769. This value is remarkably close to the value of 0.2361 that we estimate using data on Average Hourly Earnings of Production and Nonsupervisory Employees (US Bureau of Labor Statistics 2022b), deflated by the Personal Consumption Expenditure Price index (US Bureau of Economic Analysis 2022), and on Output per Worker in the Nonfarm Business Sector (US Bureau of Labor Statistics 2022l), over the 1972–2018 period.

[29] Estimated values for the Taylor rule coefficient on inflation typically range between 1.5 and above 2 (e.g., Sala, Söderström, and Trigari 2008). A well-known issue in models with incomplete markets and countercyclical idiosyncratic risk is that the Taylor principle is not sufficient to guarantee determinacy (see, for example, Bilbiie 2018 and Ravn and Sterk 2021). We pick a value at the higher side of the range to guarantee model's determinacy in all simulations.

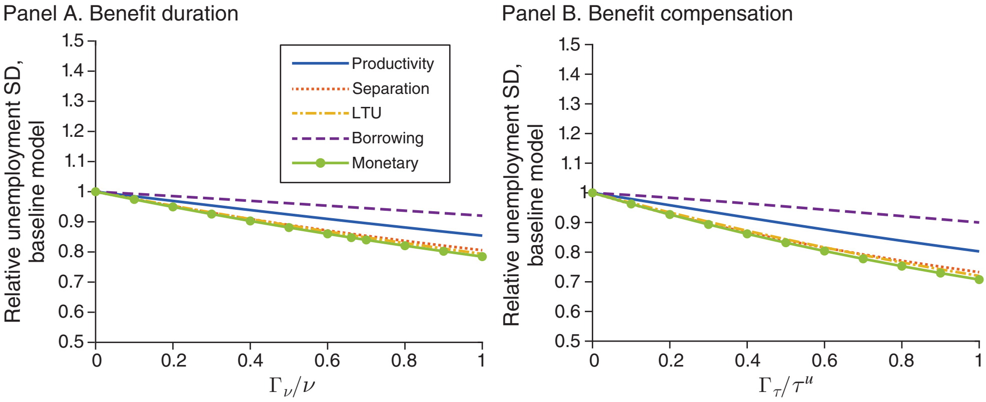

Figure 1. Unemployment Volatility as a Function of Benefit Elasticities, Different Shocks

normalize the standard deviation of unemployment relative to the acyclical case where Γ_τ and Γ_ν equal zero.

Figure 1 plots the relative standard deviation of the unemployment rate as a function of the elasticity of the recipiency rate for extended benefits programs to the unemployment rate, given by Γ_ν/ν, in the left panel, and as a function of the elasticity of benefit compensation to the unemployment rate, given by Γ_τ/τ^u, in the right panel.[30,31] In both cases, the model is subject to alternative driving forces: productivity shocks (blue solid lines), shocks to the separation rate (red dotted lines), shocks to the probability that short-term unemployed workers become long-term unemployed (yellow dashed-dotted lines), shocks to the borrowing limit (violet dashed lines), and monetary shocks (green lines with dots).

The figure shows that the volatility of unemployment unambiguously decreases as unemployment insurance becomes more countercyclical, though with different slopes depending on the driving force of fluctuations. That is, our baseline model predicts that *countercyclical* unemployment insurance plays a *stabilizing* role in response to several types of shocks when taking the form of either cyclical compensation or recipiency. The negative slopes are the outcome of contrasting mechanisms through which unemployment insurance affects the economy response to aggregate shocks and whose relative strength and net effect also depend on the calibration. For this reason, before inspecting these mechanisms analytically in Section IV, we compare the stabilizing role of unemployment insurance across seven alternative models. As these models differ by the mechanisms that they incorporate, the comparison of the slopes of the volatility curves is informative about the direction of the impact of alternative mechanisms.

We start by considering an RA version of the model with flexible prices and flexible wages, as in Mitman and Rabinovich (2020). Within this baseline RA model, we

[30] We subject the model to randomly drawn realizations of one shock innovation at a time. We simulate the model with these shocks for 12,000 periods and compute the standard deviation of the simulated unemployment series.

[31] Cyclical changes in the recipiency rate associated to regular programs are, of course, accounted for in all simulations.

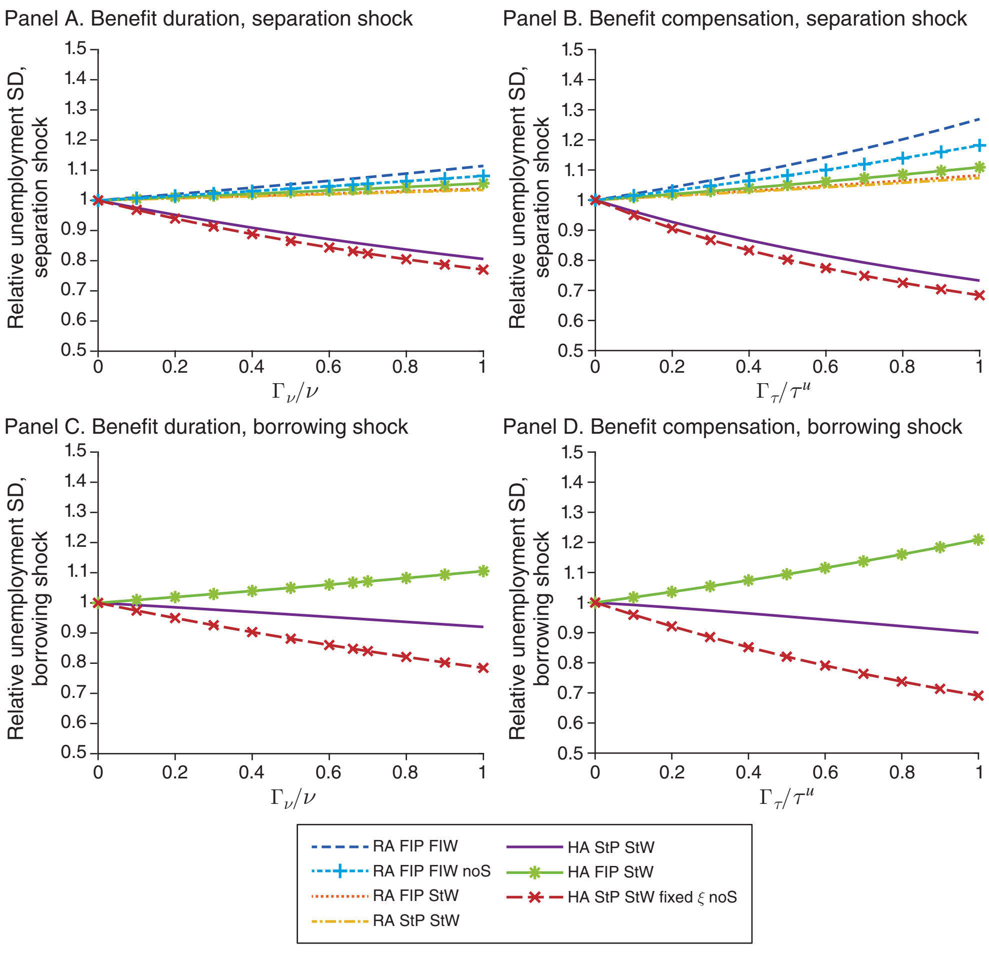

Figure 2. Unemployment Volatility as a Function of Benefit Elasticities, Different Models

also consider a version with search intensity fixed at its steady-state value. We then augment the baseline RA model with sticky real wages, first, and sticky prices, then.[32] Further incorporating HAs gives our baseline model, described in Section I. Finally, we consider two additional versions of our baseline HA model, one with flexible prices and one where the opportunity cost of employment in the wage equation and search intensity are held fixed at their steady-state values. Figure 2 reports the results. Each panel plots unemployment volatility as a function of policy cyclicality for each of the seven alternative models. The top panels consider the separation shock (a supply shock) as the driving force; the bottom panels, the borrowing

[32] To preserve comparability of quantitative predictions, when calibrating RA versions of the model, we keep the same targets with the following exceptions. We set the value of the borrowing limit, $\bar{b}$, and the difference of benefit compensation and safety net transfer, $\bar{\tau}^u - \tau^s$, as in the baseline calibration, even though consumption is equalized in all employment states. We also set the disutility of work, χ, to maintain the same relative value of nonwork, $\bar{\xi}/\bar{q}\bar{z}(1-\bar{\tau})$.

shock (a demand shock). As in Figure 1, the left panels refer to policy in terms of recipiency, and the right panels in terms of benefit compensation.

The top panels of Figure 2 focus on separation shocks and emphasize the following patterns. First, countercyclical insurance amplifies unemployment volatility in the RA model with flexible prices and wages (blue dashed lines). Second, relative to this model, the destabilizing effect of unemployment insurance is mitigated in four models—the RA model with flexible prices and wages but search intensity fixed to its steady-state value (light-blue dotted lines with pluses), the RA model with flexible prices but sticky wages (red dotted lines), the RA model with sticky prices and wages (yellow dashed-dotted lines), and the HA model with sticky wages but flexible prices (green lines with asterisks). Third, unemployment insurance becomes stabilizing within our HA model with sticky prices and wages (violet solid lines). Fourth, unemployment insurance is stabilizing to a greater extent when the opportunity cost of employment and search intensity are fixed at their steady-state levels (magenta dashed lines with crosses). Finally, we note that we observe the same patterns for the other supply shocks, productivity and LTU, whose plots are reported in the online Appendix.

What is the intuition behind these results? Consider first the RA model with flexible prices and wages. In this model, cyclical unemployment insurance affects unemployment volatility only through the labor market channel: a more (less) generous unemployment insurance, in response to rising (decreasing) unemployment, raises (reduces) workers' outside option relative to the acyclical case, which discourages (encourages) search and puts upward (downward) pressure on wages discouraging (encouraging) hiring. Put simply, countercyclical unemployment insurance amplifies the response of the economy to shocks by dampening the responsiveness of bargained wages and by amplifying the responsiveness of search intensity. For example, with separation shocks, at the value for $\Gamma_\nu/\bar{\nu}$ of 0.6613 that we estimate in Section V, unemployment volatility raises by 7.03 percent relative to the case of acyclical federal programs.[33]

Fixing search intensity within this baseline RA model closes the micro labor market channel or, equivalently, isolates the contribution of the macro labor market channel. Doing that reduces the impact of countercyclical benefits from 7.03 in the baseline RA model with both the macro and the micro channels to 5.19 percent relative to the acyclical case. This relatively small decrease indicates that the macro labor market channel is quantitatively more important than the micro one.

Adding real wage rigidity to the baseline RA model produces the third model we examine. Relative to the first model, wage stickiness not only delivers higher unemployment volatility in absolute terms[34] but also significantly decreases the response of unemployment volatility to cyclical unemployment insurance. The reason for this is that wage rigidity reduces the pass-through of countercyclical benefit policy to wages—and, hence, to job creation—limiting the strength of the macro labor market

[33] The amplification is stronger in the model with HAs and flexible wages and prices (not reported in the figure). There, at the same Γ_ν/ν, unemployment volatility raises by 11.35 percent in response to separation shocks.

[34] A well-known result emphasized in, among others, Shimer (2005); Hall (2005); and Gertler and Trigari (2009).

channel. While the lower pass-through to wages translates into a higher pass-through of benefit policy to the value of unemployment relative to that of employment—and, thus, to search intensity—amplifying the micro labor market channel, this effect is quantitative less important. Figure 2 shows that on net, wage rigidity makes the labor market channel less destabilizing: at the same $\Gamma_{\nu}/\bar{\nu} = 0.6631$, countercyclical benefit duration now only raises unemployment volatility by 2.46 percent (rather than 7.03) with separation shocks.

The next model we consider is one where we further add price stickiness. Figure 2 emphasizes that the volatility slopes are almost indistinguishable from those of the RA model with flexible prices—that is, adding price rigidity within an RA model has a negligible impact on the stabilizing effect of cyclical insurance. Indeed, within an RA framework in which workers can perfectly insure any idiosyncratic risk, unemployment insurance will play no role for aggregate demand.

Allowing next for HAs gives our baseline HA model with sticky prices and wages. Countercyclical unemployment insurance moves from having a destabilizing effect on unemployment to having a stabilizing one. The reason is simple: our baseline model also allows for an aggregate demand channel. As unemployment rises in response to a negative shock, the increase in unemployment insurance generosity stabilizes aggregate demand. It does so by redistributing resources to liquidity-constrained unemployed workers (either by raising benefit compensation or by extending duration) and by limiting the increase in idiosyncratic risk (with either a higher chance of receiving benefits or a higher expected benefit level), which in turn limits the rise in precautionary motives. The aggregate demand channel counteracts the destabilizing labor market channel and, importantly, under our baseline calibration, it dominates it. Specifically, accounting for both channels, at $\Gamma_{\nu}/\bar{\nu} = 0.6613$, it stabilizes unemployment volatility relative to the acyclical case by 14.11 percent in response to separation shocks.

We finally consider two alternative versions of our baseline HA model. The first assumes that prices are flexible. The figure shows that the volatility slopes turn positive and close to those in the RA model with sticky wages and either sticky or flexible prices. Indeed, flexible prices mute the aggregate demand effects of unemployment insurance.

The second version switches off the effect of cyclical fluctuations in the opportunity cost of labor on wages, by fixing ξ_t at its steady-state value in the wage equation, and fixes search intensity σ_t at its steady-state level. The top panels of Figure 2 clearly show that the volatility slopes become steeper than in the baseline HA model. Given the absence of labor market effects, this specification permits to quantify the extent of stabilization from the aggregate demand channel in response to selected shocks. With separation shocks, for example, the aggregate demand channel reduces unemployment volatility by 17.40 percent at the estimated value of $\Gamma_{\nu}/\bar{\nu}$.

Finally, the bottom panels of Figure 2 report relative unemployment volatility in response to the borrowing shock. We first note that the borrowing shock plays no role in RA models. The shock, however, generates a pattern consistent with that of supply shocks in the models in which it has an impact. The volatility slope is negative in the baseline model but turns positive when aggregate demand effects are muted by assuming flexible prices. This also applies to the monetary shock, whose plots are reported in the online Appendix: while the monetary shock plays no role in models with flexible prices, the volatility slope is positive in the RA model but turns negative in our baseline HA model. Further, holding ξ_t and σ_t fixed makes unemployment insurance more stabilizing, as it occurs with supply shocks. At the estimated value of $\Gamma_\nu/\bar{\nu} = 0.6613$, countercyclical unemployment insurance stabilizes unemployment volatility by 5.68 percent in the baseline model and by 15.84 percent when ξ_t and σ_t are held fixed.

IV. Inspecting the Mechanisms

To study the mechanisms through which unemployment insurance policy affects the response of the economy to aggregate shocks, we start from two key equations: the job creation condition and the search intensity condition.

The job creation condition is the solution to the firm problem stated in (16) and (17). It equates the marginal cost of vacancy posting to its marginal benefit and reads

$$\kappa = f_t^v F_{n,t}, \tag{35}$$

where κ is the per-period cost of keeping a vacancy open, f_t^v the job filling probability, and $F_{n,t}$ the value to the firm of an additional worker employed, given by

$$F_{n,t} = q_t z_t - w_t + E_t\left[\Lambda_{t,t+1}\rho_{t+1}F_{n,t+1}\right]. \tag{36}$$

Similarly, the solution to the household problem stated in (7)–(14) implies the following search intensity condition equating the marginal cost of search to its marginal benefit:

$$\varsigma'(\sigma_t) = \tilde{f}_t^s W_{n,t}, \tag{37}$$

where $\varsigma'(\sigma_t)$ is the cost of an additional unit of search, $\tilde{f}_t^s = f_t^s\left[\varphi_{t-1} + \bar{\sigma}(1 - \varphi_{t-1})\right]$ the job finding rate per unit of search, and $W_{n,t}$ the value to the household of an additional employed worker:

$$W_{n,t} = u'(c_t^n)\left[(1-\tau_t)w_t - \xi_t\right] + \beta E_t\left[\left(\rho_{t+1} - \tilde{f}_{t+1}^s\sigma_{t+1}\right)W_{n,t+1}\right]. \tag{38}$$

According to (35), a raise in the firm value of employment, $F_{n,t}$, incentivizes firms to post vacancies; according to (37), a raise in the household value of employment, $W_{n,t}$, encourages households to exert search effort. Unemployment insurance changes optimal hiring and search decisions by affecting the firm's and household's employment values. It does so via different mechanisms.

A first mechanism is the impact that unemployment insurance has on the opportunity cost of employment, ξ_t. The opportunity cost is a key determinant of the bargained wage, as shown by the solution to the Nash bargaining problem in (20):

$$w_t^* = \eta\left(q_t z_t + E_t\left[\Lambda_{t,t+1}\kappa\frac{\tilde{f}_{t+1}^s\sigma_{t+1}}{f_{t+1}^v}\right]\right) + (1-\eta)\frac{\xi_t}{1-\tau_t}. \tag{39}$$

In turn, the bargained wage, w_t^*, determines the remitted wage, w_t, according to the wage rule (21).

Specifically, a more generous unemployment insurance that raises ξ_t will put upward pressure on the wage w_t, reducing $F_{n,t}$ and discouraging hiring. We have referred to this channel as the "macro labor market" channel. At the same time, a more generous unemployment insurance raises the opportunity cost ξ_t more than it raises (net) wages $(1-\tau_t)w_t$. Put differently, there is imperfect pass-through from the opportunity cost to bargained and remitted wages. This reduces the value of an additional worker to the household, $W_{n,t}$, and discourages search. We have referred to this mechanism as the "micro labor market" channel.

A second mechanism is one by which unemployment insurance changes $F_{n,t}$ via changes in q_t, which is both the relative price of wholesale goods and the real marginal cost faced by sticky price retailers. Changes in q_t summarize the real effects that driving forces, including aggregate demand, have on the economy due to price stickiness. As aggregate demand increases, those intermediate good firms who would like to raise prices but cannot will accommodate the higher demand with higher production. Higher production of intermediate goods, which uses as inputs wholesale goods, implies in turn higher marginal costs or, equivalently, a higher relative price of wholesale goods. With flexible prices, instead, changes in aggregate demand are fully offset by adjustments in prices, and q_t is unaffected. Unemployment insurance, in turn, affects aggregate demand, c_t, by changing the consumption of agents who face heterogeneous liquidity constraints in presence of unemployment risk. Specifically, a more generous unemployment insurance raises c_t, which in presence of nominal rigidities raises q_t. The rise in q_t increases $F_{n,t}$ and stimulates hiring. We have referred to this channel as the "aggregate demand" channel of unemployment insurance.

In what follows, we derive equations that characterize the direct effect of unemployment insurance on the value of nonwork, ξ_t, and aggregate consumption, c_t. We consider both the impact of recipiency and benefit compensation.

A. *The Labor Market Channel*

In our model, the opportunity cost of employment is given by

$$(40)\qquad \xi_t = \left[\nu_t \tau_t^u + (1-\nu_t)\tau^s\right] + \left\{c_t^n - \left[\nu_t c_t^{ur} + (1-\nu_t)c_t^{un}\right]\right\} + (\lambda_t^n)^{-1}\left\{\left[\nu_t u(c_t^{ur}) + (1-\nu_t)u(c_t^{un})\right] - \left[u(c_t^n) - \chi\right]\right\} - (\lambda_t^n)^{-1}\beta E_t\left[\varsigma(\sigma_{t+1})\right],$$

revealing four separate terms. The first term is the average transfer to the unemployed including the benefit compensation, τ_t^u, weighted by the share of benefit recipients, ν_t, and the safety net transfer, τ^s, weighted by the share of nonrecipients, $1-\nu_t$. The second term is the savings from the lower average consumption of the unemployed, $\nu_t c^u r_t + (1-\nu_t)c_t^{un}$, relative to the consumption of the employed, c_t^n. The third term is the difference between the average utility from being unemployed, $\nu_t u(c_t^{ur}) +$

$(1-\nu_t)u(c_t^{un})$, and the utility from being employed, $u(c_t^n) - \chi$, expressed in consumption units, with λ_t^n denoting the marginal utility of consumption of employed workers. The last term is savings in next-period search costs, $\beta E_t[\varsigma(\sigma_{t+1})]$, expressed in consumption units. The second and the third terms originate from the lack of consumption insurance. Changes in benefit compensation, τ_t^u, and recipiency, ν_t, will affect the first three components of the opportunity cost.

To compute the direct effect of unemployment insurance on the opportunity cost of employment, ξ_t, we use the household equilibrium conditions (8)–(13) and the Euler equation for employed workers, determining c_t^n, c_t^{ur} and c_t^{un}, together with equation (40). This gives us the opportunity cost ξ_t as a function of variables taken as given by the household: $\{\bar{b}_{t+s}, w_{t+s}, d_{t+s}, n_{t+s}, \tau_{t+s}, i_{t+s+1}, \pi_{t+s+1}, \tau_{t+s}^u, \nu_{t+s}\}_{s=0}^{\infty}$. We then take the partial derivative of ξ_t with respect to either dimension of unemployment benefit policy, τ_t^u or ν_t.[35]

Consider first the impact of recipiency. The partial derivative of ξ_t with respect to ν_t gives

$$(41) \qquad \frac{\partial \xi_t}{\partial \nu_t} = (\tau_t^u - \tau^s) - (c_t^{ur} - c_t^{un}) + \frac{u(c_t^{ur}) - u(c_t^{un})}{\lambda_t^n}.$$

An increase in the recipiency rate raises the opportunity cost of employment by raising the share of unemployed receiving the benefit τ_t^u relative to the safety net τ^s (the first term) and by raising the average utility from being unemployed via a change in the composition toward benefit recipients away from nonrecipients, with recipients enjoying higher consumption and, thus, higher utility than nonrecipients (the third term); the same shift in composition, however, reduces the opportunity cost by lowering the savings from a lower average consumption of the unemployed relative to the employed, since the average consumption of the unemployed increases with recipiency (the second term). The first term is standard in the literature; the second and third terms are novel and associated to differences in consumption levels of benefit recipients and nonrecipients.

Using the binding liquidity constraints in equations (10) and (11), given by $c_t^{ur} = x_t + \tau_t^u$ and $c_t^{un} = x_t + \tau^s$, the expression in (41) can be simplified to

$$(42) \qquad \frac{\partial \xi_t}{\partial \nu_t} = \frac{u(c_t^{ur}) - u(c_t^{un})}{\lambda_t^n},$$

which shows that the partial derivative of ξ_t with respect to ν_t is unambiguously positive: an increase in recipiency directly raises the opportunity cost of employment.

Consider now the direct effect of benefit compensation. Taking the partial derivative of ξ_t from equation (40) with respect to τ_t^u gives

$$(43) \qquad \frac{\partial \xi_t}{\partial \tau_t^u} = \nu_t - \nu_t \frac{\partial c_t^{ur}}{\partial \tau_t^u} + \nu_t \frac{\lambda_t^{ur}}{\lambda_t^n} \frac{\partial c_t^{ur}}{\partial \tau_t^u},$$

[35] While the relevant policy dimension is recipiency under extended benefit, ν_t^e, rather than total recipiency, ν_t, given that $\partial \nu_t / \partial \nu_t^e = 1$, we simplify notation expressing derivatives with respect to ν_t.

with λ_t^{ur} denoting the marginal utility of consumption of unemployed receiving benefits. An increase in benefit compensation raises the opportunity cost of employment by raising the amount received by the share of recipients ν_t (the first term) and by raising the average utility from being unemployed via an increase in the consumption of the liquidity-constrained benefit recipients, c_t^{ur}, as the benefit, τ_t^u, rises (the third term); the increase in c_t^{ur}, at the same time, lowers the savings from a lower consumption of the unemployed relative to the employed (the second term). As in the case of recipiency, while the first term is standard in the literature, the second and the third are novel and associated to differences in consumption of employed and unemployed receiving benefits, the latter being liquidity constrained.

From the binding liquidity constraint of benefit recipients in equation (10), we see that a change in benefit compensation implies a one-to-one change in consumption—that is, $\partial c_t^{ur}/\partial \tau_t^u = 1$. The partial derivative of ξ_t with respect to τ_t^u in (43) can then be simplified to

$$\frac{\partial \xi_t}{\partial \tau_t^u} = \nu_t \frac{u'\left(c_t^{ur}\right)}{u'\left(c_t^n\right)}, \tag{44}$$

which makes clear that the impact of τ_t^u on ξ_t is unambiguously positive.

Intuitively, the comparison of equations (42) and (44) shows that while the effects of changes in recipiency are determined by the difference in consumption of the unemployed who receive the benefits and those who do not, the effects of changes in benefit compensation depend on the difference in consumption of the employed and the unemployed receiving the benefits. In either case, however, a more generous unemployment insurance raises the value of nonwork and, as a consequence, wages, hence discouraging hiring. At the same time, a more generous policy raises the wage by less than it raises the opportunity cost of work, hence lowering the household's surplus from an additional employed worker and discouraging search.

The key difference between our HA model and an RA version of it is that the first also features an aggregate demand channel of unemployment insurance, to which we turn shortly. The labor market channel, however, also differs across the two models. Within the RA version of the model, equations (41) and (43) would only include the first term and reduce to $\partial \xi_t/\partial \nu_t = \tau_t^u - \tau^s$ and $\partial \xi_t/\partial \tau_t^u = \nu_t$. The two additional terms present in equations (41) and (43) arise because of imperfect consumption insurance in the HA model and have a positive net effect.[36] That the value of nonwork ξ_t rises more in presence of HAs, in response to an increase in either recipiency or benefit compensation, means that the destabilizing effect of the labor market channel is stronger in the HA model than in the RA model.[37] Intuitively, the reason for this is that the higher the difference in the consumption of

[36] In equation (43), $\lambda_t^{ur}/\lambda_t^n \geq 1$, since the benefit recipients have a lower (or equal) consumption level than the employed and, thus, higher (or equal) marginal utility of consumption. In equation (41), the positive net effect arises from the concavity of utility together with the lower consumption level of the nonrecipients relative to the recipients.

[37] Indeed, if we compare an HA and an RA model, both with flexible wages and prices, so that the aggregate demand effects are also muted in the HA model, we find that with separation shocks and at the estimated value for Γ_ν, the volatility of unemployment increases by 7.03 percent in the RA model and by 11.35 percent in the HA model.

the unemployed relative to the employed, the lower the opportunity cost of work. Hence, a more generous unemployment insurance, working either via an increase in the consumption of recipients or via an increase in their share, will raise the opportunity cost of employment via a standard effect that raises the average benefit compensation, but also via a nonstandard effect that alleviates consumption differences across the unemployment and the employment state. The nonstandard effect is absent from the RA version of the model where consumption is equalized across states.

B. *The Aggregate Demand Channel*

The equations that are relevant to the inspection of the effect of a change in the generosity of unemployment insurance on aggregate demand, via redistribution toward liquidity-constrained unemployed and precautionary motives of employed, are the expression for aggregate consumption, c_t, given by

$$c_t = n_t c_t^n + (1 - n_t)\nu_t c_t^{ur} + (1 - n_t)(1 - \nu_t) c_t^{un}; \tag{45}$$

the binding liquidity constraints for benefit recipient and nonrecipient in equations (10) and (11), given by $c_t^{ur} = x_t + \tau_t^u$ and $c_t^{un} = x_t + \tau^s$; and the Euler consumption equation for employed workers, given by

$$u'(c_t^n) = \beta E_t\left[\frac{1 + i_{t+1}}{\pi_{t+1}}\left[n_{t+1} u'(c_{t+1}^n) + (1 - n_{t+1})\left(\nu_{t+1} u'(c_{t+1}^{ur}) + (1 - \nu_{t+1}) u'(c_{t+1}^{un})\right)\right]\right]. \tag{46}$$

The Euler condition equates the current marginal utility of an employed worker with her future discounted expected marginal utility, augmented with interest rate returns. It captures in particular precautionary motives associated with uninsurable unemployment risk. Specifically, a worker employed today can be in one of three employment states tomorrow—employed, unemployed with benefits, or unemployed without benefits—with the probability of each state equal to the relevant population weight, as implied by the assumption of i.i.d. idiosyncratic risk.

We start by considering the impact of recipiency via the redistribution effect. To compute the direct effect, we take the partial derivative of aggregate consumption from equation (45) with respect to ν_t,[38]

$$\frac{\partial c_t}{\partial \nu_t} = (1 - n_t)(c_t^{ur} - c_t^{un}), \tag{47}$$

[38]As in the previous subsection, we use household equilibrium conditions to write aggregate consumption, c_t, from equation (45), as a function of variables taken as given by the household, $\{\bar{b}_{t+s}, w_{t+s}, d_{t+s}, n_{t+s}, \tau_{t+s}, i_{t+s+1}, \pi_{t+s+1}, \tau_{t+s}^u, \nu_{t+s}\}_{s=0}^{\infty}$.

which is unambiguously positive. A raise in the recipiency rate changes aggregate consumption by the difference in consumption between recipients and nonrecipients, $c_t^{ur} - c_t^{un}$, weighted by the number of unemployed workers, $1 - n_t$, who can change recipiency state. Further, as unemployed workers are liquidity constrained and consume their income, nonrecipients gaining the benefit increase their consumption by the difference between the benefit, τ_t^u, and the safety net transfer, τ^s. The partial derivative in (47) can then be rewritten as

$$\frac{\partial c_t}{\partial \nu_t} = (1 - n_t)(\tau_t^u - \tau^s). \tag{48}$$

A similar redistributive effect arises in response to an increase in benefit compensation. Taking the partial derivative of c_t from equation (45) with respect to τ_t^u, using also the binding liquidity constraint for benefit recipients, gives

$$\frac{\partial c_t}{\partial \tau_t^u} = (1 - n_t)\nu_t, \tag{49}$$

where aggregate consumption varies by the measure of benefit recipients, $(1 - n_t)\nu_t$. Indeed, liquidity-constrained benefit recipients increase their consumption by change in benefit compensation.

In the model, an increase in either benefit recipiency or benefit compensation is financed with taxes on wages and dividends, redistributing resources from unconstrained employed workers to constrained unemployed workers. This result directly obtains from the assumptions that taxes balance the government budget. Section IVC provides a discussion of the role of taxes and the balanced-budget assumption.

When it comes to the precautionary motive effect, what matters is future unemployment insurance. A more generous unemployment insurance that is expected to persist into the future reduces the unemployment risk faced by employed workers and lowers their desired savings. Then, the higher the consumption demand of employed workers, c_t^n, the higher is aggregate demand, c_t.

To characterize the impact of unemployment insurance on the precautionary motive, it is useful to write the Euler equation (46) as

$$u'(c_t^n) = \beta E_t\left[\frac{1 + i_{t+1}}{\pi_{t+1}} u'(c_{t+1}^n)\Omega_{t+1}\right], \tag{50}$$

where the term Ω_{t+1}, given by

$$\Omega_{t+1} \equiv \left[n_{t+1} + (1 - n_{t+1})\nu_{t+1}\frac{u'(c_{t+1}^{ur})}{u'(c_{t+1}^n)} + (1 - n_{t+1})(1 - \nu_{t+1})\frac{u'(c_{t+1}^{un})}{u'(c_{t+1}^n)}\right], \tag{51}$$

captures unemployment risk. The higher the risk (as measured by lower employment or recipiency rates or larger consumption difference across employment states), the higher the term Ω_{t+1} (given $c_{t+1}^n > c_{t+1}^{ur} > c_{t+1}^{un}$ and strict concavity of period utility), and the higher the desire to save for precautionary reasons.

To compute the direct effect of future recipiency, we then take the partial derivative of Ω_{t+1} with respect to ν_{t+1}.[39] This gives

$$\frac{\partial \Omega_{t+1}}{\partial \nu_{t+1}} = \left(1 - n_{t+1}\right) \frac{u'\left(c_{t+1}^{ur}\right) - u'\left(c_{t+1}^{un}\right)}{u'\left(c_{t+1}^{n}\right)}, \tag{52}$$

which is unambiguously negative. A raise in ν_{t+1} increases the probability that the worker, if unemployed next period, will be in the highest consumption state, c_{t+1}^{ur}, rather than in the lowest one, c_{t+1}^{un}. This reduces unemployment risk and incentives to save this period. The magnitude of the effect depends on the difference of next-period marginal utilities of consumption of recipients and nonrecipients, $u'\left(c_{t+1}^{ur}\right) - u'\left(c_{t+1}^{un}\right)$, scaled by the next-period marginal utility of employed $u'\left(c_{t+1}^{n}\right)$, and next-period probability of being unemployed, $1 - n_{t+1}$.

The direct effect of future benefit compensation can be similarly computed taking the partial derivative of Ω_{t+1} with respect to τ_{t+1}^{u}, using also the binding liquidity constraint for benefit recipients given by $c_t^{ur} = x_t + \tau_t^u$, to obtain

$$\frac{\partial \Omega_{t+1}}{\partial \tau_{t+1}^{u}} = \left(1 - n_{t+1}\right) \nu_{t+1} \frac{u''\left(c_{t+1}^{ur}\right)}{u'\left(c_{t+1}^{n}\right)}. \tag{53}$$

This partial derivative is also unambiguously negative. A raise in τ_{t+1}^{u} increases next-period consumption in the benefit recipient state. Higher consumption in that state reduces incentives to save. The magnitude of the effect is affected by the change in the marginal utility of consumption for benefit recipients, $u''\left(c_{t+1}^{ur}\right)$, scaled by the next-period marginal utility of employed, $u'\left(c_{t+1}^{n}\right)$, and next-period probability of the recipiency state, $\left(1 - n_{t+1}\right)\nu_{t+1}$.

To conclude, it is useful to emphasize the absence of any of the aggregate demand effects of unemployment insurance discussed here in an RA version of the model. To see this, we impose perfect consumption insurance, implying equal consumption across agents, in the relevant equations. First, aggregate consumption c_t will simply equal the individual consumption levels. Accordingly, the Euler equation simplifies to $u'\left(c_t\right) = \beta E_t\left[\left(\left(1 + i_{t+1}\right)/\pi_{t+1}\right) u'\left(c_{t+1}\right)\right]$. The household budget constraint can be written as $a_{t+1}/p_t = x_t + w_t n_t + d_t n_t - c_t$, where we have also used the government budget constraint (31). Both the Euler equation and the household budget constraint clearly allow no role for unemployment insurance. The aggregate demand channel is absent in an RA version of the model.

C. *Discussion*

We next discuss several issues involving the robustness of the assumptions that underlie our analysis and the plausibility of the quantitative predictions of our model.

[39] Here, we use the household equilibrium conditions to write the measure of unemployment risk, Ω_{t+1}, from equation (51), as a function of $\left\{\bar{b}_{t+s}, w_{t+s}, d_{t+s}, n_{t+s}, \tau_{t+s}, i_{t+s+1}, \pi_{t+s+1}, \tau_{t+s}^{u}, \nu_{t+s}\right\}_{s=1}^{\infty}$.

Taxes and Government Balanced Budget.—So far, our discussion of the mechanisms has abstracted from the effect of unemployment insurance policy on taxes. Our balanced-budget assumption implies that the tax rate τ_t adjusts each period to cyclical changes in τ_t^u and ν_t so as to satisfy the government budget constraint. How do taxes affect the transmission mechanisms of unemployment insurance?

It is straightforward to see from the expression of the bargained wage (39) that tax adjustments amplify the destabilizing labor market effects of unemployment insurance. A more generous unemployment insurance raises bargained wages directly, via an increase in the opportunity cost of employment ξ_t, and indirectly, via the increase in the tax rate τ_t that is needed to finance the higher benefits. Intuitively, higher taxes on income from work raise the opportunity cost of employment expressed in terms of net labor income, given by $\xi_t/(1-\tau_t)$ in equation (39). However, in taking the derivative of ξ_t from equation (40) with respect to either ν_t or τ_t^u, we have also abstracted from the effect of τ_t on c_t^n. In Section B.2 of the online Appendix, we show that this effect can make the derivative larger or smaller depending on the calibration. Our calibration makes it smaller, mitigating the labor market channel. While the net effect of taxes on the strength of the labor market channel remains positive, it is quantitatively small.

Tax adjustments also have an ambiguous effect on the aggregate demand channel. On one hand, aggregate demand effects coming from redistribution are dampened by the balancing of the government budget. The increase in taxes associated with more generous benefits reduces the resources available to employed workers for their consumption, limiting the rise in aggregate demand. We show this formally in Section B.2 of the online Appendix, where we expand equations (47) and (49) to account for the effect of benefits on taxes (via the government budget constraint) and the effect of taxes on the consumption of employed workers (via their budget constraint). Aggregate demand effects from redistribution of course remain positive, given that employed workers have lower marginal propensity to consume than the unemployed. On the other hand, however, lower consumption of employed workers due to higher taxes amplifies aggregate demand effects coming from precautionary motives. This happens because, other things equal, consumption in the employment state gets closer to consumption in the unemployment state, further reducing labor market risk and incentives to save for precautionary motives. The online Appendix presents the formal derivations. While the net effect of tax adjustments on the aggregate demand channel is in general ambiguous, our calibration makes it stronger, but to a small degree.

At the other extreme of a balanced-budget assumption is one of constant taxes, whereby countercyclical unemployment insurance results in countercyclical government deficits.[40] Rather than explicitly introducing government debt, we proxy this alternative assumption in the model by fixing taxes at their steady-state value.[41]

[40] Indeed, benefit extensions during the Great Recession were part of a large stimulus package (the American Recovery and Reinvestment Act), which included tax incentives rather than tax increases.

[41] By doing this, we implicitly assume that the government operates under balanced budget on average rather than every period, and finances short-term deficits with foreign debt while saving in foreign assets in periods with surpluses. The foreign debt assumption ensures that there is no effect of changes in government debt on the equilibrium asset structure of the economy. We also implicitly abstract from interest payments on foreign debt.

We find that this alternative assumption does not have a large impact on the quantitative predictions of the model, in particular on those relating to extensions. For example, the (maximum) effect on the unemployment rate of the discretionary extensions implemented during the Great Recession, which we compute in Section V, changes from -0.1609 percentage points with variable taxes to -0.1396 percentage points with fixed taxes. Further, the extent to which the model fits the data during that period is not affected in any detectable manner.

Binding Liquidity Constraints and Persistence of Employment States.—Our modeling of the aggregate demand side relies for tractability on two features. First, all unemployed workers are liquidity constrained, regardless of the duration of their unemployment spell. This implies that their marginal propensity to consume out of government transfers is one—i.e., they increase consumption by the additional income from either benefits or safety net transfers. Second, employment states are i.i.d.. A richer model would allow, first, for persistent employment states and, second, for the possibility that unemployed workers may only become constrained as their unemployment spell persists over time. While simplified in certain dimensions, our formulation yet produces plausible predictions in response to redistribution and precautionary motives.

Consider first redistribution. Our calibration strategy ensures that the model is able to capture the overall effect of benefit extensions via redistribution as well as a richer model would do. This is attained by adding an extra (safety net) transfer to nonrecipients to target the *average* difference in *consumption* of unemployed workers before and after the loss of benefits, measured in the data by tracking the same worker over the unemployment spell. In general, this consumption difference is jointly determined by the drop in income at the time of benefit expiration and the relevant marginal propensity to consume. A richer model would be able to match both factors, which together should imply the decreasing path in consumption that is observed in the data as the worker remains unemployed. Indeed, in such richer models, the effect of benefit extensions on consumption will differ at the individual level by both the duration of unemployment and the level of savings.[42] We instead choose to miss on matching both factors separately to achieve tractability. Our model structure implies a unitary marginal propensity to consume of unemployed workers. Given that, we directly calibrate the difference between the income of recipients and nonrecipients to match the average consumption difference associated to the benefit loss in the data. This difference in income is determined in our model by the difference between the unemployment benefit and the safety net transfer, and we calibrate the safety net transfer to target the consumption difference. This makes the

[42] While, in our current setup, recipiency and duration are assumed to be independent, we could account for declining consumption over the course of the unemployment spell by simple relabeling, with no impact on aggregate consumption. In fact, since the household's problem only depends on the aggregate share of recipients, not on the individual recipiency states, our setup is equivalent to one where individuals are relabeled in a way that assigns a higher probability of nonrecipiency to the long-term unemployed for given aggregate shares.

model able to capture the effect of extensions on aggregate consumption in response to redistribution.[43]

We discipline the precautionary saving motive with two key assumptions. First, unemployed are constrained and therefore cannot engage in precautionary behavior. Second, employment states are i.i.d., so precautionary behavior by the employed will reflect this type of risk. We discuss each of these assumptions below in turn.

Starting from the former, while the model rules out the possibility that some unemployed may be unconstrained and choose to save for precautionary reasons—say, to insure against the risk of benefit loss—there is little evidence of that phenomena.[44] Thus, by only letting the employed agents be unconstrained and save for precautionary reasons, we may actually be quite close to reality.

Consider now the average risk faced by a worker in employment. The i.i.d. nature of risk implies that the probabilities of future employment states are given by the population weights—i.e., by the unconditional distribution of employment states. As a consequence, relative to a model with persistent states, our model implies that on average the risk of unemployment in the immediate term (next period) is higher for workers currently employed (the unemployment rate is higher than the probability of separating to unemployment) and lower for workers currently unemployed (the unemployment rate is lower than the probability of not finding a job).[45] However, over time, the conditional distribution will converge to the unconditional one, and the convergence is relatively quick, which is important as the decision to save for precautionary motives is a forward-looking one.[46] Furthermore, the average risk faced by employed workers also depends on the consumption levels in the three future employment states. This dimension is disciplined by matching relative consumption differences.

Turning to the cyclicality of risk, it is driven by both the cyclicality of the transition probabilities among states and the cyclicality of the relative consumption levels across states. We first note that with both i.i.d. and persistent employment states, the probabilities of becoming unemployed, at different horizons, comove positively with current and future separation rates and negatively with current and future job finding rates, though the extent of comovement may differ across the two setups. While our model may overestimate the cyclicality of short-term unemployment (STU) risk, if the separation rate is less cyclical than the unemployment rate, conditional probabilities converge to unconditional ones at longer horizons. At the same time, our model

[43] The pass-through from extensions to aggregate consumption is determined by the product of the average benefit change and the average marginal propensity to consume, which equals the average consumption response to an increase in recipiency. By targeting the average consumption change, we match this aggregate pass-through of richer models.

[44] Ganong and Noel (2019) compute an average 12 percent consumption drop at benefit expiration. They argue that this cannot be rationalized within a model of forward-looking agents with liquidity constraints. In such a model, agents would optimally accumulate savings to smooth the expected income drop, implying a gradual decrease in consumption.

[45] We similarly overestimate the immediate term risk for a currently employed of moving to the nonrecipient unemployed state relative to the recipient state.

[46] For example, under the current calibration, an employed worker would face a conditional probability of being unemployed next month equal to 3.5 percent (the separation rate) and a conditional probability of being unemployed 6 months ahead equal to 5.9 percent, which is already very close to the unconditional probability of 6.2 percent (the unemployment rate). Full convergence occurs after 17 months (first four decimal digits are the same).

will likely underestimate the cyclicality of risk associated to variation in relative consumption levels across states. This happens because consumption in the unemployment state does not directly respond to risk in our model. In a richer model, instead, an increase in risk may cause some unconstrained unemployed workers to save for precautionary reasons and decrease consumption. The lower consumption in the (future) unemployment state constitutes further risk for workers employed today, a cyclical component that is absent from our model with unemployed always liquidity constrained. (Though, as said above, existing evidence indicates this effect is likely small.)

Further, because the object of interest is the effect of benefit extensions on aggregate demand, the appropriate comparison is between the predictions of our model and the *aggregated* responses of agents in a model with richer heterogeneity. Our household problem delivers predictions for aggregate consumption across employment states directly, via an aggregate Euler equation for employed workers. Instead, the setup with individual savings and persistent employment states delivers individual Euler equations for both employed and unemployed individuals that need to be *aggregated* across the distribution of asset levels. Such aggregation brings the predictions of the two models even closer together, with remaining differences mainly due to nonlinearities associated to the concavity of utility. As individual Euler equations are aggregated through population weights, individual consumption differences across employment states get averaged. At the same time, the individual transition probabilities multiplied by the current population weights in each employment state equal the future population weights, exactly the objects that enter our aggregate Euler equation.

To further drive the point home, we conduct numerical experiments to compare the effects on savings for precautionary motives of changes in perceived future risk in two alternative setups. The first is our baseline model with household savings and i.i.d. employment states. The second is a richer model with individual savings and persistent states. In the richer setup, we aggregate the responses of individual agents who make heterogeneous saving decisions. In both setups, we consider the problems of the households in a partial equilibrium setting with no search, and subject the agents to shocks to expected future transition rates with no realized changes. This way, we abstract from both general equilibrium effects and compositional effects associated to changes in transition rates and variable search intensity. Hence, we isolate the change in aggregate consumption that is due to precautionary saving effects and assess how close it is in the two setups. Section B.3 of the online Appendix formulates the model with individual savings and persistent employment states and details the quantitative experiments that we conduct. We find that the effects on aggregate consumption are of the same order of magnitude in the two setups. We also find that in both models, the effects are small if compared to the responses to actual (realized) shocks. That composition effects largely prevail in these partial equilibrium experiments further suggests that the extent to which we may miss the strength of the precautionary saving channel will not have large effects on the overall results.

Opportunity Cost of Employment with Household-Level Bargaining.—Our model assumes wage bargaining at the household level. As a consequence, the opportunity cost of employment that enters the wage equation and affects the firms' hiring decision is an average among household members, including benefit recipients and nonrecipients. A richer model would instead have wages bargained at the worker level. Furthermore, differential asset accumulation among employed and unemployed workers in the richer model may introduce additional components to the cost of moving from unemployment to employment.

Nonetheless, the predictions of the richer model for the effect of benefit extensions on firms' hiring decisions will be largely comparable to those of our model.[47] This happens for two reasons. First, the decision to post vacancies depends on the wages that firms expect to pay to the workers they are yet to meet. In a richer model, those expected wages will depend on the expected opportunity cost of employment within the pool of searching workers. Accordingly, the relevant opportunity cost will similarly be given by a population-weighted average of the opportunity cost of employment of agents with different outside options, in particular the option to receive benefits. This implies that, abstracting from differential asset positions across employment states, the average opportunity cost of employment implied by individual bargaining will coincide with the opportunity cost implied by household-level bargaining and given in equation (40). We show this formally in Section B.4 of the online Appendix. Second, the additional component associated to differential asset accumulation is likely to be little affected by changes in benefit duration and compensation, as we argue in the online Appendix. This is true in particular as most unemployed workers will be liquidity constrained, especially those impacted by benefit extensions, and hence choose future assets at the borrowing limit.

That the opportunity cost is comparable in the two setups makes us confident about the predictions of our model for the effects of benefits on wages and hiring via the opportunity cost of work.

V. Explaining Unemployment

In this section we evaluate the ability of our model to account for unemployment dynamics. To do this, we estimate a number of exogenous shocks, feed them into the model, and compare simulated unemployment dynamics to actual data. We first (and mostly) restrict our attention to the Great Recession but later also consider the pandemic recession. We explore several sources of aggregate fluctuations that fit the narrative of the 2008 downturn and allow for both automatic and discretionary extensions, which we measure in the data.[48] We further quantify the stabilizing effect of the unprecedented benefit extensions introduced during the Great Recession and evaluate the contribution of each channel in shaping that effect. We finally turn our attention to the pandemic recession and evaluate the impact of benefit policy in this unusual downturn. In doing this, the focus is on assessing the impact of changes in benefit duration versus compensation. In what follows, Section VA explains how we

[47] See Chodorow-Reich and Karabarbounis (2016) for a similar argument.

[48] In the online Appendix we present results for a longer sample and focus on productivity as the single driving force, keeping with the existing literature.

measure extensions. Section VB studies the Great Recession. Section VC focuses on the pandemic recession.

A. *Measuring Automatic and Discretionary Extensions*

In the United States there is a standard of 26 weeks of unemployment compensation, known as regular or state unemployment insurance benefits. The United States also has programs for extending benefits. One is a permanent extended benefits program, introduced in 1970. Extended benefits allows for the automatic temporary extensions of benefit duration during high levels of state-level unemployment. The program provides up to 13 or 20 additional weeks of benefits when a state is experiencing high or extremely high unemployment. Additionally, during national recessions, the federal government often extends unemployment insurance benefits temporarily as part of a broader discretionary countercyclical policy. This has occurred in 1958, 1961, 1971, 1974, 1982, 1991, 2002, 2008, and 2020. On June 30, 2008, in particular, the Emergency Unemployment Compensation (EUC08) program was signed into law. The program had four tiers that differed by the number of extra weeks available depending on the state-level unemployment rate, with up to 53 additional weeks in total. The program expired on December 28, 2013.

To estimate automatic and discretionary extensions from US data, we use the monthly recipiency rate—the share of unemployed workers receiving unemployment insurance. The series is available starting in January 1971 from ETA report 5159 (United States Department of Labor 2022). The data comprise recipiency under both regular programs, in particular State Unemployment Insurance Benefits, and federal programs, including extended benefits and other emergency benefits, among which is EUC08.[49]

Accordingly, and as we noted in Section IF, the recipiency rate ν_t can be thought as the sum of two components, $\nu_t = \nu_t^r + \nu_t^e$, where ν_t^r is the share of unemployed receiving benefits under regular programs and ν_t^e the share receiving benefits under extended and emergency benefits programs. While our focus is on the second policy component, ν_t^e, we need to separately account for cyclical changes in recipiency under regular programs, ν_t^r. Indeed, mostly because the composition of the unemployed mechanically shifts toward the short-term unemployed, the number of recipients rises as unemployment rises even absent any extension.

Regular Unemployment Insurance Programs.—To capture the countercyclicality present by construction in the unemployment insurance system, we estimate the following rule for the recipiency rate under regular programs, ν_t^r:

$$\nu_t^r = \bar{\nu}_t^r + \Gamma_{r,\varphi} \log\left(\frac{\varphi_{t-1}}{\bar{\varphi}_{t-1}}\right) + \Gamma_{r,u} \log\left(\frac{u_{t-1}}{\bar{u}_{t-1}}\right) + \varepsilon_{r,t}, \tag{54}$$

[49] The report contains data on total weeks of benefits claimed in each state in each month. We normalize total weeks claimed by 12/52 to get the number of recipients during each month in each state. We then divide the sum of recipients across states by the US number of unemployed for each month. Finally, we take a 13-months centered moving average of the resulting series to smooth out erratic behavior.

where $\bar{\nu}_t^r$ is the trend of the average recipiency rate for regular programs, φ_{t-1} is the past share of short-term unemployed and $\bar{\varphi}_{t-1}$ its trend, u_{t-1} is the past unemployment rate and $\bar{u}_{t-1}$ its trend, $\Gamma_{r,\varphi}$ is a parameter governing the reaction of recipiency to the past short-term share, $\Gamma_{r,u}$ is a parameter governing the reaction to past unemployment, and $\varepsilon_{r,t}$ is an exogenous shock. The second term on the RHS of (54) in φ captures cyclical changes in recipiency associated to cyclical changes in the composition of unemployed by duration. The third term in u is meant to capture cyclical movements other than composition (e.g., changes in take-up rates).

We estimate (54) on the 1972–2018 sample.[50] We compute trends with an HP filter with smoothing parameter equal to 129,600 (the analog for monthly data of 1,600 for quarterly data). We recover a coefficient $\Gamma_{r,\varphi}$ on the past short-term share equal to 0.4695 and a coefficient $\Gamma_{r,u}$ on the past unemployment rate equal to 0.1335. We also fit an AR(1) process to the residual $\varepsilon_{r,t}$ to allow for additional variation not directly associated to composition or unemployment and estimate an autocorrelation $\rho_{r,\nu} = 0.8918$ and a standard deviation $\sigma_{r,\nu} = 0.0067$.

We feed the estimated ν_t^r rule, including the process $\varepsilon_{r,t}$, in all simulations in this section, this way accounting for the "mechanical" changes in the recipiency rate.

Automatic and Discretionary Benefit Extensions.—As we mentioned, benefit extensions, whether automatic or discretionary, are included in the federal programs. We then measure extension policies using the recipiency rate under the federal programs. To distinguish between automatic and discretionary extensions, we use the empirical version of the recipiency rule in (32), given by

$$\nu_t^e = \bar{\nu}_t^e + \Gamma_\nu \log\left(\frac{u_{t-1}}{\bar{u}_{t-1}}\right) + \varepsilon_{\nu,t}, \tag{55}$$

and regress the recipiency rate under federal programs ν_t^e on its trend $\bar{\nu}_t^e$ and on deviations of the log of past unemployment u_{t-1} from its trend $\bar{u}_{t-1}$, and use the residual $\varepsilon_{\nu t}$ as an exogenous series. As before, trends are computed with an HP filter.

The second term on the RHS of (55), $\Gamma_\nu \log\left(u_{t-1}/\bar{u}_{t-1}\right)$, is endogenous and taken to capture the automatic extensions embedded in the US system and triggered by increases in unemployment above certain thresholds. One example of these extensions are those prescribed by the extended benefits program. We note that while benefit duration is usually changed in a discrete way—say, from a maximum of 26 weeks to 39—the recipiency rate changes smoothly.[51] As a result, we can estimate a rule that makes the recipiency rate a smooth function of past unemployment. Further, we emphasize that because the policy rule is estimated exclusively on recipiency under federal programs, this component captures "automatic" increases in recipiency beyond the "mechanical" increases due to the inflow into unemployment at the start of the recession.

[50] Data are available since 1971, and we initially exclude 2020 and 2021 given the unusual policy response during COVID-19 (see Section VC). Since we take a 13-months centered moving average, our longest usable sample is 1972–2018.

[51] At a given time, the discrete changes in maximum duration only bind for the subset of unemployed workers who find themselves at benefit exhaustion. The effect of extensions on the recipiency rate is thus smoothed out over time by taking the average of a recipiency status indicator function across unemployed workers.

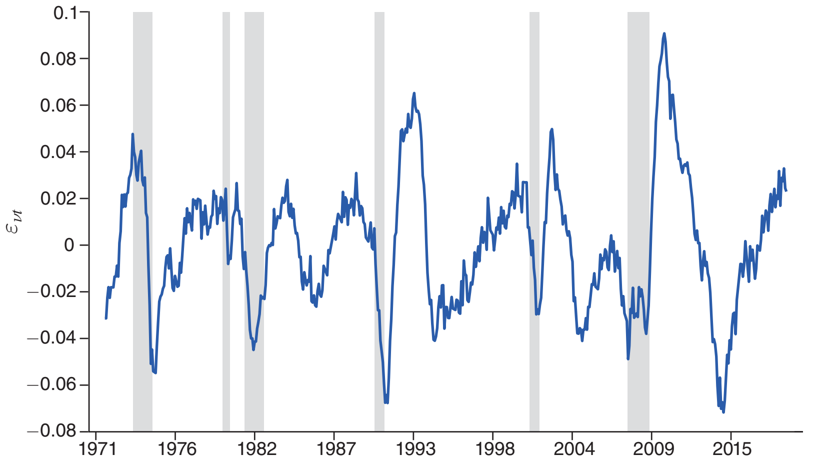

Figure 3. Recipiency Process, $\varepsilon_{\nu t}$

The third term, $\varepsilon_{\nu t}$, is exogenous and taken to capture discretionary changes in benefit duration—for example, those introduced by EUC08. Even though these extensions naturally occur during periods of particularly high unemployment, they are not guaranteed by law, and their amount and timing is fully discretionary. Yet, our estimation strategy allows for part of the discretionary extensions to be captured by the endogenous component. This is consistent with an interpretation of the endogenous component as capturing extensions implied by either automatic provisions built into the system or recurrent discretionary provisions at times of high unemployment. Accordingly, the exogenous component of the rule captures deviations of extensions from those normally implied by the evolution of unemployment and thus likely includes most of the discretionary extensions.

We estimate an effect of automatic extensions to unemployment, Γ_{ν}, equal to 0.2616, with implied elasticity Γ_{ν}/ν of 0.6613. We then fit an AR(1) process on the recipiency residual, $\varepsilon_{\nu t}$, and recover an autocorrelation coefficient, ρ_{ν}, equal to 0.9661, and a standard deviation, σ_{ν}, equal to 0.0072. Figure 3 plots the recipiency process $\varepsilon_{\nu t}$. When the recipiency process takes values above zero, duration policy is more generous than what current economic conditions would normally imply. As expected, the figure shows that the discretionary component is usually above zero after recessions, consistent with the idea that policymakers choose to extend benefits after recessions. Values below zero instead capture a less generous duration than what is implied by the historical policy behavior.

B. *The Great Recession*

The economic literature has identified a number of candidate driving forces of the Great Recession, including credit tightening and mass layoffs.[52] For instance, Mian

[52] Consistent with the literature, the online Appendix shows that the model has a hard time tracking unemployment during the Great Recession when productivity shocks drive fluctuations.

and Sufi (2014) show that more than half of the fall in employment can be accounted for by a deterioration in household net worth, which lowered consumer demand through a negative wealth effect and a tightening of the borrowing capacity.[53] At the same time, Ravn and Sterk (2017) show that during the Great Recession, a sharp burst in layoffs largely contributed to the sharp increase in unemployment, while the persistence of high unemployment can be explained by the unprecedented incidence of LTU, with the long-term unemployed finding jobs at lower rates.

Accordingly, the driving forces that we consider (and that our rich model can accommodate) are shocks to the exogenous borrowing limit $\bar{b}_t$, to the exogenous separation rate $1 - \rho_t$, and to the exogenous probability of becoming long-term unemployed δ_t.[54] We first explain how we estimate the exogenous processes and then present the results of the feed-in exercise, including the role of automatic and discretionary extensions.

Estimating Borrowing, Separation, and LTU Shocks.—We estimate the shocks starting in 2001, the earliest time the Job Openings and Labor Turnover Survey (JOLTS) is available, and until 2018. Given the focus on the Great Recession and its aftermath, we plot data starting in 2007.

To compute separation shocks, we use monthly layoffs and discharges in the nonfarm sector from JOLTS. We normalize layoffs and discharges (JTSLDL series, US Bureau of Labor Statistics 2022f) by employment (PAYEMS series, US Bureau of Labor Statistics 2022a) in the same sector and subtract it from 1 to obtain the retention rate. To estimate the borrowing process, we use quarterly debt securities and loans for households and nonprofit organizations (liability, level, CMDEBT series, Board of Governors of the Federal Reserve System 2022a) from the Fed Board. We take the change from a year ago and normalize it by the disposable personal income for households and nonprofit organizations (HNODPI series, Board of Governors of the Federal Reserve System 2022b).[55] Finally, to construct the LTU shock, we use the laws of motion for STU and LTU from the model, given by equations (5) and (6). We sum the two equations to obtain the job finding rate per unemployed (in efficiency units), $f_t^s \sigma_t$, as

$$f_t^s \sigma_t = \frac{u_t^{new} + u_{t-1} - u_t}{u_{t-1}^{ST} + \bar{\sigma} u_{t-1}^{LT}}, \tag{56}$$

[53] Guerrieri and Lorenzoni (2017) use an HA model to show that a tightening in consumers' borrowing capacity can lead to a sharp drop in output by forcing constrained agents to reduce their consumption and by inducing unconstrained agents to raise their precautionary savings. In their model, labor market risk is exogenous.

[54] As in Ravn and Sterk (2017), who similarly introduce shocks that drive the composition of the unemployed in terms of search efficiency, this shock helps to account for the persistent decline in job finding rates during the Great Recession and the unprecedented rise in the average duration of unemployment in the recovery phase.

[55] We use the change in debt rather than the level because it better corresponds to the interpretation of debt in the model. In the model, debt is used for current consumption; in the data, it is more likely that newly issued debt (or the change in the debt) is used for current consumption rather than the overall stock of debt.

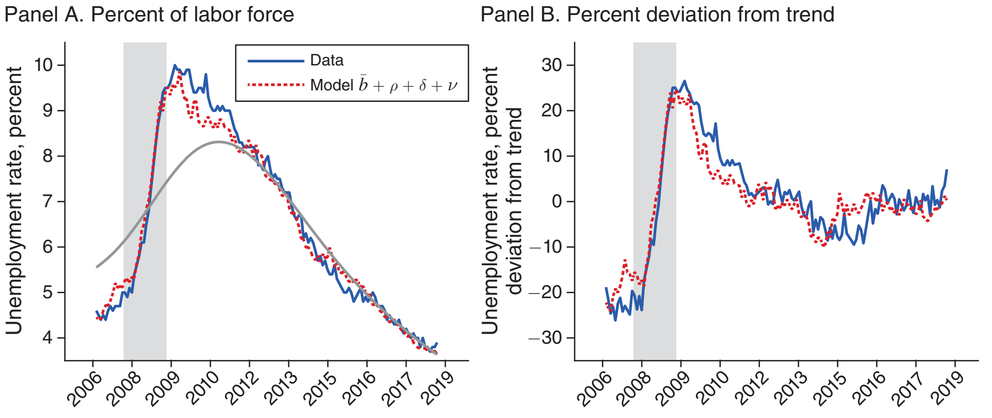

Figure 4. Great Recession, with Borrowing, Separation, and LTU Shocks

where $u_t^{new} \equiv (1-\rho_t)n_{t-1}$ denotes the number of newly unemployed workers, in the spirit of *Shimer* (2005). Given $f_t^s \sigma_t$, we use equation (5) (or equation (6)) to obtain the LTU transition rate as

$$\delta_t = \frac{u_t^{LT} - u_{t-1}^{LT}(1 - f_t^s \sigma_t \bar{\sigma})}{u_{t-1}^{ST}(1 - f_t^s \sigma_t)}. \tag{57}$$

We compute δ_t using data on unemployment by duration from the BLS (US Bureau of Labor Statistics 2022g, h, i, j, c). We measure u_t^{new} with the number of workers unemployed for 0 to 4 weeks, u_t^{LT} with the number of unemployed for 27 weeks and over, and u_t^{ST} with the number of unemployed for less than 27 weeks. We set $\bar{\sigma} = 0.5$, as in our calibration. We smooth out the resulting LTU series by taking a six-months centered moving average.

We finally estimate AR(1) processes on the (logged) HP-filtered series and use the residuals as exogenous inputs to the model. The resulting series appear in the online Appendix.

Tracking Unemployment, with Borrowing, Separations, and LTU Shocks.—Figure 4 compares actual unemployment (blue solid line) during the Great Recession to unemployment simulated from the model (red dotted line) feeding in borrowing, separation, and LTU shocks, as well as the recipiency shocks. Panel A plots the levels in percent of the labor force, panel B the cyclical components in percent deviation from the trend. For completeness in panel A, we also plot the trend from HP filtering the data (gray thin line).[56]

The figure clearly demonstrates that the model's unemployment rate with the four shocks tracks closely the actual rate. The correlation between unemployment from the model and in the data in the five years that follow the 2007 business cycle peak is remarkable: 0.9797 for the levels and 0.9546 for the cyclical components (compared to 0.3078 and 0.1227 when productivity shocks drive fluctuations, as shown in online Appendix C). We should add that we also match the behavior of

[56] To compute the levels of unemployment in the model, we add the HP-filtered trend estimated in the data to the simulated deviations from the steady state in the model.

aggregate consumption exceptionally well, with a correlation for the cyclical components over the same years of 0.9328 (see the figure in online Appendix D). Hence, the model matches the data in several key dimensions.

Before digging deeper into the reasons behind the model's success, we note that even though the nominal interest rate becomes negative in our simulations of the Great Recession period, we abstract from incorporating a binding zero lower bound (ZLB). In fact, to fully capture the actual extent of monetary policy accommodation over that period, one would also need to account for the unconventional monetary policies (quantitative easing and forward guidance), implemented to make up for the conventional monetary policy shortfall. In this respect, Debortoli, Galí, and Gambetti (2019) evaluate the effect of the ZLB on the performance of the economy during the Great Recession and find that both the volatility of macro variables and the economy's response to shocks were largely unaffected by the ZLB. They interpret these results as suggesting that unconventional policies may have been highly effective at getting around the ZLB constraint. Consistently, they show that these findings can be reconciled with the predictions of a baseline New Keynesian model if they assume a shadow interest rate rule capturing the role of forward guidance or other types of unconventional monetary policies in overcoming the constraints imposed by the ZLB. In a related study, Lombardi and Zhu (2018) use a large set of US data to propose a shadow policy rate that also reflects unconventional policy measures, and show that it drops significantly below zero during the Great Recession. Importantly, they document that their shadow rate tracks the effective federal funds rate very closely before the crisis and that it is largely consistent with the predictions of standard Taylor rule benchmarks both before and during the crisis. In light of these results, we consider our approach of letting the nominal interest rate become negative during the Great Recession while keeping the same monetary policy rule, a reasonable approximation of the combined effects of a binding ZLB and unconventional monetary policies.

The Role of Heterogeneous Agents.—To show that allowing for HAs is key to the model's ability to track actual unemployment, Figure 5 compares the unemployment rate generated by our HA model (red dotted line) to the rate generated by a nested RA model (green dashed-dotted line) with the same four shocks. The figure shows that the unemployment rate from the RA model does not track well the actual rate: it misses to a great extent the magnitude of the increase during the downturn.

There are two main reasons for this. The first is that the borrowing shock only plays a role in the HA model. In this model, short-term borrowing sustains consumption of unemployed workers, permitting to smooth consumption across individual states and partially insuring against idiosyncratic risk. The credit tightening that we estimate during the Great Recession thus causes a large drop in aggregate demand, in turn causing a significant increase in unemployment. In the RA model, instead, consumption in different states is fully insured, and the credit contraction has no impact on aggregate demand.[57]

[57] Figure D.5 in the online Appendix makes clear that the borrowing shock is the main driver of the different predictions. When the borrowing shock is shut off, unemployment from our model becomes much closer to unemployment from the RA model.

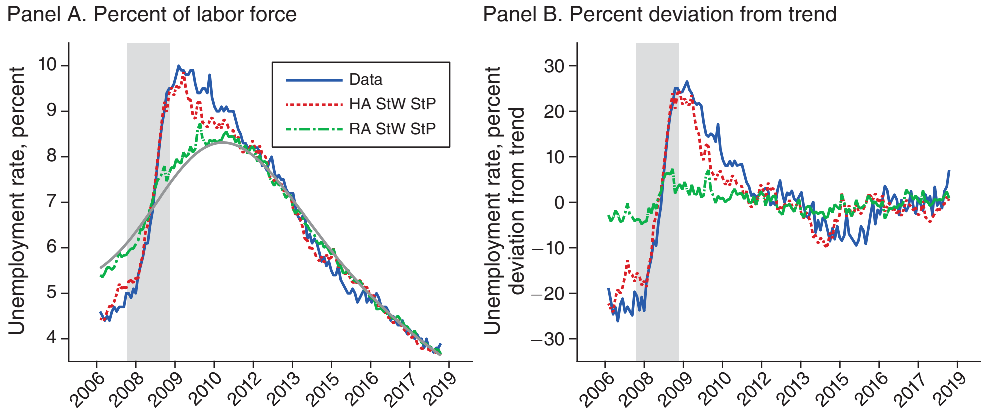

FIGURE 5. HA VERSUS RA MODEL, WITH BORROWING, SEPARATION, AND LTU SHOCKS

The second reason that the HA model better captures the rise in unemployment is that the interaction of precautionary motives with endogenous idiosyncratic risk amplifies the response of the economy to any aggregate shock, as we discuss in Section A.5 of the online Appendix.[58]

Quantifying the Impact of Automatic and Discretionary Extensions.—Having shown that with borrowing, separation, and LTU shocks, unemployment from the model closely tracks actual unemployment during the Great Recession, we now assess whether extensions have played either a stabilizing or a destabilizing role, and quantify their effect.

We first consider the role of automatic extensions, which is illustrated in the top panels of Figure 6. The left panel plots the actual unemployment rate (blue solid line) against unemployment from both our baseline model (red dotted line) and a counterfactual model (green dashed-dotted line) where we shut off automatic extensions by setting the elasticity parameter of the recipiency rule for the federal programs, Γ_ν, equal to 0. The right panel plots the difference of unemployment in the baseline and the counterfactual model—that is, the net effect of automatic extensions.

The figure demonstrates that automatic extensions contributed to stabilizing unemployment during the Great Recession—that is, unemployment has been lower rather than higher as a consequence of the automatic increases in duration embedded in the the US system. However, the impact is not quantitatively large: at their peak effect, automatic extensions lowered unemployment by 0.2153 percentage points. One reason for this is the presence of offsetting channels of unemployment insurance, as we discussed in Section III. The timing of the effect is intuitive: the extent of stabilization raises over the recession as unemployment increases and peaks in September 2009, soon after the business cycle trough, when unemployment reaches a rate of around 10 percent.

[58]The amplification relative to an RA model with no idiosyncratic risk is illustrated in online Appendix Figure D.6, in response to separation and LTU shocks.

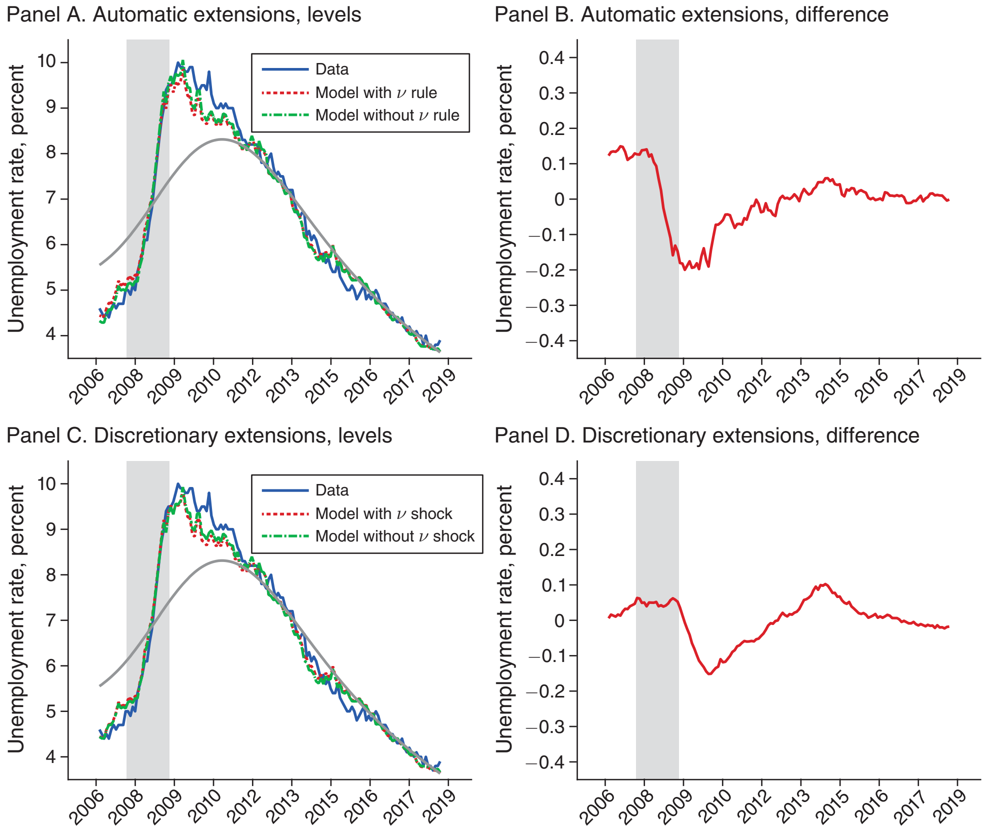

Figure 6. Impact of Automatic versus Discretionary Extensions

The impact of discretionary extensions is illustrated in the bottom panels of Figure 6. In this case, the counterfactual model is one where we close discretionary extensions by shutting off the exogenous recipiency process for the federal programs $\varepsilon_{\nu t}$. Not surprisingly, the model predicts that discretionary extensions also played a stabilizing role in unemployment. Indeed, the stabilizing and destabilizing channels of unemployment insurance embedded in our model will similarly play out in net in response to both types of extensions. What are more interesting are the extent and timing of the response to discretionary extensions, as these are also influenced by the properties of the estimated recipiency process. We find that the quantitative effect of discretionary extensions is not large, as for automatic extensions. The timing of their stabilizing effect is instead different, as discretionary extensions played out mostly in the recovery phase. The largest stabilizing effect occurred in July 2010 and decreased unemployment by 0.1609 percentage points.

As previously discussed, the estimated recipiency process captures extensions beyond those normally implied by the evolution of the unemployment rate. In Figure 3, we recover a negative process at the start of the Great Recession since at that time unemployment was increasing fast and extensions were lagging behind.

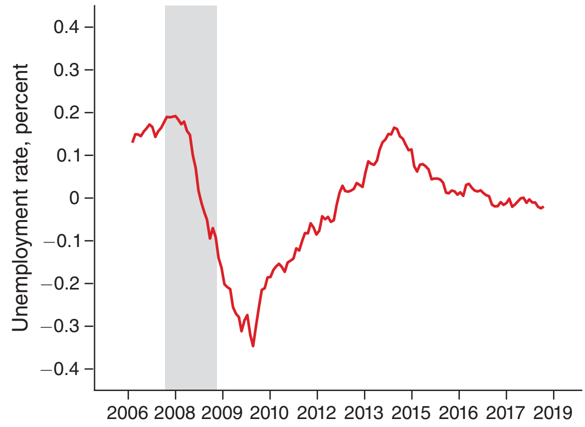

Figure 7. Joint Impact of Automatic and Discretionary Extensions, Difference

When the EUC08 program was signed into law in June 2008, the recipiency rate started to increase. It then accelerated after the expansion of the program in November 2009, reaching a peak of almost 70 percent around mid-2010, after which benefit duration began to decline in some of the states. However, starting at the end of 2009, while the actual recipiency rate was still rising as a consequence of the extensions prescribed by the ARRA, unemployment began to gradually revert. This explains why the largest positive values of the recipiency process occur in 2010, half a year after the official end of the recession, and why in the bottom-right panel of Figure 6 we observe the strongest stabilizing effect during the recovery rather than the recession phase. Unsurprisingly, it takes time to design and implement discretionary measures.

Figure 7 combines the net effect of automatic and discretionary extensions on unemployment. The total peak effect of extensions occurred in July 2010 and stabilized the unemployment rate by 0.3640 percentage points. Importantly, such quantitative impact falls within the range of estimates in Chodorow-Reich, Coglianese, and Karabarbounis (2018). These authors estimate that the effect of benefit extensions on unemployment during the Great Recession is between −0.5 and 0.3 percentage points. The comparison is relevant since their estimation strategy is likely to capture both aggregate demand and labor market effects of unemployment insurance, as we have argued in the related literature section.

Quantifying the Contribution of the Channels.—This section quantifies the contribution of each channel of unemployment insurance to the net stabilizing effect of extensions on unemployment. We focus on discretionary extensions, as their size and dynamics are exogenous and, hence, model invariant, making their effects comparable across models.[59]

[59] Instead, automatic extensions are endogenous and driven by the model-implied dynamics of unemployment. These can be quite different across model, making the results hardly comparable.

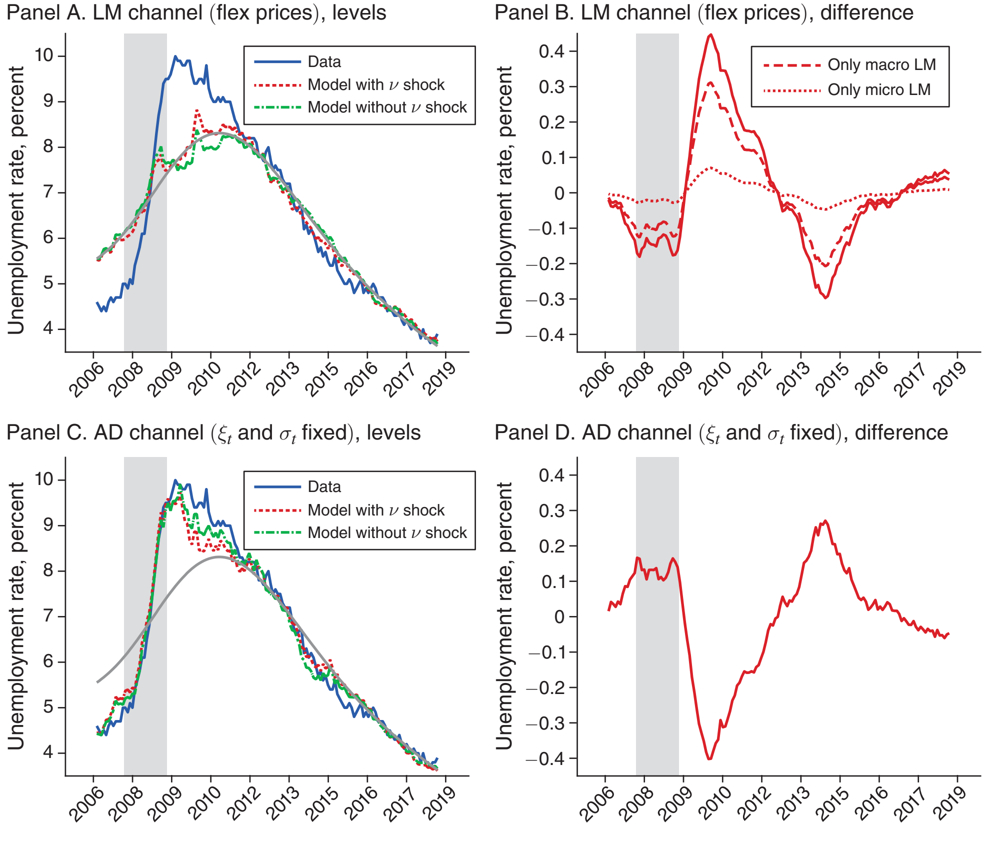

Figure 8. Discretionary Extensions: Impact of Transmission Channels

The two top panels of Figure 8 report the impact of discretionary extensions when aggregate demand effects are shut off by assuming flexible prices. Absent price rigidity, benefits mainly affect the economy via their effect on outside options and wages. To give the labor market channel its maximum strength, we also assume flexible wages. The red solid line in panel B plots the difference between model-implied unemployment with discretionary extensions and absent discretionary extensions. It shows that absent aggregate demand effects, discretionary extensions would have increased the unemployment rate during the recovery phase by 0.4460 percentage points, via macro and micro labor market channels. This result is in line with the analysis in Mitman and Rabinovich (2020), who consider an RA model and find that benefit extensions increase unemployment in recessions. Our results demonstrate the importance of taking into account aggregate demand effects via worker heterogeneity.[60]

[60] We note that the effect of extensions via labor market effects in Mitman and Rabinovich (2020) appears to be stronger quantitatively. We speculate that this happens for two reasons. Consistent with data on the consumption drop at benefit exhaustion, we calibrate a *net* benefit of extensions, given by the difference of the benefit and the safety net transfer. We also calibrate a lower opportunity cost of work, using micro evidence on replacement rates and labor supply elasticity.

In panel B of the figure, we further decompose the effect of extensions on unemployment via the labor market channel into the macro and the micro effects. The red dashed line plots the effect of the macro labor market channel alone, by further assuming that search intensity σ_t is fixed at its steady-state level. The red dotted line instead plots the effect of the micro labor market channel alone by fixing the opportunity cost of employment ξ_t at its steady-state value in the wage equation. The plots emphasize that the macro effect is quantitatively more important than the micro effect: the former would have pushed unemployment up by 0.3201 percentage points absent aggregate demand effects, the latter by only 0.0713 percentage points.

The two bottom panels of Figure 8 quantify the effect of extensions via the aggregate demand channel. To close the labor market channel, we fix both search intensity, σ_t, and the opportunity cost of employment, ξ_t, at their steady-state values. Relative to the impact when both channels are present, extensions become more stabilizing. The largest impact of discretionary extensions during the recovery from the Great Recession more than doubles, from a reduction of unemployment of 0.1609 percentage points when both channels are present to a reduction of 0.4169 percentage points when the labor market channel is switched off. These results emphasize the importance of microfounding the effect of benefits on the opportunity cost of work and wages for assessing the stabilizing effects of extensions.[61]

C. *The Pandemic Recession*

While the debate around the stabilizing effects of extensions emerged in the context of the Great Recession, the recent downturn caused by the coronavirus pandemic also gave rise to unparalleled benefit policies. Moreover, the pandemic also entailed a dimension of countercyclical benefit compensation, which was absent from any previous US recessionary episode.

In this section we use the model to assess the impact of countercyclical benefit policy in the pandemic recession, in terms of both compensation and duration. To do that, we keep with our strategy of estimating driving forces directly from the data. However, since the model does not allow for certain unusual features of the recent downturn—including those related to the role played by the lockdowns and social distancing, as well as by separations into temporary layoffs and hiring via recalls—we use exogenous processes that proxy for more structural driving forces.[62]

Section VC discusses how we measure policies and driving forces. Section VC presents the results from the counterfactual experiments.

[61] The effects from the two channels do not add up to the overall effect in this experiment. This happens because when measuring the labor market channel, we assume flexible prices but also flexible wages. This way, the channel carries its maximum strength and is comparable to the results in the existing quantitative literature.

[62] To accommodate these features, we would have to introduce in the model a separate unemployment state, distinguishing between workers in temporary-layoff unemployment and workers in regular (jobless) unemployment. See Gertler, Huckfeldt, and Trigari (2022) for a model along these lines.

Measuring Unemployment Benefits Policies and Driving Forces.—

The Policy Framework: The Coronavirus Aid, Relief, and Economic Security (CARES) Act, signed into law on March 27, 2020, established the Pandemic Emergency Unemployment Compensation (PEUC) program. PEUC allowed people who had exhausted their regular unemployment benefits to receive up to 53 additional weeks of benefits.[63] The program expired on September 6, 2021. In addition to the PEUC program, the CARES Act expanded unemployment benefits through two other initiatives: the Pandemic Unemployment Assistance (PUA) program and the Federal Pandemic Unemployment Compensation (FPUC) program. Both programs also expired on September 6, 2021. PUA extended unemployment benefits eligibility to workers who are not typically eligible for unemployment insurance.[64] As a consequence of both PUA and PEUC programs as well as the compositional changes among the unemployed, recipiency from the regular programs—and, later, total recipiency—reached an unprecedented rate of 100 percent in June 2020. Total recipiency plateaued there for several months before reverting back to more typical levels when the programs expired.[65] Finally, the FPUC program provided workers with an extra $600 weekly on top of their regular state unemployment insurance or PUA benefits until July 31, 2020, and an extra $300 weekly from December 27, 2020, until program expiration. Hence, the pandemic recession also entailed a dimension of cyclical benefit compensation policy.

Regular Unemployment Insurance Programs: The recipiency rate under regular unemployment insurance programs, ν_t^r, naturally increased at the onset of the coronavirus pandemic because of the sharp increase in separations and the resulting surge in the share of short-term unemployed. We use data from January 2016 (a date when unemployment had fully recovered to its value at the peak of the Great Recession) to March 2022 (our latest available data) in the estimated rule (54) from Section VA to account for the "mechanical" changes in recipiency under regular programs during the pandemic recession.

Benefit Extensions: As we discussed, in response to the coronavirus pandemic, PEUC provided an additional 53 weeks of unemployment insurance benefits to workers who run out of regular state unemployment insurance benefits. Also, in many states, workers qualified for an extra 13 weeks of benefits on top of PEUC as

[63] The program initially granted 13 additional weeks, but the number of weeks an individual could claim PEUC benefits was increased from 13 to 24 by the Consolidated Appropriations Act of December 27, 2021, and by an additional 29 weeks by the American Rescue Plan Act of March 11, 2021.

[64] This included people who are self-employed (such as independent contractors and freelancers) as well as people whose irregular or insufficient work histories don't qualify them for regular state unemployment insurance benefits. Workers receiving PUA benefits received the same weekly benefits that they would have received if they had qualified for regular unemployment insurance.

[65] First, recipiency from the regular programs and, later, total recipiency actually raised slightly above 100 percent. This likely occurred because workers with reduced hours as a result of the coronavirus pandemic also qualified for benefits. When we estimate benefit extension policy, we cap the total recipiency rate at 100 percent and attribute the difference between 100 percent and the recipiency from the regular programs to the extensions.

part of the extended benefits program. Similar to our analysis of the Great Recession, we measure extensions using the recipiency rate under the federal programs, ν_t^e.

We differ, however, as we switch off the estimated policy rule in (55) and instead model the recipiency rate as an AR(1) process. We do this for two reasons: first, given the unusual features of the pandemic recession, it would not be appropriate to assume that the government followed a similar policy to previous recessions; second, the sharpness and the short-livedness of the downturn and the associated policy response make it difficult to decompose changes in recipiency into an automatic and a discretionary component. We then estimate an exogenous AR(1) process using data on (HP-filtered) recipiency under federal programs from January 2016 to March 2022.

Benefit Compensation: To model countercyclical policy in terms of benefit compensation from the FPUC program, we proceed as follows. We first calibrate the size of the policy change to match a partial equilibrium effect of the \$600 weekly supplement paid from April to July 2020 that equals 2 percent of aggregate consumption, as estimated in Ganong et al. (2021).[66] We recover an increase in benefit compensation of 0.1503 for each of the four months that the \$600 supplement was in place. To calibrate the \$300\$ payments from January to August 2021, we divide the calibrated policy change from the first FPUC phase by 2. We then estimate an AR(1) process on the resulting (HP-filtered) series over the period from January 2016 to March 2022, as for extensions.

Driving Forces: We model the pandemic recession as driven by two exogenous shocks that we estimate from the data. The first is a separation shock. An unprecedented number of employed workers—more than 15 percent—moved to unemployment from March to April 2020, the onset of the recession. We use the AR(1) process estimated in Section VB and set the realizations of the shock to fit the (HP-filtered) series of monthly layoffs and discharges over the pandemic period, extending it until March 2022. The second shock is a shock to the matching efficiency, in the same spirit of Mitman and Rabinovich (2021). We take this shock to capture the effects of formal "lockdowns" and voluntary aversion to the virus, whereby firms could not operate and would not post vacancies despite high unemployment, and workers could not work and would not search for work if unemployed. We obtain matching efficiency as a residual from the (log of the) matching function in equation (1), using data on unemployment (US Bureau of Labor Statistics 2022m), the short-term unemployed share, vacancies (US Bureau of Labor Statistics 2022e), and total hires (US Bureau of Labor Statistics 2022d) over the period from January 2016 to March 2022 under the parameters calibrated in Section II. We finally estimate an AR(1) processes on the resulting (HP-filtered) series for matching efficiency and use the residuals as exogenous inputs to the model.

[66] Ganong et al. (2021) estimate an average marginal propensity to consume of 29 percent out of the extra \$600 and use it to compute a partial equilibrium effect of 2 percent of aggregate consumption. We note that our strategy here parallels that in Section II to calibrate the safety net transfer targeting consumption differences from recipiency from Ganong and Noel (2019).

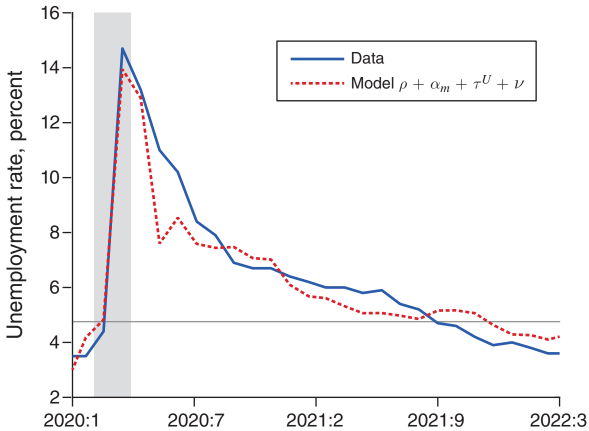

Figure 9. COVID-19 Recession, with Separation and Matching Efficiency Shocks

Results.—Figure 9 compares actual unemployment (blue solid line) during the pandemic recession to unemployment simulated from the model (red dotted line), feeding in separation and matching efficiency shocks as well as benefit compensation and recipiency shocks. Unemployment is in levels, in percent of the labor force. We also plot the trend from HP-filtering the data (gray thin line).

The model's unemployment with the four shocks tracks closely with actual unemployment. The correlation between unemployment from the model and in the data starting April 2020 is remarkable: 0.9357 for the levels and 0.9433 for the cyclical components. This clearly demonstrates that our shocks constitute a reasonable proxy of the different processes going on in the economy during both lockdown and reopening phases. In particular, while matching efficiency stands in for more structural forces that cannot be accommodated by this version of the model, the fit is remarkable.

We then evaluate in Figure 10 the role of countercyclical benefit policy. Panels A and B consider the impact of the increase in benefit compensation. The left panel plots actual unemployment (blue solid line) against unemployment from both our baseline model (red dotted line) and a counterfactual model (green dashed-dotted line) where we shut off the exogenous benefit compensation process. The right panel plots the difference of unemployment in the baseline and the counterfactual model—that is, the net effect of benefit compensation. The figure shows that higher compensation contributed to stabilizing unemployment during the pandemic recession: at its peak effect in July 2020, benefit compensation lowered unemployed by 0.7981 pp. This appears to be a relatively moderate effect if compared to the large size of the policy change.

Panels C and D consider the impact of benefit extensions. The effect of extensions only appears in the recovery phase, when some of the unemployed became long term and more categories of unemployed were included in the federal programs. At their peak effect in June 2021, extensions decreased unemployment by 0.7940 pp, a larger effect than during the Great Recession. This is not surprising given significantly wider eligibility during the pandemic: extensions provided benefits to

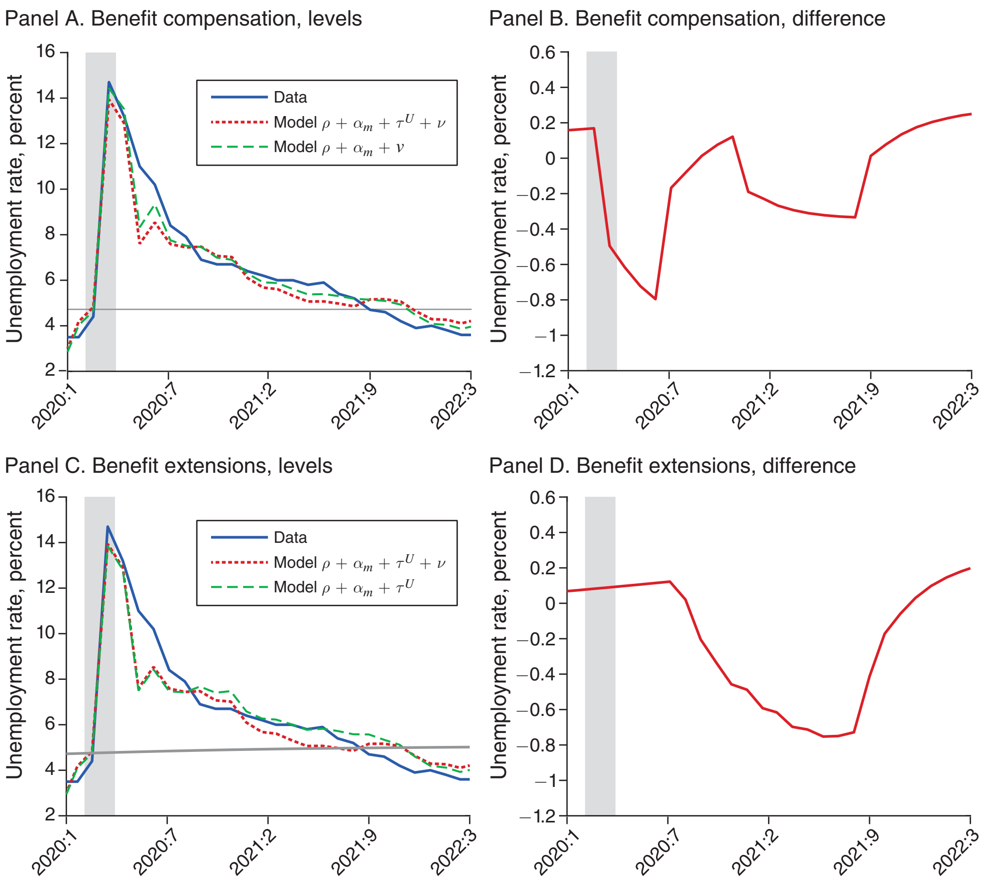

Figure 10. Impact of Benefit Compensation versus Extensions

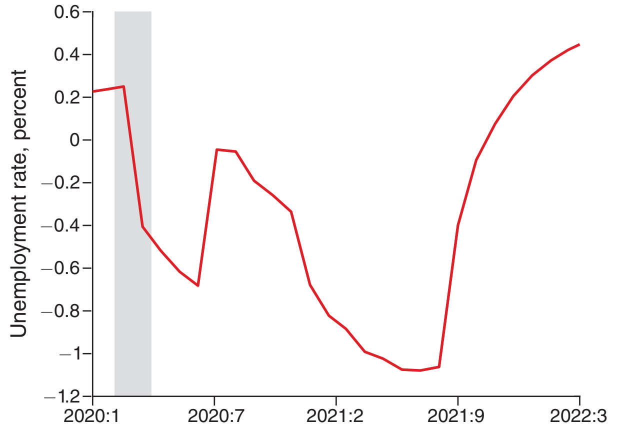

Figure 11. Joint Impact of Benefit Compensation and Extensions, Difference

more than an extra 60 percent of unemployed workers, compared to "only" an extra 35 percent during the Great Recession.

Finally, Figure 11 shows the joint effect of benefit compensation and extensions. Combined, the policies decreased unemployment by a peak effect of 1.1202 pp in July 2021. This effect is quantitatively sizeable in absolute terms, yet moderate relative to the magnitude of benefit policy interventions during the pandemic.

VI. Conclusions

We study the stabilizing effect of cyclical benefit extensions in a rich but tractable model that incorporates the two key transmission mechanisms of unemployment insurance, a labor market and an aggregate demand channel. The setup also allows for amplification of precautionary motives via endogenous unemployment risk and accommodates shocks to the consumers' borrowing capacity. We consider both automatic and discretionary extensions.

We calibrate the model to the US economy and find that both channels are quantitatively important but that the stabilizing aggregate demand channel mildly prevails. We analytically characterize each mechanism and show that differences in consumption by employment states are key to both. We show that considering both channels within a unified framework is important. For example, the labor market channel is stronger in presence of HAs. We also show that unemployment from the model tracks actual unemployment during the Great Recession remarkably well if estimated shocks to borrowing capacity, layoffs, and transitions to LTU are fed into the model. The unprecedented benefit extensions implemented since 2008 contributed to stabilizing unemployment, but their effect has not been large. Overall, extensions stabilized unemployment by a peak effect of 0.3640 percentage points in 2010. Importantly, the magnitude of this effect falls within the range of empirical estimates in the literature.

We also use our model to assess the impact of the unemployment insurance provisions put into effect by the US government during the recent pandemic recession, in terms of both benefit compensation and extensions. We find that the combined policies decreased unemployment by a peak effect of 1.1202 pp during the recovery phase. Capturing with our model a downturn that was so different from all previous business cycles implied taking a number of shortcuts. We leave for future research the inclusion of the distinct features of the pandemic recession, as well as the microfoundation of the underlying driving forces.

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