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Softening the blow: Job retention schemes in the pandemic

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Abstract

We evaluate the welfare effects of the economic consequence of the COVID shock and job retention schemes (JRS) in a heterogenous agents DSGE model calibrated to the euro area. We find that the welfare cost of the COVID shock is large. Households who hold a limited stock of financial wealth and are unable to perfectly insure against shocks to their labor incomes experience larger welfare losses. JRS implemented in response to the pandemic have large favorable welfare effects and benefit all households. These gains are particularly strong for liquid-asset-poor households, especially for those that are also unemployed or furloughed. JRS bring stronger benefits in economies characterized by labor markets with low exit/entry rates from/to unemployment

Keywords: COVID-19, job retention schemes, furlough, household inequality, idiosyncratic risks, labor markets, welfare cost, DSGE.

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Non-technical summary

The pandemic caused an unprecedented collapse in economic activity. In response, governments around the world implemented or extended various stabilization policies. In the euro area, job retention schemes (JRS) played a crucial role. JRS preserved employment links between workers and employers, even when work was fully suspended during the pandemic. They enabled many workers to be furloughed: they were temporarily laid off, supported by governments, and thus protected against job loss.

Our main contribution is to measure the welfare effects of the economic contraction induced by the pandemic and of temporary JRS introduced or extended in response to it.

While JRS help to absorb the blow, the welfare cost of the COVID shock remains large, especially for liquid-asset-poor households (PHs). The COVID shock causes a large fall in aggregate consumption and an increase in labor income risks. These effects, combined, result in substantial welfare losses: PHs would have been ready to give up 0.94% of their lifetime consumption in every period to avoid the economic consequences of the first year of the COVID-19 outbreak. Liquid-asset-rich households were better able to absorb losses to their labor income: their welfare losses amount to 0.67% of their lifetime consumption.

JRS implemented in response to the pandemic have large favorable welfare effects. When search and matching frictions are present on the labor market, preserving potentially viable employment matches - that would otherwise take time to rebuild - mitigates the persistence of the fall in labor supply. JRS thus benefit all households by supporting aggregate consumption and the economic recovery.

PHs benefit the most from JRS. These schemes lessen the unemployment risk faced by all households. PHs are particularly vulnerable to this risk as they do not hold sufficient savings buffer to maintain consumption during prolonged unemployment spells. Without JRS, PHs would have been ready to permanently reduce their consumption by 1.70% to hedge against the economic consequences of the first year of the pandemic.

The welfare gains of JRS are large in economies characterized by labor markets with low exit/entry rates from/to unemployment. In economies that are less effective at creating new job opportunities for the unemployed, JRS prevent a prolonged drop in employment, that would otherwise result in prolonged unemployment spells for many households.

Our results lend support to the temporary JRS introduced in the euro area in response to the COVID shock. In the absence of such policies, inequalities in consumption, income and wealth might have widened even further. This paper also highlights the benefits of JRS for all households, implying broad support for these types of stabilizing policies. Looking forward, JRS should be appropriate stabilizing tools in the event of a new pandemic leading to renewed economic restrictions or widespread input shortages leading to idling of productive capacities.

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1 Introduction

The pandemic caused an unprecedented collapse in economic activity. In response, governments around the world implemented or extended various stabilization policies. In the euro area, job retention schemes (JRS) played a crucial role. JRS preserved employment links between workers and employers and enabled many workers to be furloughed: they were temporarily laid off, supported by governments, and thus protected against unemployment. In this context, we explore the following questions. How large are the economic consequences of the COVID shock for households? Does it affect all households equally, or do their wealth and employment status play a role? Are JRS successful at mitigating the impact of a pandemic-driven recession in the euro area? What types of economies benefit the most from JRS?

We address these questions through the lens of a dynamic stochastic general equilibrium (DSGE) model calibrated to the euro area. We find that the welfare cost of the COVID shock is large. Households who hold a limited stock of liquid wealth and are unable to perfectly insure against shocks to their labor incomes experience larger welfare losses. JRS implemented or extended temporarily during the pandemic have large favorable welfare effects and benefit all households in the short run. These gains are particularly strong for liquid-asset-poor households, especially for those that are also unemployed or furloughed. JRS bring stronger benefits in economies characterized by labor markets with low exit/entry rates from/to unemployment.

Our model has three crucial ingredients: search and matching (SAM) frictions on the labor market, JRS, and households' heterogeneity. SAM frictions generate persistence in (un)employment dynamics and imply that households transition between employment and unemployment in normal times. When the COVID shock hits the economy, public authorities have the option of activating JRS. In this model, JRS are temporary measures implemented in response to the COVID shock and phased out as economic restrictions are gradually lifted. They have no side effect on labor allocation/productivity in the long run. Workers affected by the COVID shock get furloughed if JRS are activated or face the risk of becoming unemployed otherwise. Like the unemployed, furloughed workers do not contribute to production and receive unemployment benefits. Unlike the unemployed, they do not search for a new job but have a chance to return to their previous job in subsequent periods. In addition to their employment status (employed, unemployed, or furloughed), households also differ with respect to their types (liquid-asset-rich or -poor). Liquid-asset-rich households (henceforth, RHs) enjoy a diversified source of income and hedge against any idiosyncratic risk by

sharing risk together. In contrast, liquid-asset-poor households (PHs) only earn wages (or unemployment benefits) and are only able to share risks together when employed.

We make two assumptions to ensure that our model remains analytically tractable while retaining a refined heterogeneity in our dimension of interest. First, following Challe et al. (2017), we assume that the transfer of resources is not possible among PHs that are not employed. Unemployed and furloughed PHs thus depend on their own savings and unemployment benefits to finance consumption. Second, we assume that PHs that are not employed become financially constrained after three quarters. These constraints capture financial market imperfections and generate consumption and wealth dispersion within the PHs group based on their employment status, including the number of consecutive periods they spend without a job. Unemployment or furlough durations play an important role as PHs gradually exhaust their limited liquid wealth.

Our main contribution is to measure the welfare effects of the economic contraction induced by the pandemic and of JRS introduced in response to it. For this purpose, we calibrate our model to the pre-pandemic situation in the euro area with micro and macro data. We simulate the impact of the COVID shock with a combination of aggregate demand and aggregate supply shocks. In our baseline experiment where JRS are activated, we calibrate our COVID shock to reproduce the fall in aggregate consumption and hours worked observed in the euro area. We then perform a counterfactual analysis with no JRS to measure their impact on households. We assume that the COVID shock is unanticipated, that the replacement rates of furloughed and unemployed households are identical, and that the government stabilizes its debt with lump-sum transfers. We relax these assumptions in the appendix and show that our main conclusions remain qualitatively valid.

The welfare cost of the COVID shock is large, especially for PHs. The COVID shock causes a large fall in aggregate consumption and an increase in labor income risks leading to higher consumption dispersion among PHs. These effects, combined, result in substantial welfare losses: PHs would have been ready to give up 0.94% of their lifetime consumption in every period to avoid the economic consequences of the first year of the COVID-19 outbreak.

JRS implemented in response to the pandemic have large favorable welfare effects. When SAM frictions are present on the labor market, preserving potentially viable employment matches - that would otherwise take time to rebuild - mitigates the persistence of the fall in labor supply. JRS thus benefit all households by supporting aggregate consumption and the economic recovery.

PHs benefit the most from JRS. These schemes mitigate the unemployment risk faced by all households. PHs are particularly vulnerable to this risk as they do not hold sufficient

savings buffer to maintain consumption during a prolonged unemployment spell. Without JRS, PHs would have been ready to permanently reduce their consumption by 1.70% to hedge against the economic consequences of the first year of the pandemic. This is equivalent to the premium they would be ready to pay to mute all labor market idiosyncratic risks over a lifetime (in an economy with no aggregate shocks).

Finally, the welfare gains of JRS are larger when SAM frictions are greater. In economies that are less effective at creating new job opportunities for the unemployed, JRS prevent a prolonged drop in employment, that would otherwise result in a prolonged decline in economic activity and long unemployment spells for many households.

This paper belongs to an already rich and growing literature on the heterogenous effect of the pandemic and of fiscal policy responses on households. Kaplan et al. (2020); Bayer et al. (2020) and Faria-e-Castro (2021) study the impact of the pandemic and of the Coronavirus Aid, Relief, and Economic Security (CARES) Act in the US. In Kaplan et al. (2020), the pandemic hits the middle of the income distribution particularly hard but has less effect on households at the bottom of the distribution who depend on government transfers. Bayer et al. (2020) find that welfare losses of the COVID shock are smaller for wealthier households with the means to self-insure. The CARES Act mitigates the fall in activity and the increase in inequality, and has large welfare effects, especially for households with low incomes. However, Kaplan et al. (2020) also argue that it brings little gains for households in the middle of the income distribution. Faria-e-Castro (2021) builds a two-agent model with savers and borrowers where cash transfers are particularly effective at stabilizing consumption, especially for borrowing households that rely heavily on their labor income. We analyze similar topics in a different setting: we consider SAM, which play an important role in the recovery phase of the pandemic, and apply our model to the euro area, which, in contrast to the US, implemented massive JRS.

Auray and Eyquem (2020) evaluate the welfare cost of lockdown restrictions in the euro area. They model the lockdown as a shock to the job-separation rate, which triggers a drop in aggregate supply and demand through the precautionary savings channel. Company owners (who do not own any other asset than their firms) incur the largest welfare cost. However, they also make the simplifying assumption that all households hold no wealth in equilibrium. We show that the welfare cost can be larger for PHs than for RHs (owning the firms) when the wealth distribution is unequal and when RHs have a more diversified source of income.

Dengler and Gehrke (2021) and Martin and Okolo (2022) study the impact of JRS with heterogenous agents New-Keynesian (HANK) models in the OECD and the UK, respectively. They also find that JRS were successful at mitigating the increase in unemployment.

Dengler and Gehrke (2021) focus on JRS ability to stabilize aggregate demand and employment through their impact on households' precautionary savings. They find that JRS are particularly effective in economies with large labor market flows. JRS mitigate the endogenous firing risk faced by workers - which is higher in more dynamic economies - and thus have a favorable effect on their consumption demand. In contrast, we find that such policies were less likely to improve welfare in economies with large labor market flows: a higher job-finding rate ensures that unemployed households rapidly return to employment before exhausting their savings. This consideration is absent in their papers, because they assume that all households hold no wealth in equilibrium. Martin and Okolo (2022) focus on the difference between graduates' and non-graduates' employment. They disregard labor market idiosyncratic risks and do not discuss the welfare effects of JRS.

More on JRS JRS cover different types of policies including wage subsidies, short-time work (STW), and furlough schemes (see Drahokoupil and Müller, 2021). While their specificities differ across time and countries, they share a common objective. They all aim to preserve the employment link (and contract) between a worker and his/her employer, even when work is fully suspended, during a period of temporary adverse economic conditions. In contrast to wage subsidies, STW and furloughs subsidize hours not worked. Furloughs are often viewed as a special case of STW where hours are cut to zero.

During the pandemic, most OECD countries extended existing JRS or introduced new ones. JRS had already been used in response to the global financial crisis (GFC) but to a much lesser extent. By May 2020, 50 million jobs (10 times more than during the GFC) were supported by JRS (OECD, 2020). When pre-existing JRS were extended, procedures were simplified, coverage extended, and/or generosity increased. New schemes were also designed, often to support workers when hours were reduced to zero. In most OECD countries, JRS enabled firms to adjust hours at zero cost during the pandemic. The distinction between STW and furlough schemes also became blurred as both were made more flexible to accommodate the exceptional circumstances of the crisis. At the onset of the crisis, employed workers who had not worked at all accounted for two-thirds of the reduction in hours worked in the OECD, and for an even larger fraction in Europe (OECD, 2021). For this reason, we focus on furloughed workers supported by the traditional furlough schemes or by extended STW schemes during the pandemic. They were the most affected by the crisis and accounted for the bulk of the decline in hours worked. Moreover, it would be difficult to account for the full heterogeneity in hours worked in a tractable HANK model.

While we show that JRS brought large welfare gains by mitigating the immediate impact

of the crisis, there is also an important debate on their medium- to long-run effects on labor reallocation, which had already been discussed before the pandemic, and recently attracted new attention (e.g., Cooper et al., 2017; Andrews et al., 2021; OECD, 2021). JRS potentially slow labor reallocation, which may have an adverse impact on labor productivity. Workers covered by these schemes and employed in non-viable jobs could also decide not to search for better opportunities. In this paper, we capture this adverse impact on employment by assuming that furloughed workers do not search for another job as long as JRS are in place, even when their jobs become non-viable for reasons unrelated to the pandemic. We view our assumptions - that furloughed workers never look for a job while the unemployed always do, even during the lockdown period - as conservative when weighing up the benefits of JRS. But we disregard the impact of JRS on labor productivity through reallocations from low- to high-productivity firms. Considering the exceptional circumstances of the pandemic, the crisis-mitigation benefits of JRS are likely to outweigh their impact on labor productivity, if JRS are properly phased out.

Other related literature Our paper draws on the SAM literature pioneered by Diamond, Mortensen and Pissarides (e.g., Mortensen and Pissarides, 1994) with rigid wages (e.g., Bodart et al., 2006; Gertler et al., 2008; Gertler and Trigari, 2009). In our setting, wages are rigid in real terms: they follow a weighted average of a constant wage norm (e.g. Hall, 2005; Blanchard and Galí, 2010) and a surplus splitting wage determined by an exogenous bargaining-power parameter (e.g. Cooley and Quadrini, 1999; Krause and Lubik, 2007; Thomas, 2008). Our paper also relates to Krause and Uhlig (2012); Faia et al. (2013); Balleer et al. (2016); Cooper et al. (2017) that endogenize firms' temporary lay-off decisions in the presence of JRS. In this paper, the decision is exogenous because restrictions on activity were imposed by public authorities. The focus is on the heterogenous consequences of JRS for households.

Our paper also relates to a booming area of literature that develops analytically tractable HANK models. HANK models highlight the importance of households' wealth dispersion, exposure to idiosyncratic risks, and incomplete financial markets for the transmission of aggregate shocks to macroeconomic variables (e.g., Kaplan and Violante, 2018 and the references therein). Wealth dispersion generally implies that some households are constrained (due to the existence of a debt limit) and behave as hand-to-mouth consumers, which introduces a current income channel for consumption. The possibility of hitting a borrowing constraint introduces a precautionary savings channel, as households with a limited level of wealth are encouraged to save to self-insure against this risk. Moreover, households' het-

erogeneity is an important factor for the design of stabilization policies and some questions - such as those asked in this paper - can only be answered by considering a certain degree of heterogeneity. However, traditional HANK models come at the cost of complex solution methods currently limiting the set of shocks, frictions and estimation methods that they can handle. Tractable HANK models reduce the amount of heterogeneity - enabling standard solution and estimation methods that are routinely used for representative agents (RANK) models - while keeping some important ingredients of HANK models.

Some early literature developed two-agent models where a constant fraction of agents consume their entire disposable income at every period (e.g. Campbell and Mankiw, 1989; Mankiw, 2000; Iacoviello, 2005; Coenen and Straub, 2005; Erceg et al., 2006; Galí et al., 2007; Bilbiie, 2008).[1] These hand-to-mouth consumers introduce a current income channel for consumption that is similar to HANK model. More recently, some two-agent models were developed to capture a precautionary savings channel. These models assume that households face unemployment risks and that risk sharing is impossible between employed and unemployed households (Heathcote and Perri, 2018; Bilbiie and Ragot, 2021). However, risk sharing is possible within the employed and unemployed households' groups. The wealth distribution is thus extremely simple in the sense that there are only two levels of wealth: one common to all employed workers, and one common to all unemployed workers. In this paper, we draw on Challe et al. (2017), who propose an analytically tractable HANK model where unemployment duration has a strong impact on PHs' consumption, as a prolonged unemployment spell can exhaust their limited stock of savings. What distinguishes our paper from Challe et al. (2017) is our focus on the impact of the pandemic and JRS in the euro area. Calibrating the model to the euro area (instead of the US) implies that unemployed households do not liquidate all their wealth immediately when falling into unemployment. Thus, unemployment duration plays a more important role as households gradually exhaust their wealth.

Finally, other papers also highlight the importance of households' heterogeneity and financial constraints for the design of (different types of) fiscal and monetary policies with HANK (e.g., McKay and Reis, 2016; Gornemann et al., 2016; Le Grand and Ragot, 2017; Bhandari et al., 2021) and two-agent models (e.g., Garcia et al., 2011; Prasad and Zhang, 2015; Iyer, 2016; Ascari et al., 2017; Cugat, 2019; Mohimont, 2022). They highlight a social insurance motive for these policies that is also present with JRS.

[1] Debortoli and Galí (2017) identify three important dimensions of heterogeneity captured by HANK models that have important repercussions for the dynamics of aggregate variables. They show how a simple two-agent model can approximate the dynamics of a baseline HANK model in some dimensions.

2 Model

Model overview The domestic economy is populated by households, firms (producers and distributors), and public authorities. Households differ with respect to their types (RHs and PHs) and employment status (N for employed, U for unemployed, or F for furloughed). RHs enjoy a diversified source of income and hedge against any idiosyncratic risk by sharing risk together. In contrast, PHs have limited savings (if any), only earn wages (or unemployment benefits) and are only able to share risks together when employed. PHs that are not employed (U or F) therefore depend exclusively on their stock of savings and unemployment benefits to finance consumption. Producers hire workers and rent capital to assemble an intermediate good. Distributors introduce price stickiness to the final good. On the labor market, SAM frictions generate unemployment. Public authorities set the interest rate, collect taxes, pay unemployment benefits, and have the option of implementing JRS. JRS are temporary measures implemented in response to the COVID shock and phased out as economic restrictions are gradually lifted. They give rise to the furloughed status (F-status) that complements the standard employed (N-status) and unemployed status (U-status) from/to which households transition in SAM models.

Households' preferences There is a continuum of households of mass 1 indexed by j with identical preferences. Their expected lifetime utility is given by

$$\mathbb{W}_{j,t} = \mathrm{E}_0^j \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_{j,t})^{1-\sigma_c} - 1}{1 - \sigma_c} \right] \tag{1}$$

where E is the expectation operator, β the discount factor, $C_{j,t}$ consumption of household j, and σ_c denotes the inverse of the inter-temporal elasticity of substitution for consumption.

Producer's objective The firm's objective is to maximize the present value of its future flows of profits given by:

$$\mathbb{P}_t = MC_t Y_t - R_t^k K_t - \int_0^1 W_{j,t} N_{j,t} \mathrm{d}j - \frac{\chi}{1+\theta} (V_t)^{1+\theta} + \beta \frac{(C_{t+1}^{RH})^{-\sigma_c}}{(C_t^{RH})^{-\sigma_c}} \mathbb{P}_{t+1} \tag{2}$$

The first term represents revenues: each firm operates in perfect competition and sells its products Y_t at real marginal cost MC_t. Note that, throughout the paper, prices and wages are expressed in real terms and the price of the final good is used as deflator. The second and third terms are the capital and wage costs, respectively. The fourth term is the cost of posting vacancies V_t, where χ is a scaling parameter and $\theta > 0$ implies that the cost of

posting vacancies is convex.[2] The final term is the discounted value of future profits. Since RHs own the firms, future profits are discounted with their expected marginal utility of consumption $(C_{t+1}^{RH})^{-\sigma_c}$.

Sequence of events and the COVID shock Figure 1 gives an overview of the model and the sequence of events that takes place within each period (one period lasts one quarter), in normal times, and when the COVID shock hits the economy. This shock is modeled by combining an employment shock $\varepsilon_{n,t}$ (capturing the idling of a share of the labor force), a matching shock $\varepsilon_{m,t}$ (capturing a freeze in hiring), a capital-productivity shock $\varepsilon_{k,t}$ (capturing the idling of a fraction of the physical capital) and a demand shock $\varepsilon_{d,t}$ (capturing a fall in consumption and investment demand).

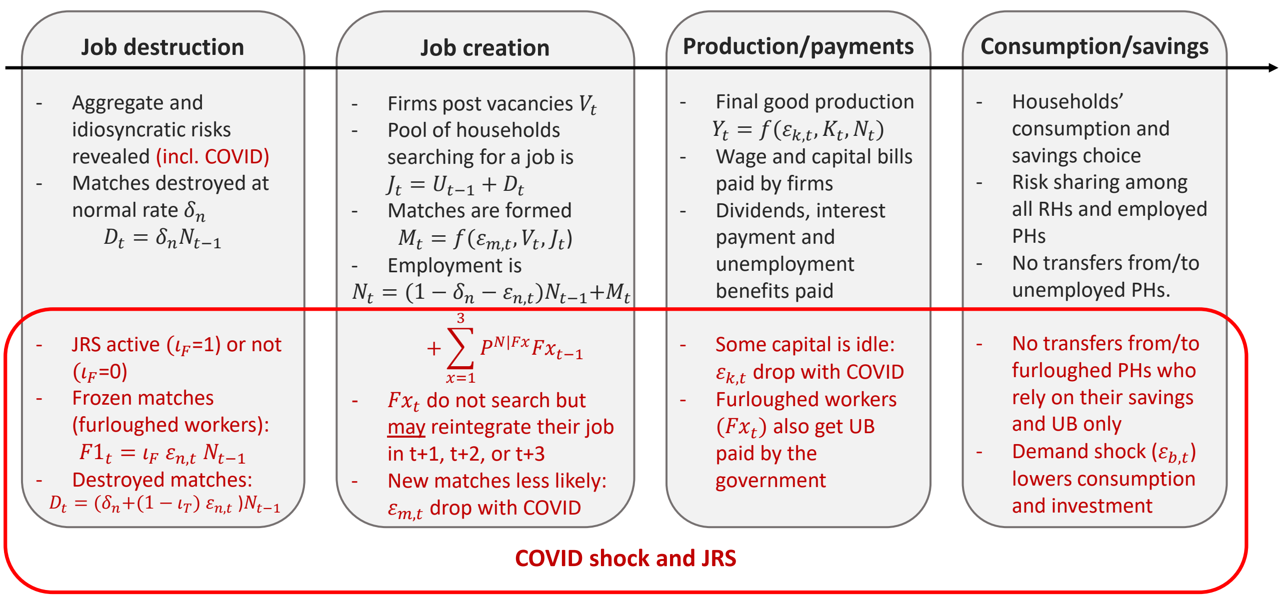

Figure 1: Model overview and sequence of events within each period

Every period begins with a job destruction stage, where existing matches between firms and workers are destroyed at rate δ_n. When the COVID shock hits the economy, an additional fraction $\varepsilon_{n,t}$ of matches is frozen (when JRS are activated) or destroyed (when they are not). Workers with a frozen match are furloughed while those with a broken match join the pool of job-seekers, and eventually become unemployed if they do not immediately find a new job.

[2] For simplicity, we assume that the vacancy cost is paid to an advertising firm which operates at no cost and transfers its profits back to RHs as dividends. Posting vacancies does not generate a waste of resources, which is a conservative assumption when evaluating the benefits of JRS.

Jobs are created in a second stage: some households searching for a job are matched with firms posting vacancies. The COVID shock also makes new matches less likely. We assume that furloughed workers do not search for a new job but wait for a random signal to return to their previous job. At the end of the JRS, calibrated to last for a maximum duration of three periods, those who have not received this signal become unemployed. At the same time, firms and workers agree on a wage that depends on their relative bargaining power and a wage norm.

In the third stage, firms produce investment and consumption goods and pay wages to employed RHs and PHs. They also rent capital and pay dividends to RHs. The COVID shock causes a drop in capital productivity. Households with a U- or F-status receive unemployment benefits.

In the final stage, households make their consumption and savings decisions. Financial frictions affecting PHs generate wealth and consumption dispersion among this group, which depends on their employment status (N, U, or F) and the number of consecutive periods spent without a job. In contrast, RHs form a homogenous group. They also invest in physical capital. The COVID shock depresses demand for consumption and investment goods. The rest of this section describes the model in detail.

2.1 Job destruction stage

At the beginning of every period t, matches have an exogenous probability δ_n to break. When the COVID shock hits the economy, an additional fraction $\varepsilon_{n,t}$ of matches is frozen (when JRS are activated) or destroyed (when they are not). The fraction of households entering the F-status is:

$$F1_t = \iota_F \varepsilon_{n,t} N_{t-1} \tag{3}$$

where ι_F is an indicator equal to one when the JRS is active and zero otherwise. The number of jobs that are destroyed is given by:

$$D_t = \left(\delta_n + (1-\iota_F)\varepsilon_{n,t}\right) N_{t-1} \tag{4}$$

2.2 Job creation stage

Job-seekers All households that are not matched to an employer at the beginning of the job creation stage search for a job at no cost. Since households with an F-status remain tied

to their employer, they do not search for another job. The number of job-seekers is:

$$J_t = U_{t-1} + D_t \tag{5}$$

where variable U_{t-1} is the (past) unemployment rate and D_t represents the fraction of households whose matches broke in the job destruction stage.

New matches The matching process is governed by

$$M_t \quad = \quad A_m \varepsilon_{m,t} \left(J_t\right)^{\sigma_m} \left(V_t\right)^{1-\sigma_m} \tag{6}$$

where A_m is a scaling parameter, $\varepsilon_{m,t}$ is a matching shock, σ_m is the elasticity of matches to the number of job-seekers, and V_t is the number of vacancies. From these assumptions, it is convenient to define the job-finding rate of unemployed households: $P_t^{N|U} = \frac{M_t}{J_t}$. For simplicity, we assume that firms cannot target their vacancies at PHs and RHs. Therefore, PHs' and RHs' job-finding rate and employment rate are identical.

Vacancies Firms post vacancies to hire workers. Profit maximization yields

$$\chi V_t^{\theta} = Q_t Z_t^F \tag{7}$$

where the left-hand side represents the real marginal cost of posting a vacancy and the right-hand side its expected benefit expressed as the product of the probability of filling a vacancy $Q_t = \frac{M_t}{V_t}$ and the average firm's surplus Z_t^F.[3] The firm's surplus from employing any household j is expressed in consumption units and given by:

$$Z_{j,t}^F \quad = \quad \frac{\partial \mathbb{P}_{j,t}}{\partial N_{j,t}} = \overline{W}_t - W_{j,t} + (1-\delta_n)\beta \frac{(C_{t+1}^{RH})^{-\sigma_c}}{(C_t^{RH})^{-\sigma_c}} Z_{j,t+1}^F \tag{8}$$

where the first term is the firm's reservation wage; the second term is the real wage paid to the worker; and the final term is the firm's expected discounted future surplus conditional on keeping the worker. The firm's reservation wage is the real value of output produced by

[3] In theory, the wage bargain can result in PHs and RHs receiving different wages because they have different discount factors. This implies that the firm's surplus from employing RHs or PHs can differ. Hence, we need to compute $Z_t^F = \omega_{PH} Z_{j\in(0,\omega_{PH}),t}^F + (1-\omega_{PH}) Z_{j\in(\omega_{PH},1),t}^F$. Note, however, that wages are identical at steady state, and follow (almost) the same dynamics after the COVID shock.

an additional employee:

$$\overline{W}_t = MC_t \frac{\partial Y_t}{\partial N_t} \tag{9}$$

Return to work after a furlough We assume that the F-status has a maximum duration of three periods. In the first and second periods following the COVID shock, households with an F-status have a probability $P^{N|F1}$ and $P^{N|F2}$ to return in employment with their former employer. Otherwise, they keep their F-status for an additional period. In the third period, when the F-status ends, households have a probability $P^{N|F3}$ of returning to employment and a probability $1-P^{N|F3}$ of falling into unemployment. These probabilities depend on the persistence of the COVID shock and on the rate δ_n at which each match, active or frozen, can break at every period for reasons unrelated to the COVID shock (more details in section 2.6). The fraction of households staying with an F-status for two or three consecutive periods is thus given by

$$F2_t = \left(1 - P^{N|F1}\right) F1_{t-1} \tag{10}$$

$$F3_t = \left(1 - P^{N|F2}\right) F2_{t-1} \tag{11}$$

Employment and unemployment At the end of the job destruction and creation stages, total employment is given by

$$N_t = (1 - \delta_n - \varepsilon_{n,t})N_{t-1} + M_t + P^{N|F1} F1_{t-1} + P^{N|F2} F2_{t-1} + P^{N|F3} F3_{t-1} \tag{12}$$

where $\delta_n N_{t-1}$ correspond to the number of old matches that are destroyed and M_t is the number of new matches. The term $\varepsilon_{n,t} N_{t-1}$ gives the number of matches frozen/destroyed by the COVID shock, while $P^{N|F1} F1_{t-1}$, $P^{N|F2} F2_{t-1}$ and $P^{N|F3} F3_{t-1}$ correspond to the number of households with an F-status returning to their previous job after one, two or three periods on furlough, respectively. Finally, the unemployment rate is simply given by the fraction of households that are not employed or furloughed:

$$U_t = 1 - N_t - F1_t - F2_t - F3_t \tag{13}$$

Wage-bargaining Wages follow a weighted average of a constant wage norm (e.g. Hall, 2005; Blanchard and Galí, 2010) and a surplus splitting wage determined by an exogenous bargaining-power parameter (e.g. Cooley and Quadrini, 1999; Krause and Lubik, 2007).

Real wages are given by

$$W_{j,t} = \xi_w W + (1 - \xi_w) W^*_{j,t} \tag{14}$$

where W is a constant wage norm defined as the real wage at steady state, ξ_w a wage stickiness parameter, and $W^*_{j,t}$ is a surplus splitting wage determined by

$$Z^N_{j,t}\left(W^*_{j,t}\right) = \omega_w \left[Z^N_{j,t}\left(W^*_{j,t}\right) + Z^F_{i,t}\left(W^*_{j,t}\right)\right] \tag{15}$$

where ω_w is the employees' bargaining power, $Z^F_{i,t}$ is the firm's surplus, and $Z^N_{j,t}$ is the employee's surplus defined by the contribution of the marginal job to a household's lifetime utility expressed in consumption units:

$$Z^N_{j,t} = \frac{\partial \mathbb{W}_{j,t}}{\partial N_{j,t}} \times \frac{1}{C^{-\sigma_c}_{j,t}} = (1 - \tau_w) W_{j,t} - \underline{W}_{j,t} + (1 - \delta_n)\beta \frac{C^{-\sigma_c}_{j,t+1}}{C^{-\sigma_c}_{j,t}} Z^N_{j,t+1} \tag{16}$$

The first term represents the real wage net of tax (τ_w is the tax rate), the second is the employees' reservation wage, and the final term is the discounted future employee's surplus conditional on keeping the job. In equation (16), the reservation wage is given by

$$\underline{W}_{j,t} = ub_t + (1 - \delta_n)\beta \frac{C^{-\sigma_c}_{j,t+1}}{C^{-\sigma_c}_{j,t}} P_{t+1} Z^N_{j,t+1} \tag{17}$$

which is a function of real unemployment benefits ub_t and of the discounted expected value from searching for a job when unemployed (note even the employed have a probability δ_n of looking for a job in the next period). The latter depends on the probability of finding a job and on the expected employee surplus.

2.3 Production stage

The production and delivery of final goods is organized in three steps: *i)* production of an undifferentiated intermediate good using capital and labor, *ii)* its differentiation with brand-naming technology by monopolistic retailers, and *iii)* its aggregation into a final product and distribution to households.

2.3.1 Intermediate good producers

The representative firm uses capital K_t and labor inputs to produce an undifferentiated good denoted Y_t. It maximizes the present value of its future flows of profits given by equation (2). We assume that labor inputs can be adjusted at the extensive margin only and that there is perfect substitutability between household types. Labor inputs are thus simply given by the employment level N_t. The production function is

$$Y_t = \left(\varepsilon_{k,t} K_t\right)^{\alpha} \left(N_t\right)^{(1-\alpha)} \tag{18}$$

where α is the capital income share and $\varepsilon_{k,t}$ is a capital-productivity shock. Producers operate in perfect competition and sell their products to monopolistic retailers at real marginal cost MC_t.

2.3.2 Monopolistic retailers

Monopolistic retailers introduce Calvo (1983) price stickiness. Any retailer i differentiates its input with brand-naming technology and sets its own price $P^d_{i,t}$. It has a probability $1-\xi_d$ to be allowed to reset its price. It keeps it unchanged otherwise. It maximizes

$$\mathrm{E}_t \sum_{s=0}^{\infty} (\beta \xi_d)^s \frac{(C^{RH}_{t+s})^{-\sigma_c}}{(C^{RH}_t)^{-\sigma_c}} \left(\frac{P^d_{i,t}}{P^d_{t+s}} - MC_{t+s} \right) Y_{i,t+s} \tag{19}$$

where P^d_t is the final good price used as deflator. The intermediate good market clears when $Y_t = \int_0^1 Y_{i,t} \mathrm{d}i$. Retailers sell their products to final good distributors.

2.3.3 Final good distributors

Distributors aggregate retailers' output into a final good $\mathbb{Y}_t$ with the following technology:

$$\mathbb{Y}_t = \left(\int_0^1 \left(Y_{i,t}\right)^{\frac{\epsilon_d - 1}{\epsilon_d}} \mathrm{d}i \right)^{\frac{\epsilon_d}{\epsilon_d - 1}} \tag{20}$$

The final good $\mathbb{Y}_t$ is used for consumption and investment such that $\mathbb{Y}_t = C_t + I_t$. Overall, inflation follows a standard Phillips curve where retailers have a probability $1-\xi_d$ of resetting their prices and ϵ_d is the input demand elasticity.

2.4 Consumption and savings stage

PHs and RHs share the same objective (they have the same utility function described in equation 1) but face different budget constraints. They thus make different consumption and savings decisions.

2.4.1 The asset-poor

There is a continuum of PHs of mass ω_{PH} indexed by $j \in (0, \omega_{PH})$ that forms a large family. Decisions are taken by a family head which faces two constraints. (1) Transfer of resources is only possible among employed PHs. (2) PHs that are not employed become financially constrained after k periods. These constraints capture financial market imperfections and generate consumption and wealth dispersion within the family. At the same time, these assumptions ensure that heterogeneity remains finite-dimensional as in Challe et al. (2017).

Constraint (1) allows perfect risk sharing between employed PHs and thus ensures that they form a homogenous group, independently of their own past histories. Moreover, PHs with a U or F-status of identical duration also form homogenous cohorts. Indeed, each member of a specific U or F-cohort starts with identical savings when becoming unemployed or furloughed. As long as they do not return to employment, they remain homogenous as they receive identical unemployment benefits, face the same employment prospects, and thus make the same consumption and savings decision.

Constraint (2) implies that the number of U and F-cohorts remains finite-dimensional. Under our calibration discussed in the next section, PHs entering their third period with an F- or U-status entirely consume their residual wealth. All PHs that remain without a job for four periods or longer are thus undistinguishable as they all hold zero wealth and simply consume their entire unemployment benefits at every period.

PH categories The constraints discussed above imply that we build different PH categories based on their employment status (F, U or N) and number of consecutive periods spent with an F- or U-status. All employed PHs forming a first homogenous group denoted with N. For furloughed PHs, we define three cohorts denoted with *F1*, *F2* and *F3*. For the unemployed, we define four cohorts tracking unemployment duration with *U1*, *U2*, *U3* and *U4*, where the last category comprises all PHs without a job for four periods or longer (including PHs that previously had an F-status). In total, we thus keep track of eight PH categories with different employment status, wealth, and consumption levels. Figure 2 offers a visual interpretation of households' transition from/to the N-, U- and F-status along with

the transition probabilities discussed in sections 2.1 and 2.2.

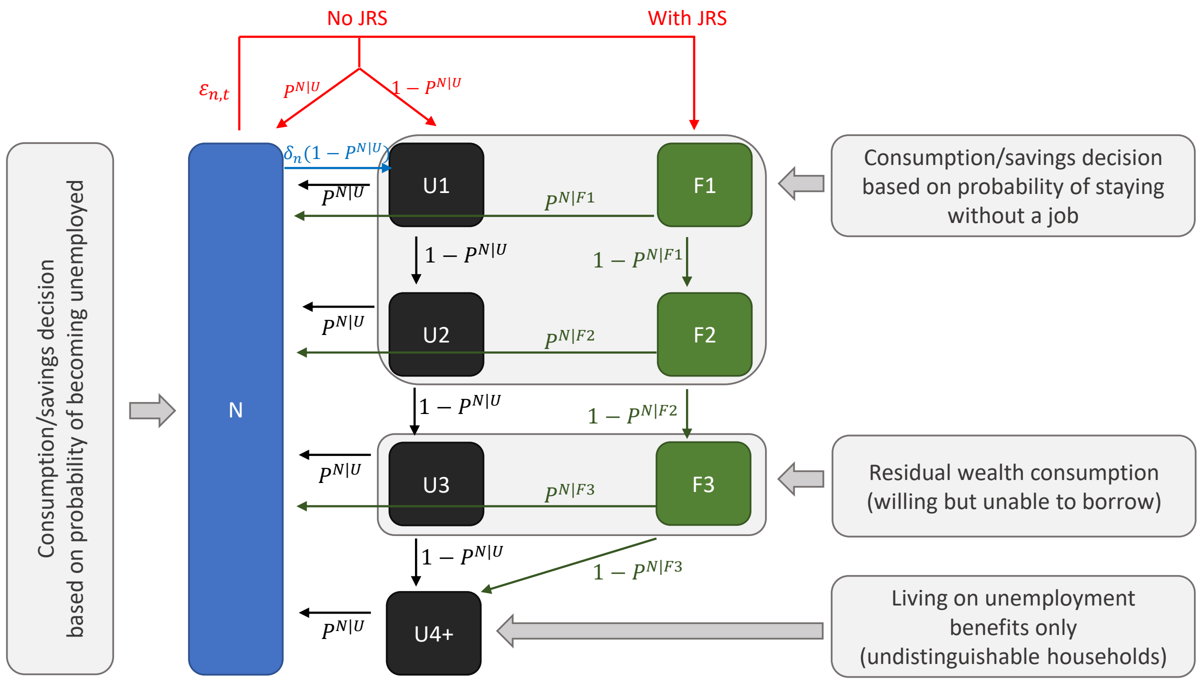

Figure 2: Transition tree with/without JRS

The family-head problem Formally, we can express the constraints discussed above as

$$
\begin{aligned}
B_t^N &= \bar{R}_t \left[(1-S_t)N_{t-1}B_{t-1}^N + \sum_{n=1}^{2} \left(P_t^{N|U} Un_{t-1}B_{t-1}^{Un} + P_t^{N|Fn} Fn_{t-1}B_{t-1}^{Fn} \right) \right] /N_t \\
&+ (1-\tau_w)W_t^{PH} - \varepsilon_{d,t}C_t^N + TR_t^N \qquad (21)\\
B_t^{X1} &= \bar{R}_t B_{t-1}^N + ub_t + TR_t^{X1} - \varepsilon_{d,t}C_t^{X1} \qquad (22)\\
B_t^{X2} &= \bar{R}_t B_{t-1}^{X1} + ub_t + TR_t^{X2} - \varepsilon_{d,t}C_t^{X2} \qquad (23)\\
C_t^{X3} &= \left(\bar{R}_t B_{t-1}^{X2} + ub_t + TR_t^{X3} \right) /\varepsilon_{d,t} \qquad (24)\\
C_t^{U4} &= \left(ub_t + TR_t^{U4} \right) /\varepsilon_{d,t} \qquad (25)
\end{aligned}
$$

where $S_t = \delta_n(1 - P_t^{N|U}) + \varepsilon_{n,t}(1 - (1 - \iota_F)P_t^{N|U})$ is the job-separation rate that includes temporary lay-offs. $X \in (U, F)$ is an indicator for PHs with a U- or F-status. $\bar{R}_t = \frac{\varphi R_{t-1}}{\pi_t}$ is the real rate of return on PHs' savings. It depends on the nominal gross risk-free interest rate R_t and the inflation rate $\pi_t = P_t^d/P_{t-1}^d$. The parameter φ creates a systematic wedge between the return on PHs' savings and the risk-free interest rates. It is calibrated to ensure that PHs hold a targeted level of wealth at steady state. $\varepsilon_{d,t}$ is a demand shock used to simulate a

drop in consumption (for both PHs and RHs) and investment (for RHs) during the pandemic. When $\varepsilon_{d,t} > 1$, households understand that the cost of consumption is higher than its price and are thus encouraged to delay consumption, which can for example capture the risks of getting infected by COVID. Technically, $\varepsilon_{d,t}$ works as a tax affecting the marginal cost of consumption. We assume that the cost of this tax is then rebated to households through lump-sum transfers. Thus, the shock $\varepsilon_{d,t}$ affects households' marginal incentive to consume while having no direct effect on their budget (other than those operating through a change in consumption volumes). Lump-sum transfers have two components. For example, lump-sum transfers to PHs with N-status are given by $TR_t^N = (\varepsilon_{d,t} - 1)C_t^N + TR_t^G$, where the first component offsets the direct cost of the tax while the second is identical for all households and is set by the government to ensure debt stability.

Equation (21) shows that employed PHs pool their resources together and thus have the same stock of savings B_t^N. The latter is given by the sum of the savings of previously employed PHs keeping their N-status, savings of previously unemployed PHs who just found a job (B_t^{Un}), and savings of furloughed workers returning to their previous employer (B_t^{Tn}) where n refers to the number of periods without a job.

In equation (22), PHs becoming unemployed (furloughed) at period t receive the share of savings they could claim when they were employed in the previous period B_{t-1}^N and unemployment benefits ub_t. They consume C_t^{U1} (C_t^{F1}) and save B_t^{U1} (B_t^{F1}). Assumption (1) implies that it is not possible for the family head to transfer resources from employed PHs to newly unemployed or furloughed PHs. Equation (23) simply states that PHs with a U- and F-status for two periods finance consumption with unemployment benefits and may also save/borrow.

Equations (24-25) show that PHs spending three consecutive periods with an F- or U-status become financially constrained. They consume their residual wealth (or repay their debt) in period three and then exclusively rely on unemployment benefits in their successive periods without a job.

Consumption/savings The first-order conditions to the problem defined above give the following consumption and savings decisions for PHs that are not financially constrained:

$$(C_t^N)^{-\sigma_c} = \beta \mathrm{E}_t \frac{\varepsilon_{d,t}}{\varepsilon_{d,t+1}} \bar{R}_{t+1} \left\{ (1 - S_{t+1})(C_{t+1}^N)^{-\sigma_c} + S_{t+1}(C_{t+1}^{U1})^{-\sigma_c} \right\} \tag{26}$$

$$(C_t^{Xn})^{-\sigma_c} = \beta \mathrm{E}_t \frac{\varepsilon_{d,t}}{\varepsilon_{d,t+1}} \bar{R}_{t+1} \left\{ P_{t+1}^{N|X} (C_{t+1}^N)^{-\sigma_c} + (1 - P_{t+1}^{N|X})(C_{t+1}^{Xn+1})^{-\sigma_c} \right\}, 1 \leq n < 3 \tag{27}$$

Equations (26-27) describe the consumption and savings decisions of unconstrainted PHs

with an N- and U- or F-status, respectively. PHs with an N-status (F- or U-status) consider the probability of falling into unemployment (staying without a job) in the next period. The unemployment risk encourages precautionary savings and thus lower current consumption. Households with an F- and U-status make different consumption decisions if they face different employment prospects. When $P_{t+1}^{N|Fk} > P_{t+1}^{N|U}$, PHs with an F-status are encouraged to consume more than those with a U-status. After three periods, PHs become financially constrained: their consumption is given by equations (24) and (25). More details on the three-period threshold in section 2.6 and Appendix A.1.

2.4.2 The asset-rich

There is a continuum of RHs of mass $\omega_{RH} = 1 - \omega_{PH}$ indexed by $j \in (\omega_{PH}, 1)$ that forms a large family. The family head maximizes the welfare of its members. It can freely transfer resources to each family member independently of their employment status. This implies that all RHs have the same consumption level. RHs also own the stock of physical capital. For any given period t, their budget constraint is given by

$$\begin{aligned} & \varepsilon_{d,t}\left(C_t + I_t\right) + B_t^{RH} - \frac{R_{t-1}}{\pi_t} B_{t-1}^{RH} \\ = \quad & \left((1-\tau_k)R_t^k u_t^k - a(u_t^k)\right)\bar{K}_{t-1} + (1-\tau_w)W_t^{RH}N_t^{RH} + (1-N_t^{RH})ub_t + TR_t^{RH} + Div_t \end{aligned} \tag{28}$$

where W_t^{RH} represents the period t real labor income (in this case, a quarterly wage) and B_t^{RH} denotes the value of bonds. The terms TR_t^{RH} and Div_t represent net transfers from the government and firms, respectively. RHs invest I_t in private capital $\bar{K}_t$. Capital accumulation is subject to investment adjustment costs and follows

$$\bar{K}_t = (1-\delta)\bar{K}_{t-1} + \left(1 - \phi_i\left(\frac{I_t}{I_{t-1}} - 1\right)^2\right) I_t \tag{29}$$

where δ is the depreciation rate and ϕ_i governs the investment adjustment cost. RHs set the utilization rate of capital u_t^k such that capital services are:

$$K_t = u_t^k \bar{K}_{t-1} \tag{30}$$

RHs pay the utilization cost $a(u_t^k)$ and rent K_t to the firms at the rental rate R_t^k.[4]

[4] We use the same functional form for $a(u_t^k)$ as Christiano et al. (2010). Once linearized, the FOC w.r.t the utilization rate of capital is $\hat{u}_t^k = 1/\sigma_k \hat{R}_t^k$, where σ_k is the inverse of the elasticity of utilization of capital to its rental rate.

2.5 Closing market condition

To close the model, we describe the behavior of public authorities.

Fiscal policies The government oversees fiscal policies. Its budget constraint is given by

$$\tau_w W_t N_t + \tau_k R_t^k K_t + B_t^G = G + ub_t(1 - N_t) + TR_t^G + \frac{R_{t-1}}{\pi_t} B_{t-1}^G \tag{31}$$

where B_t^G is the government debt (equal to zero at steady state, for simplicity) and G is public consumption (fixed at its steady-state value). The government stabilizes its debt by adjusting transfers: $TR_t^G = TR^G - \tau_b B_t^G$, where τ_b is the elasticity of government transfers to public debt (that ensures stability of the model).

Monetary policy The monetary authority follows a simple rule

$$R_t = \rho_r R_{t-1} + (1 - \rho_r)\left(R + \tau_\pi \left(\pi_t - 1\right)\right) \tag{32}$$

where ρ_r is the interest rate smoothing parameter and τ_π is the response to inflation. The bond market clears when the central banks issue B_t^{CB} is consistent with $B_t^{CB} + B_t^G = \int_0^1 B_{j,t} \mathrm{d}j$.

2.6 Calibration

Most parameters are calibrated to standard values presented in table 1, where we also mention the source of the data used and/or the papers from which we borrow our calibration. In what follows, we detail the calibration of some parameters (or steady-state targets) that have an important impact on our quantitative results and our strategy to simulate a COVID shock.

PHs' liquid wealth and financial constraint With HFCS data, we identify asset-poor households as those with a stock of deposits (the most liquid form of wealth) smaller than their monthly gross incomes (more details in Appendix A.2). They represent about 35% of the sample and we calibrate ω_{PH} to this value. We then set φ to match a stock of savings to gross monthly income ratio of 0.5, corresponding to the median savings within the asset-poor households category.

Our strategy to calibrate PHs savings differs from that used by Challe et al. (2017). They use different discount factors for RHs and PHs and calibrate the latter to reach a desired

Table 1: Calibrated parameters

Households	Value	Description
β	0.99	Discount factor
σ_c	2.00	Inverse of the intertemporal elasticity of consumption
ω_{PH}	0.35	Share of PHs (HFCS)
$S/(W^{PH})$	0.165	PHs wealth to quarterly gross income ratio (implied parameter is φ)
Firms		
α	0.33	Capital income share
δ	0.02	Depreciation rate of capital
ϕ_i	3.50	Inv. adj. cost: Smets and Wouters (2005); de Walque et al. (2017)
ϕ_k	1.00	Cap. adj. cost: Smets and Wouters (2007); Christiano et al. (2010) priors
ξ_d	0.875	Price stickiness: Smets and Wouters (2005); de Walque et al. (2017)
ϵ_d	10.0	Input demand elasticity (Calvo)
Labor market		
P	0.30	Job-finding rate (for short-term unemp. from EC. Implied para. is δ_n)
Q	0.50	Probability to fill a vacancy (implied parameter is χ)
θ	1.00	Elasticity of vacancy cost: Thomas (2008); Gertler and Trigari (2009)
σ_m	0.40	Matches elasticity to unemployment: Blanchard and Diamond (1989)
ω_w	0.40	Employees' share of surplus: Blanchard and Diamond (1989)
ξ_w	0.86	Wage stickiness to norm: Challe (2020); Auray and Eyquem (2020)
U	0.076	Unemployment rate from EC (implied parameter is A_m)
Public sector		
ρ_r	0.80	Central bank interest rate smoothness
τ_π	1.50	Central bank inflation response
$ub/((1-\tau_w)W)$	0.55	Net replacement rate (single, median wage, 7 months unempl. from EC)
τ_w	0.38	Labor income tax rate (implicit rate from EC)
τ_k	0.21	Capital income tax rate (effective NFC tax rate from EC)
τ_b	0.05	Lump-sum transfers elasticity to public debt

Data sources: European Commission (EC) and Household Finance and Consumption Survey (HFCS).

stock of savings for PHs. In this paper, we do not want to impose different discount factors as they would have an impact on our welfare analysis. By following their strategy, we would find that PHs are more impatient than RHs, which would arbitrarily raise the welfare cost of the COVID shock. As it is a temporary shock affecting the economy immediately, impatient PHs would naturally be ready to give up a larger share of their lifetime consumption to hedge against this shock. In contrast, we assume that PHs hold a limited stock of wealth due to the absence of more profitable investment opportunities. Under our calibration, the real rate of return on PHs savings at steady state is close to minus one percent.

We assume that PHs hit the borrowing constraint after $k = 3$ periods, which ensures tractability of the model. Exogenous borrowing limits - in terms of amount - has often been used to ensure tractability (see for e.g. Challe et al., 2017; Heathcote and Perri, 2018; Ravn and Sterk, 2020; Bilbiie and Ragot, 2021 and references therein). In our framework, however, imposing a borrowing limit would mean that the number of periods after which PHs become financially constrained might change over time, because the COVID shock is big. Instead, we impose a number of periods during which PHs have access to financial markets. In Appendix A.1, we show that $k = 3$ corresponds to the number of periods after which PHs become financially constrained when the debt limit is set to zero and when shocks are sufficiently small.

Unemployment risks We calibrate A_m and δ_n to target an unemployment rate of 7.6% and a quarterly job-finding rate of 30%, as observed before the pandemic in the euro area. When falling into unemployment in normal times, PHs thus face a 49% chance (0.7^2) of hitting the borrowing constraint two quarters latter and a 34% chance (0.7^3) of living on unemployment benefits only after fully exhausting their savings. This calibration also implies a job-separation rate of 2.4% at steady state.

The COVID shock The pandemic had a large impact on economic activity while inflation initially remained relatively stable. Many authors thus modeled or identified the impact of the pandemic with a combination of adverse demand and supply shocks (Boscá et al., 2021; Cardani et al., 2021; Kollmann, 2021), or with a New-Keynesian supply shock causing a contraction in both aggregate demand and supply (Guerrieri et al., 2022). In this paper, the supply shock causes the idling of a share of the capital stock and of the labor force and a freeze in hiring. It also leads to a small contraction in aggregate demand, as PHs respond to the increase in idiosyncratic labor income risks with higher precautionary savings. But the fall in consumption demand caused by our supply shock is too small to account for the observed fall in consumption and the relative stability of prices. We thus combine it with a demand shock. Preference shocks have been used extensively in the literature, including shocks to the number of different varieties of consumption goods demanded by households (Bayer et al., 2020; Faria-e-Castro, 2021). Considering our welfare analysis, we abstain from imposing shocks on households' preferences. Rather, our demand shock introduces a pseudo tax on consumption and investment capturing the COVID infection risk associated with these activities (which is endogenized in Kaplan et al., 2020; Eichenbaum et al., 2021).

To calibrate the combination of shocks caused by the COVID-19 pandemic, we proceed

in three steps. First, we assume that all supply shocks (employment, matching and capital productivity) have the same size. While it is mostly a simplifying assumption, it can also be rationalized by the fact that some sectors (not explicitly modeled) had to suspend activity, implying that they could not use both their labor force and capital (hence an identical drop in $\varepsilon_{n,t}$ and $\varepsilon_{k,t}$). Firms active in these sectors also had a very low incentive to post vacancies and unemployed households could not look for jobs in these sectors (hence an identical drop in $\varepsilon_{m,t}$). Thus, one can interpret the size of the supply shock as the fraction of the economy that had to suspend all activities during the pandemic.

Second, we calibrate the persistence of the COVID shock (ρ_c) to 0.5. As documented in Anderton et al. (2020), the average share of employees on JRS was close to 25% in April 2020 (simple average for the France, Germany, Italy and Spain group) and fell to about 6.5% two quarters later in October. A persistence of 0.5 matches this pattern reasonably well ($25 * 0.5^2 = 6.25$).

Third, we are left with two parameters to calibrate: the size of supply ($\varepsilon_{n,t}$=$\varepsilon_{k,t}$=$\varepsilon_{m,t}$) and demand shocks ($\varepsilon_{d,t}$). They are set to match two targets: the fall in yearly consumption and hours worked observed between 2019 (before the pandemic) and 2020 (the first year of the pandemic). This shock thus captures the economic consequences of the first year of the pandemic.[5] We obtain $\varepsilon_{n,t}$=$\varepsilon_{k,t}$=$\varepsilon_{m,t} = 0.17$ - implying that 17% of employed households are furloughed in the baseline or face the risk of becoming unemployed in the absence of JRS - and $\varepsilon_{d,t} = 0.31$ - implying that the pseudo tax on consumption and investment amounts to 31% of their prices at the onset of the pandemic.

JRS and furloughs A furloughed worker returns to his/her previous job if two conditions are met. First, restrictions must be lifted. Given the persistence of the COVID shock, we assume that 50% of the initial restrictions are lifted after one period, 25% are lifted after two periods, while the remaining 25% are lifted after three periods, which also corresponds to the maximum duration of the F-status. Second, when restrictions are lifted, the employment match must still exist. Since all matches have a probability δ_n of breaking at every period, the second condition has a $(1 - \delta_n)^n$ probability of being met, where n is the number of periods spent with an F-status. For simplicity, we assume that households are only made aware of the outcome of these two random events if both conditions are met. It implies

[5] The COVID shock is kept relatively simple in some dimensions to highlight the most important mechanisms. For example, we do not consider other supportive fiscal or monetary policies that were implemented in combination to JRS. In a more complex model, one should expect to get a stronger adverse aggregate demand shock partially compensated by expansionary fiscal and monetary measures. In this paper, the demand shock nets out these demand effects at a low cost for our estimates, because we calibrate our COVID shock to match the observed fall in aggregate consumption.

that households keep an F-status for three periods when restrictions are lifted in the first or second period but the match breaks for reasons unrelated to the pandemic. Thus, all PHs with an F-status form a homogenous group. Also note that the number of PHs with a broken match and an F-status is small because δ_n is also small. The probabilities of returning to a previous job after one, two and three periods on furlough are given by: $P^{N|F1} = (1-\rho_c)(1-\delta_n) = 0.48$, $P^{N|F2} = \rho_c(1-\rho_c)(1-\delta_n)^2/(1-P^{N|F1}) = 0.45$ and $P^{N|F3} = \rho_c^2(1-\delta_n)^3/\left((1-P^{N|F1})(1-P^{N|F2})\right) = 0.79$. Under this calibration, households with an F-status for one (two) period(s) have a 0.48 (0.45) probability of returning to their previous in the next period. They keep this status for an additional period otherwise. When JRS end, households with an F-status have a 0.79 probability of returning to their previous job. Otherwise, they fall into unemployment.

2.7 Simulations and welfare cost

The COVID shock is simulated with a first-order approximation to our calibrated model. For simplicity, we disregard standard business cycle shocks, so that in the absence of the COVID shock, the economy would stay at its stead state at all times.

For each category of households, we compute the welfare cost of the COVID shock. This is defined as the fraction of consumption $\lambda_{j,covid}$ that an agent j would be ready to give up in every period to avoid the economic consequences of the COVID shock. The welfare cost is thus expressed in consumption units as in Lucas (1987, 2003). We assume that an agent knows his/her type (PHs or RHs) but not his/her employment status at the beginning of the experiment. We thus compute two $\lambda_{j,covid}$: one for PHs and one for RHs. Formally, $\lambda_{j,covid}$ is given by $\mathrm{E}_t\mathbb{W}_{j,t}\left(C_{j,t} \mid \epsilon_t^{covid}=1\right) = \mathrm{E}_t\mathbb{W}_{j,t}\left((1-\lambda_{j,covid})C_{j,t} \mid \epsilon_t^{covid}=0\right)$.

For PHs, we also measure an idiosyncratic risk insurance premium. It is defined as the fraction of consumption $\lambda_{j,idio}$ that an agent would be ready to give up in every period to replace its own consumption flow subject to idiosyncratic labor income risks with a consumption flow based on the average consumption level of all other PHs. Formally, $\lambda_{j,idio}$ is given by $\mathrm{E}_t\mathbb{W}_{j,t}\left(C_{j,t}\right) = \mathrm{E}_t\mathbb{W}_{j,t}\left((1-\lambda_{j,idio})C_t^{PH}\right)$.

3 Results

We have three objectives. First, we assess the macroeconomic effects of the COVID shock and JRS. Second, we evaluate their welfare effects on households. Third, we identify the structural characteristics of an economy that influence the effectiveness of JRS.

3.1 Macroeconomic consequences of the COVID shock and JRS

In this section, we evaluate the macroeconomic effects of the COVID shock and JRS that were implemented to mitigate the consequences of the pandemic. For this purpose, we consider two scenarios. In the baseline, we simulate the impact of the COVID shock in an economy calibrated to the euro area with JRS activated. In the counterfactual, we assume that JRS were not activated. We show the dynamic response of macroeconomic variables to the COVID shock with and without JRS in figure 3. We begin by discussing the consequences of the COVID shock on important macroeconomic variables in our baseline economy. We then turn to the effect of JRS by comparing this baseline with the counterfactual experiment.

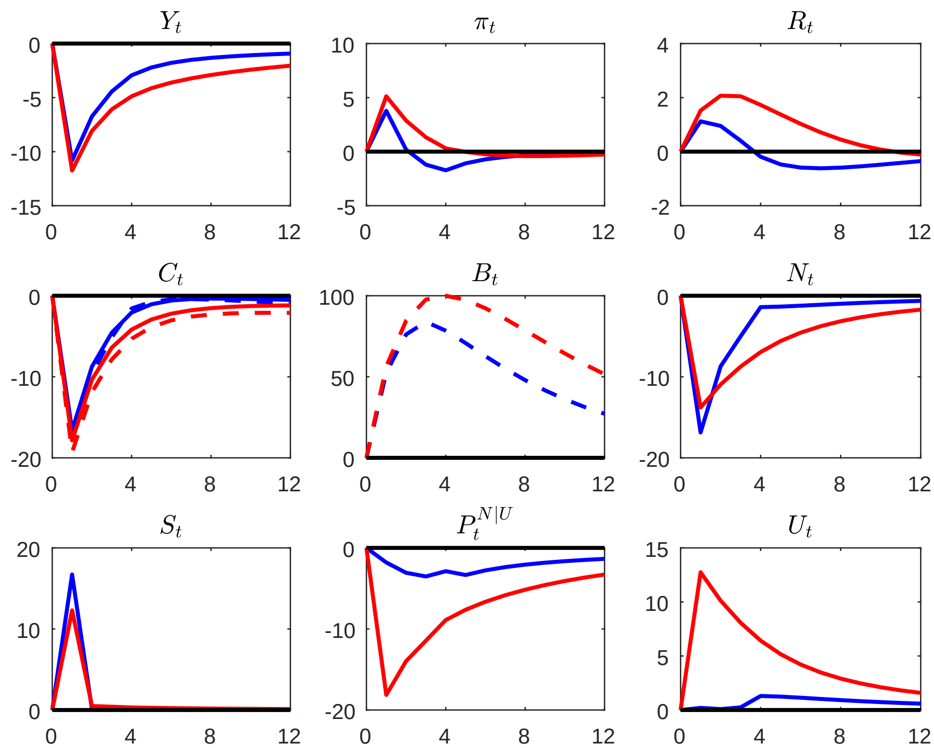

Figure 3: Dynamic response of macroeconomic variables to the COVID shock.
Notes: Variables expressed in percentage deviation from steady state. Inflation and interest rates annualized. Unemployment, separation and job-finding rate in percentage point deviation from steady state. B is the sum of PHs savings. Horizon in quarters. Blue: baseline model. Red: No JRS. Dashed lines: PHs. Plain lines: macro aggregates.

In the baseline scenario, the COVID shock causes a sharp decline in economic activity. It consists of a combination of aggregate demand and supply shocks that is meant to reproduce the impact of the pandemic. The calibration ensures that the fall in consumption and labor supply in the baseline economy matches the negative yearly growth rate of -8% observed for these two variables in the euro area. Inflation goes up because the rise in marginal production

costs (caused by the combination of a shrinking labor supply and capital productivity) dominates the fall in aggregate demand. The Taylor rule commands a moderate and short-lived increase in the interest rate. In Appendix A4, we provide a robustness check where we use an additional shock to target the dynamics of inflation.

The economic contraction also leads to a decline in the new job-finding rate. In the baseline scenario, the model predicts a 3 percentage point (pp) drop in the job-finding rate, from 30% before the pandemic, to 27% in the first year. The lower job-finding rate is explained by the combination of an adverse matching shock, a (small) increase in the number of unemployed households searching for a job, and weak vacancy posting by firms facing a drop in aggregate demand.

The drop in the job-finding rate triggers precautionary savings as households vulnerable to shocks to their labor income try to self-insure against this risk. Unemployed and furloughed PHs that are not financially constrained reduce consumption as they anticipate a longer unemployment spell. Employed households are also encouraged to reduce their consumption expenditure as they face a higher probability of falling into unemployment. Together with the decline in consumption demand steeming directly from the COVID shock (the demand shock component), precautionary savings lead to an increase in PHs savings. One year into the crisis, our model predicts an 80% increase in their aggregate savings stocks.

The model also predicts a steeper fall in consumption for PHs. In the baseline scenario, PHs' consumption falls by 8.5%, compared to 8% for aggregate consumption. The COVID shock causes a large drop in the employment rate, with many households entering an F-status (with JRS) or U-status (without). In contrast to RHs, PHs must cut consumption drastically when becoming unemployed or furloughed as their savings are not sufficient to perfectly smooth consumption. Note that the drop in PHs' consumption is larger even though the demand component of the COVID shock does not affect all PHs directly. By assumption, the demand shock ($\varepsilon_{b,t}$) affects all RHs but only affects PHs that are not financially constrained (it does not affect PHs unemployed for three periods or longer).

JRS mitigate the fall in economic activity. In the baseline scenario, GDP declines by 6.2% in the first year of the pandemic (which is close to the -6.5% growth rate observed in 2020 in the euro area), against 7.7% in the counterfactual.

JRS prevent a large and immediate rise in unemployment. Indeed, the increase in the unemployment rate is very limited and delayed in the baseline scenario: it only goes up by about one pp after a year before slowly returning to its equilibrium level. This prediction is consistent with the data: in the euro area, the unemployment rate increased by one pp, from 7.2% in March 2020 to 8.2% in March 2022. In contrast, in the absence of JRS, our

model predicts that the unemployment rate rises by about 12.7 pp on impact. This increase is slightly larger than the one observed in the US, where the unemployment rate rose by 11.2 pp, from 3.5% in February to 14.7% in April 2020.

The COVID shock causes a large increase in furloughed workers, most of whom would have become unemployed without JRS. We analyze households' employment status in figure 4. Households that are not working are classified into short-term unemployment (one to three quarters), long-term unemployment (one year or longer) or on furlough. Initially, the increase in furloughs with JRS is larger than the increase in unemployment without them. In the absence of JRS, households affected by the COVID shock join the pool of households searching for a job and are given a chance to immediately find another job. This increase in the number of job-seekers has a positive impact on new employer-worker matches. This is the drawback of JRS in our model: households do not actively search for a new job but simply wait for a random signal to return to their previous job. However, since the job-finding rate is extremely low at the beginning of the crisis, the increase in unemployment is very large without JRS.

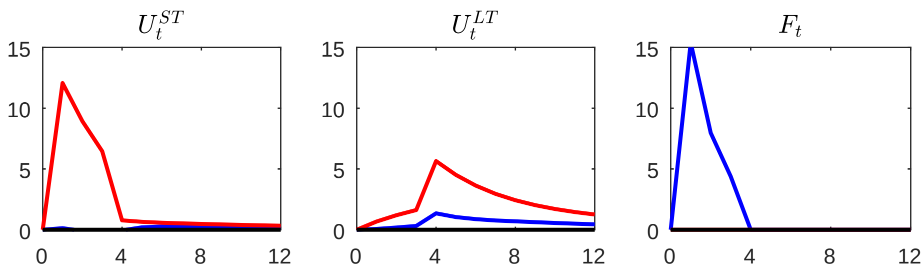

Figure 4: Furloughs and unemployment by duration.
Notes: Variables expressed in percentage point deviation from steady state. Horizon in quarters. U_t^{LT} is the long-term unemployment rate (1 year or longer). $U_t^{ST} = U_t - U_t^{LT}$ is the short-run unemployment rate. Blue: baseline model. Red: No JRS.

JRS are also successful at avoiding a strong increase in the long-term unemployment rate. Indeed, households with an F-status are more likely to quickly return in employment than those with a U-status and are thus less likely to fall into long-term unemployment. Without JRS, the model predicts an increase of 5.6 pp in the long-term unemployment rate within a year, compared to 1.3 pp in the baseline scenario. The unemployed without a job for one year or longer account for almost 60% of all the unemployed in the counterfactual (compared to one third at steady state).[6]

The contraction in labor supply is less persistent when JSR are implemented. JRS enable

[6] In the US, the share of unemployed without a job for six months or longer doubled in one year, from 19.1% in February 2020 to 41.3% in February 2021.

furloughed workers to quickly return to their previous employer with a high probability. In the absence of JRS, SAM frictions on the labor market imply that it takes time to form new matches as all vacancies are not immediately filled. JRS thus mitigate labor supply shortages and prevent a larger increase in inflation that would require a stronger tightening of monetary policy. Together, the direct effect of JRS on labor supply and its indirect effects on inflation and interest rates mitigate the fall in GDP caused by the pandemic.

Without JRS, the job-finding rate collapses, leading to a stronger increase in precautionary savings and a steeper fall in consumption for PHs. In the counterfactual experiment, a large population of unemployed households competes for the few jobs available. In the first quarter, the job-finding rate declines by 18 pp (from 30% at steady state, to 12%), dividing the odds of unemployed households finding a new job by two and a half. PHs accumulate more savings than in the baseline scenario and tend to hold on to these for longer, exacerbating the fall in demand. In our counterfactual analysis, aggregate consumption falls to -9.7% during the first year of the pandemic, compared to -8% with JRS. PHs cut consumption by 11.1%, compared to 8.5% in the baseline scenario.

These simulations indicate that the COVID shock and JRS had a strong impact on households' aggregate consumption and exposure to idiosyncratic labor market risks. PHs were affected more severely, due to the combination of a higher drop in aggregate consumption for PHs (on average) and an inability to perfectly hedge against idiosyncratic risks. In the next section, we investigate the welfare effects of the COVID shock and JRS.

3.2 Welfare effects of the COVID shock and JRS

The welfare cost of the economic consequence of the COVID shock is high, especially for PHs. In the baseline economy, PHs and RHs suffer a welfare loss equivalent to a permanent drop of 0.94% and 0.67% of their steady-state level of consumption, respectively (table 2). In other words, PHs and RHs would have been ready to give up 0.94% and 0.67% of their consumption in every period to avoid the economic consequences of the COVID-19 outbreak.

The larger fall in PHs' aggregate consumption and the increase in consumption dispersion both contribute to the higher welfare cost for this category of households. As explained in the previous section, the COVID shock causes a sharper drop in aggregate consumption in the PHs group than in the RHs group (see figure 3).

Even in the absence of aggregate shocks, labor market idiosyncratic risks generate income, wealth and consumption dispersion within the PHs group. Employed PHs earn wages while others receive unemployment benefits. For PHs with imperfect access to financial markets,

Table 2: The welfare cost of the COVID shock and the insurance premium

	Baseline	No JRS	No shock
RHs: welfare cost of COVID shock	0.67	1.02	-
PHs: welfare cost of COVID shock	0.94	1.70	-
PHs: idiosyncratic risk insurance premium	1.72	1.80	1.70

Note: Welfare cost (idiosyncratic risk insurance premium) expressed as the percentage of consumption that an agent would be ready to give up in every period to avoid the economic consequences of the COVID-19 outbreak (mute idiosyncratic labor income risks). See section 2.7.

this income dispersion translates into wealth and consumption dispersion. Indeed, unemployed (or furloughed) PHs gradually cut back on consumption during an unemployment spell as they exhaust their limited stock of savings and hit their borrowing constraint.

To measure the welfare losses associated with consumption dispersion within the PH category, we compute an idiosyncratic risk insurance premium. It is defined as the fraction of consumption that an agent would be ready to give up in every period to mute idiosyncratic labor income risks. At steady state, the idiosyncratic risk insurance premium amounts to 1.70% of consumption. Any PH would thus be willing to give up 1.70% of its average consumption level to replace its own consumption flow subject to idiosyncratic labor income risks with a consumption flow based on the average consumption level of all other PHs in normal times.

The COVID shock causes an increase in consumption dispersion within the PH category translating into an increase in the idiosyncratic risk insurance premium. In the baseline economy hit by the COVID shock, the value of idiosyncratic risk insurance increases to 1.72%, compared to 1.70% at steady state. The COVID shock thus has an adverse impact on PHs' welfare through an increase in the cost of consumption dispersion within the PH category.

JRS have large favorable welfare effects and benefit all households, but the gains are larger for PHs. Without JRS, the welfare cost of the COVID shock increases by 0.76 and 0.35 pp, to 1.70 and 1.02% of consumption for PHs and RHs, respectively. Without JRS, PHs would have been ready to abandon 1.70% of their consumption to hedge against the economic consequences of the first year of the pandemic. This is equivalent to the premium they would be ready to pay to mute all labor market idiosyncratic risks over a lifetime in an economy with no aggregate shocks.

JRS improve welfare for all households by mitigating the fall in PHs' and RHs' consumption. As explained in the previous section, JRS enable households to return to work faster,

limiting the persistence of the contraction in aggregate labor supply. Moreover, JRS limit the increase in idiosyncratic labor market risks faced by PHs, which reduces the need for precautionary savings and encourages consumption. Figure 5 shows the different consumption response of employed, unemployed and furloughed PHs with and without JRS compared to aggregate PH consumption. JRS have a favorable effect on consumption for all PHs with different employment status.

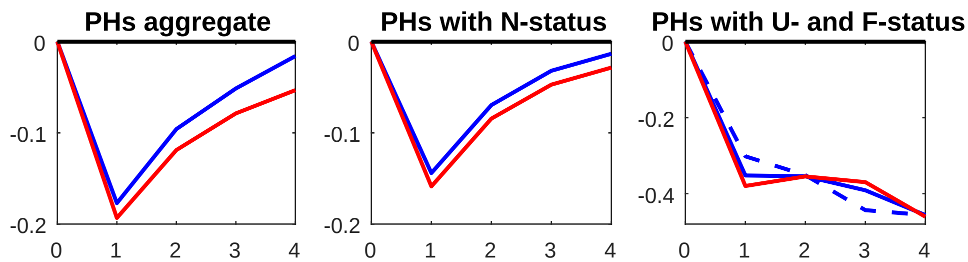

Figure 5: Dynamic response of PHs consumption by employment status.
Note: Variables expressed as a fraction of consumption before the shock. Left chart: PHs aggregate consumption. Center: PHs with an N-status during the first year following the COVID shock. Right chart: PHs with an N-status before the shock that immediately transitions to and stays with a U (plain line) or F-status (dashed line). Horizon in quarters. Blue: Baseline model. Red: No JRS. Dashed: PHs with F-status.

JRS also have a favorable welfare effect on PHs by mitigating the increase in labor market idiosyncratic risk and consumption dispersion caused by the COVID shock. In the counterfactual analysis, the idiosyncratic risk insurance premium increases to 1.80%, compared to 1.72% with JRS. Thus, JRS also mitigate the welfare cost of the COVID shock for PHs through a decline in consumption dispersion within this household category.

Why does consumption dispersion decline with JRS? First, as explained in the previous section, JRS drastically reduce the odds of workers falling into long-term unemployment. There are fewer PHs hitting the borrowing constraint with very low consumption levels. Second, knowing that they face better odds of quickly returning to their previous job, PHs on furlough are encouraged to maintain higher consumption levels, compared to those that are unemployed. Figure 5 shows that the consumption gap between PHs with an F- or U-status for one period is substantial. On impact, PHs transitioning from an N- to an F-status reduce consumption by 30% while those transitioning to a U-status cut consumption by 35%. Of course, they may have to eventually cut back further on consumption if they do not return to their previous job, but the lower probability is enough to ensure that JRS have a favorable impact (and PHs' decision is optimal in the sense that they take this possibility into account). Third, the behavior of PHs transitioning to a U-status also depends on JRS. When there are no JRS, these PHs cut consumption by 38% (compared to 35% for PHs with

the same status in the baseline economy).

The increase in wealth dispersion is also less persistent with JRS. The Lorenz curves in figure 6 show the change in wealth dispersion within the PHs group (at steady state, in the baseline economy hit by the COVID shock with JRS, and in the counterfactual analysis without). Wealth dispersion increases immediately after the shock. Initially, the increase in wealth dispersion is more pronounced when JRS are activated. There are more furloughed workers in the baseline scenario than workers losing their job in the counterfactual economy and furloughed workers are more inclined to draw on their savings to finance consumption. However, as furloughed workers quickly return to work, wealth dispersion goes back to its equilibrium level. In contrast, wealth dispersion remains persistently higher in the counterfactual analysis.

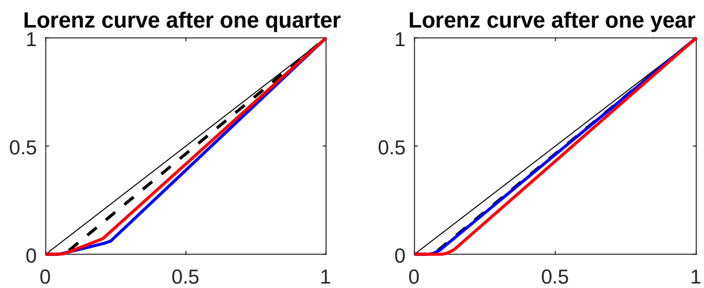

Figure 6: Wealth dispersion within the PH category.
Note: Lorenz curves based on the population of PHs and their savings after one quarter (left) and one year (right). Blue: Baseline model. Red: No JRS. Dashed-black line: No shock (economy at steady state).

Finally, we compute the consumption losses of households according to their type (PHs or RHs) and employment status (note RHs' consumption does not depend on their employment status) when the COVID shock hits the economy. Losses are expressed as a fraction of employed household (of the same type) consumption before the shock. We break these losses down into three components. The first component (in blue) captures losses that are independent from the COVID shock. In normal times, households can also transition from/to the U- and N-status and PHs falling into unemployment also reduce consumption compared to those who are employed. RHs do not experience any losses from labor market idiosyncratic risks. The second component (in green) is the loss of consumption that can be directly attributed to the COVID shock in the baseline economy. It is computed using the drop in consumption in the baseline economy compared to a situation with no shock for each category of households. The third component (in yellow) is the extra loss of consumption that would have occurred in the absence of JRS. We show these losses over one-quarter and one-year horizons (figure 7).

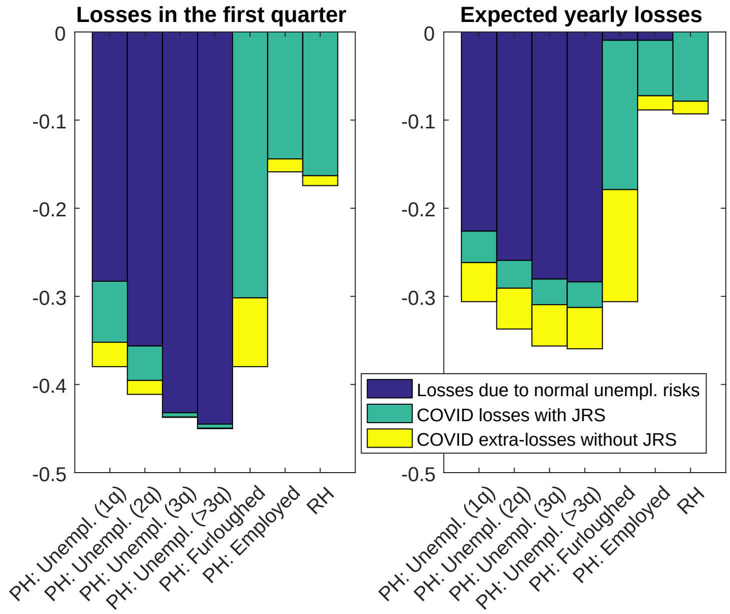

Figure 7: Consumption losses by employment status.
Left panel: consumption losses in the first quarter for PH and RH by employment status expressed as a fraction of employed PHs' or RHs' consumption at steady state. Right panel: expected consumption losses of PHs and RHs over a one-year period (as a fraction of yearly consumption). These costs are conditional on a specific employment status (on the x axis) when the COVID shock hits the economy. Job transition probabilities are then used as weights to compute expected costs in the next three quarters.

The consumption losses that are directly attributed to the COVID shock are highest for furloughed PHs and lowest for unemployed PHs. In the absence of such a shock, furloughed workers would have kept their job and would not have had to cut consumption. For PHs that fell into unemployment before the shock, or for reasons unrelated to the shock, the consumption loss of the COVID shock is small. In the short run, consumption decisions of PHs hitting the financial constraint (unemployed for three quarters) or that have already exhausted all their savings (unemployed for one year or longer) are barely affected by the COVID shock because their consumption mostly depends on (unchanged) unemployment benefits. Over a one-year horizon, consumption losses of unemployed PHs are explained by a lower job-finding rate. However, the welfare effect of these losses should not be underestimated, as they hit households in an already very precarious situation by lowering their odds of quickly returning into employment.

The consumption gains of JRS are largest for furloughed PHs and substantial for unemployed PHs. JRS enable furloughed PHs to quickly return into employment with a high probability. Such schemes boost furloughed PHs' consumption through higher expected incomes and lower precautionary savings. Although the consumption losses attributed to the

COVID shock are (relatively) small for unemployed PHs, they are the second largest beneficiaries of JRS. It means that, in the absence of JRS, they suffer large consumption losses from the COVID shock. JRS mitigate the fall in the job-finding rate of the unemployed, and thus also boost their consumption through higher expected incomes and lower precautionary savings. Although the impact of JRS on GDP and aggregate consumption has been modest, their welfare effects have been much larger, because they had a sizable effect on the most vulnerable PHs.

Consumption gains of JRS materialize over time. The average gains of JRS over a one-year horizon are larger than the immediate gains in the first quarter for all household groups. This difference is particularly pronounced for furloughed and unemployed PHs, as the higher probability of quickly returning to employment mitigates expected future losses. This effect is particularly strong for PHs with an F-status, but those with a U-status also benefit from a higher job-finding rate in the baseline economy with JRS.

Overall, these results show that JRS had a favorable welfare effect on all categories of households (RHs and PHs) and status (U, T and N). These policies were particularly effective at mitigating the consumption and welfare losses of furloughed and unemployed PHs. However, even with JRS, the welfare cost of the economic consequences of this shock remains very high, especially for PHs.

3.3 JRS and structural characteristics

What explains the success of JRS at mitigating the impact of the COVID shock? In this section, we explore the role of three structural characteristics of an economy that could, a priori, influence the effectiveness of JRS. The first factor is the job-finding rate, which captures the dynamism of the labor market and the ability of households to quickly bounce back into employment. In economies that are capable of quickly creating new job opportunities for the unemployed, the value of preserving a match with JRS might be lower. The second and third factors are the generosity of unemployment benefits and the stock of PHs savings prior to the COVID shock. Households with comfortable savings buffers receiving generous unemployment benefits should be better able to maintain consumption during an unemployment spell and might thus benefit less from JRS.

Starting from our model calibrated to the euro area, we change the values of the job-finding rate at steady state (which implies that δ_n adjusts to the new target), the unemployment benefits net replacement rate, and of PHs' wealth (φ adjusts to the new target). We change the values of these parameters one at a time, simulate our baseline model (with

JRS) and the counterfactual (without), and compute the welfare gains of JRS as the fraction of permanent consumption that a household living in the counterfactual economy would be ready to give up to live in the baseline economy with JRS. Results are shown in figure 8.

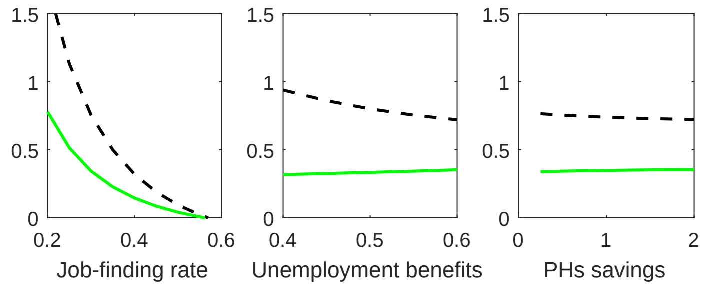

Figure 8: Welfare gains of JRS and structural characteristics.
Note: Dashed-black line: PHs. Green: RHs. Welfare gains of JRS expressed as percentage of permanent consumption that a household living in the counterfactual economy would be ready to give up to move to the baseline economy with JRS.

The welfare gains of JRS are much larger in economies with a lower job-finding rate in equilibrium. In our model, JRS increase the odds of returning to a previous job by preserving most employment matches (those not affected by the normal separation rate δ_n). However, JRS also imply that households with an F-status do not search for a new job: they will only start searching for a new job if they become unemployed when JRS come to an end. In economies with more dynamic labor markets, the value of searching for a job is higher, and these economies thus benefit less from JRS. This result is consistent with our discussions in the previous sections, where we often referred to the odds of quickly returning to employment to explain the consumption and welfare effects of JRS. Our results could also justify the different policy choices in US and the euro area. In the US, where the job-finding rate is on average much higher, JRS could be less effective.

PHs in economies with less generous unemployment benefits and lower savings buffers are also more likely to benefit from JRS. However, the welfare gains of JRS are less sensitive to these parameters than to the job-finding rate for PHs. For RHs, welfare gains of JRS are more or less independent from these parameters as they already enjoy perfect insurance against idiosyncratic labor market risks. These results indicate that some vulnerable households might have benefited from JRS in the US (at least those with a lower job-finding rate). In the US, however, cash transfers were sent to households, and may have played a role similar to the generally more generous unemployment benefits in the euro area.

4 Conclusion

Our results lend support to the temporary JRS introduced in the euro area in response to the COVID shock. In the absence of such policies, liquid-asset-poor households would have suffered even more from the economic consequences of the pandemic. Inequalities in consumption, income and wealth might have widened even further. This paper also highlights the benefits of JRS for all households, implying broad support for these types of stabilizing policies.

JRS bring large welfare gains in the short run through two main channels. First, JRS mitigate the persistence of the fall in labor supply, thereby supporting economic activity and aggregate consumption, which benefits all households. Second, JRS dampen the increase in labor income idiosyncratic risks and consumption dispersion among liquid-asset-poor households. It is important to note that these large gains are obtained under the assumption that JRS are gradually phased out as economic restrictions are lifted and that JRS have no side effect on labor allocation/productivity in the long run.

The nature of the shock - including an exogenous labor supply shock causing a temporary freeze in some employment matches - and dynamism of the labor market - measured by households' ability to quickly transition from unemployment to employment in normal times - are key determinants of these results. JRS should be appropriate stabilizing tools in the event of a new pandemic leading to renewed economic restrictions or widespread input shortages leading to idling of productive capacities. Their benefits are higher in economies with less dynamic labor markets.

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Appendix

A.1. When do PHs hit the borrowing constraint ?

We set the number of consecutive periods without a job (k) at which PHs become financially constrained such that the dynamics of our model are consistent with the HANK model of Challe et al. (2017) for small shocks hitting an economy initially at its steady state. These authors assume that (1) transfer of resources is only possible among employed households and (2) households that are not employed are not allowed to borrow. Together, these assumptions endogenously give a threshold k at which PHs become financially constrained and also ensure that heterogeneity remains finite-dimensional.

Following Challe et al. (2017) and disregarding PHs with an F-status and from exogenous

shocks (for simplicity), the family-head constraint is:

$$
\begin{aligned}
B_t^N &= \frac{R_{t-1}\left[(1-S_t)N_{t-1}B_{t-1}^N + \sum_{i=1}^{\infty} P_t^{N|U} U i_{t-1} B_{t-1}^{Ui}\right]}{\pi_t N_t} \\
&+ (1-\tau_w)W_t^{PH} - C_t^N + TR_t^G \qquad (33) \\
B_t^{U1} &= \frac{R_{t-1}}{\pi_t} B_{t-1}^N + ub_t + TR_t^G - C_t^{U1} \geq 0 \qquad (34) \\
B_t^{Uj} &= \frac{R_{t-1}}{\pi_t} B_{t-1}^{Uj-1} + ub_t + TR_t^G - C_t^{Uj} \geq 0, \ \forall\, j \geq 2 \qquad (35)
\end{aligned}
$$

where savings are constrained to be greater or equal to zero. Under Challe et al. (2017)'s assumptions, PHs become financially constrained when their optimal consumption/savings decisions imply a breach in the borrowing constraint. Formally, this happens when

$$
(C_t^{PHUk})^{-\sigma_c} = \beta \mathrm{E}_t \frac{R_t}{\pi_{t+1}} \left\{ P_{t+1}^{N|U} (C_{t+1}^{PHN})^{-\sigma_c} + (1 - P_{t+1})(C_{t+1}^{PHUk+1})^{-\sigma_c} \right\}, \qquad (36)
$$

implies that $B_{t+1}^{PHUk} < 0$ when all variables are set at their steady state. In that case, PHs unemployed for k periods would like - but are unable - to borrow. When we replace our assumption (2) discussed in the paper with the assumption of Challe et al. (2017), we find a threshold $k = 3$ in our baseline calibration.

Why don't we simply use Challe et al. (2017)'s assumptions? Their threshold k has the advantage of being endogenous but only holds at steady state and for sufficiently small shocks. For shocks that are sufficiently large, the threshold could change. For example, shocks causing a large increase in the unemployment risk could encourage PHs to save, causing an increase in this threshold as it would take them longer to exhaust their savings.

This is the case when the COVID shock hits the economy. Figure 9 shows the dynamic response of PHs (desired) savings. Initially, the economy is at its steady state (period 0). Employed PHs hold savings equivalent to half a month of income. When falling into unemployment, they spend most of their savings in the first and second period. In the third consecutive period without a job, they spend their residual savings. We thus compute their desired savings which show that they would have liked to borrow. At steady state, the threshold at which PHs become financially constrained is thus $k = 3$.

When the COVID shock hits the economy, employed PHs increase their savings. PHs that fall into unemployment after being able to accumulate extra savings are in a very different position. After being unemployed for two periods, they still hold a large stock of savings. At some point, they even prefer to keep a small but positive level of savings after three periods

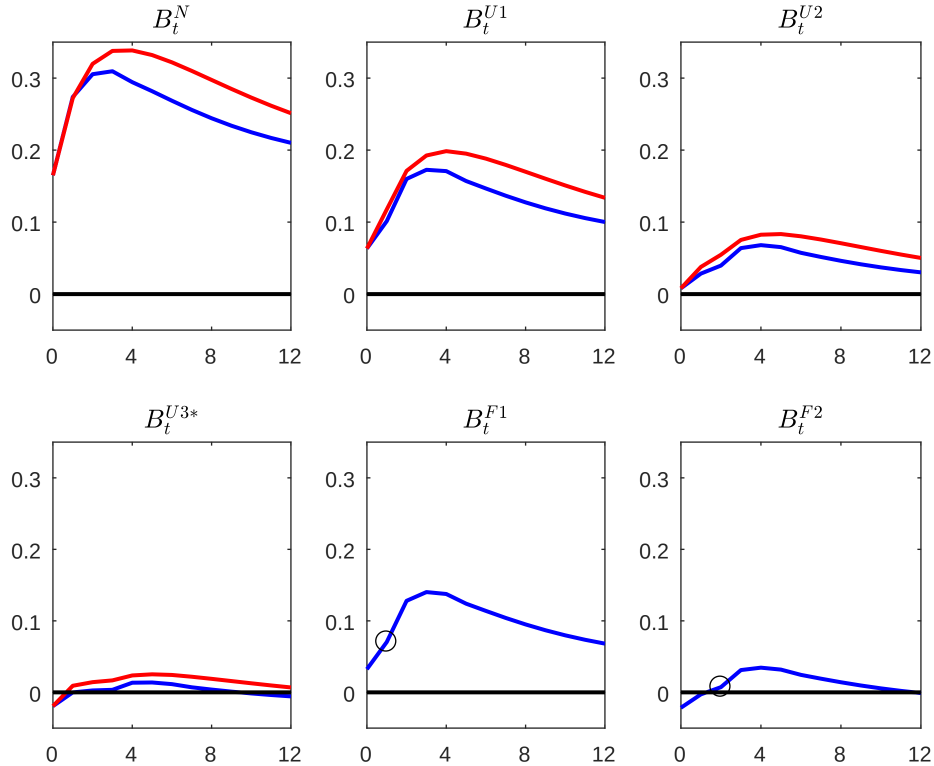

Figure 9: Dynamic response of PHs (desired) savings to the COVID shock.

Note: From top-left to bottom-right: employed-PHs savings, PHs savings after 1 period in unemployment, PHs savings after 2 periods in unemployment, PHs desired savings after 3 period in unemployment (when they hit the constraint), PHs savings after 1 period with F-status, PHs desired savings after 2 period with F-status. For PHs with F-status, the o marker indicates the periods with a non-zero households mass in that category. Savings expressed as a fraction of quarterly gross incomes at steady state. Blue: baseline simulations with JRS activated. Red: JRS not activated.

into unemployment. They hit the budget constraint later: after four periods instead of three.

To ensure that our model remains consistent with large shocks (such as the pandemic) and that its dynamics remain linear, we exogenously impose the threshold k, but our choice is guided by the predictions of a microfounded HANK model. Considering that the desired stock of savings after three periods in unemployment is negative at steady state and remains relatively low during the pandemic, we argue that imposing $B_t^{U3} = 0$ instead of $B_t^{U3} \geq 0$ is of little consequence.

A.2. Identifying the share of PHs in the euro area

To identify liquid-asset-poor households, we use HFCS data. As explained by the ECB (2020b), "the Household Finance and Consumption Survey (HFCS) is a joint project of all the national central banks of the Eurosystem, the central banks of three EU countries that have not yet adopted the euro, and several national statistical institutes. The HFCS provides detailed household-level data on various aspects of household balance sheets and related economic and demographic variables, including income, private pensions, employment, and measures of consumption. [...] The HFCS is conducted in a decentralised manner. Each institution participating in the Household Finance and Consumption Network (HFCN) (the national central bank and/or the national statistical institute) is responsible for conducting the survey. The European Central Bank (ECB), in conjunction with the HFCN, coordinates the whole project, ensuring the application of a common methodology, pooling the country datasets and performing quality control on them, as well as disseminating the survey results and microdata through a single access gateway."

The third wave of the HFCS (the results of which we use in this paper) was conducted mainly in 2017 in 22 EU countries. We focus on the 19 coutries forming the euro area. The table below provides the participating countries and the size of the sample:

Country	Net sample size
Austria	3 072
Belgium	2 329
Cyprus	1 303
Estonia	2 679
Finland	10 210
France	13 685
Germany	4 942
Greece	3 007
Ireland	4 793
Italy	7 420
Latvia	1 249
Lithuania	1 664
Luxembourg	1 616
Malta	1 004
Netherlands	2 556
Portugal	5 924
Slovakia	2 179
Slovenia	2 014
Spain	6 413
Total	78 059

Figure 10: Euro area countries and sample size.
Note: number of households in each countries included in HFCS data. Source: ECB (2020a).

We identify liquid-asset-poor households as those with a stock of deposits (the most liquid form of wealth) smaller than their monthly gross incomes. According to this definition, they

account for 35% of the population of households in the euro area. Considering other forms of liquid assets would not affect our results qualitatively: the share of households with a stock of liquid assets lower than their monthly gross incomes is 34%. Those we identify as PHs are unlikely to invest in financial assets. For example, only one percent of them own publicly traded shares. As an alternative identification strategy, we could have used the share of households with a stock of deposits/liquid assets smaller than the median monthly gross incomes in their country of residence. Under these definitions, the share of PHs goes up to 38-40%. However, we use the more conservative definition discussed above and calibrate this share to 35%.

Table 3: Share of PHs

Deposits $<$ 1 month gross income	0.35
Deposits $<$ 1 month median gross income	0.40
Liquid assets $<$ 1 month gross income	0.34
Liquid assets $<$ 1 month median gross income	0.38

Note: Own computations based on HFCS data. Liquid assets defined as the sum of bank deposits and money invested in bonds, shares, non-self-employment private business, mutual funds and managed accounts.

In this paper, we also assume that PHs depend exclusively on labor incomes and social transfers as they do not invest in productive capital and do not own the firms. In figure 11, we show the income composition of PHs and RHs. On average, PHs earn very limited income from financial assets and real estates.

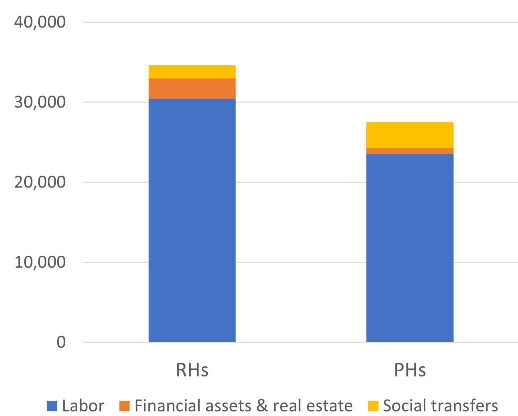

Figure 11: Average income composition of RHs and PHs.
Note: in euros. Own computations based on HFCS data. Labor income includes employee income and self-employment income. Social transfers do not include pensions.

A.3. Anticipated COVID shock

At least to some extent, the economic consequences of the COVID shock might have been anticipated. It was discovered in China, then spread to Europe, and then restrictions on mobility and economic activity were imposed. We thus perform a robustness exercise assuming that the shock is revealed in 2020Q1 but restrictions on economic activity are imposed in 2020Q2. When the shock is revealed, PHs vulnerable to labor income risks immediately reduce consumption (figure 13). Employed PHs anticipate higher furlough and unemployment risks, encouraging them to increase their savings to self-insure against these risks. The Euler condition for employed PHs is slightly different (compared to equation 26) when the possibility of being furloughed is anticipated:

$$(C_t^N)^{-\sigma_c} = \beta \mathrm{E}_t \frac{\varepsilon_{d,t}}{\varepsilon_{d,t+1}} \bar{R}_{t+1} \tag{37}$$
$$\times \left\{ (1 - S_{t+1})(C_{t+1}^N)^{-\sigma_c} + (S_{t+1} - \iota_F \varepsilon_{n,t+1})(C_{t+1}^{U1})^{-\sigma_c} + \iota_F \varepsilon_{n,t+1} (C_{t+1}^{F1})^{-\sigma_c} \right\}$$

where employed PHs anticipate that matches can break at the normal rate δ_n or as a result of the COVID shock leading to unemployment or furlough. Note that when the shock is not anticipated, $\mathrm{E}_t \varepsilon_{n,t+1} = 0$ and equation (37) simplifies to (26). The initial drop in consumption is smaller with JRS because they mitigate the severity of the idiosyncratic risk (the drop in consumption is smaller for PHs with an F-status compared to those with a U-status) and because anticipation of higher marginal costs prompt firms to immediately increase prices, leading to an immediate tightening of monetary policy (which also affects RHs). For PHs, the increase in the separation rate (which is higher with JRS) plays in the opposite direction but is dominated by the two effects just mentioned. The rest of the dynamics are similar to our baseline with an unanticipated shock, as shown in figure 12. Our welfare analysis also yields similar results:

Table 4: The welfare cost of the anticipated COVID shock and the insurance premium

	Anticipated	Anticipated & no JRS	No shock
RHs: welfare cost of COVID shock	0.81	1.21	-
PHs: welfare cost of COVID shock	1.18	2.06	-
PHs: idiosyncratic risk insurance premium	1.73	1.81	1.70

Note: Welfare cost (idiosyncratic risk insurance premium) expressed as the percentage of consumption that an agent would be ready to give up in every period to avoid the economic consequences of the COVID-19 outbreak (mute idiosyncratic labor income risks). See section 2.7.

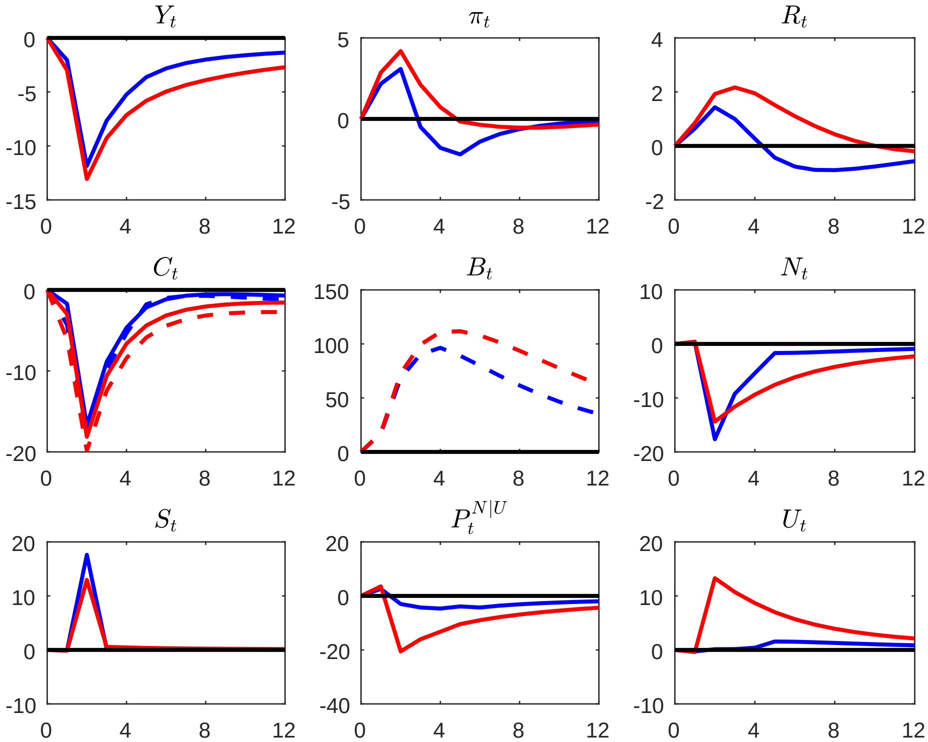

Figure 12: Dynamic response of macroeconomic variables to the anticipated COVID shock.
Notes: Variables expressed in percentage deviation from steady state. Inflation and interest rates annualized. Unemployment, separation and job-finding rate in percentage point deviation from steady state. Horizon in quarters. Shock revealed in period 1, hitting in period 2. Blue: baseline model with anticipated shock. Red: No JRS. Dashed lines: PHs. Plain lines: macro aggregates.

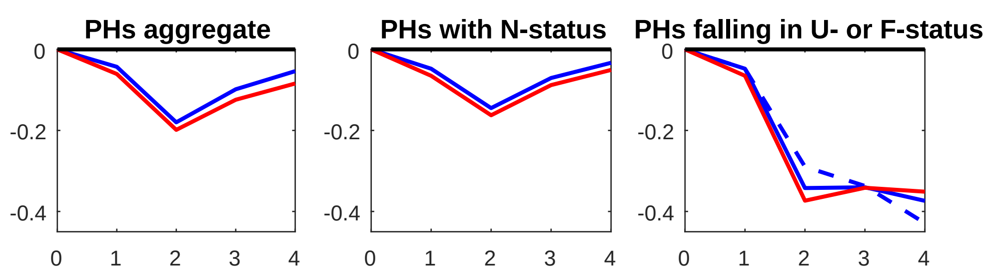

Figure 13: Dynamic response of PHs consumption by employment status (anticipated shock).
Note: Variables expressed as a fraction of consumption before the shock. Left chart: PHs aggregate consumption. Center: PHs with an N-status during the first year following the COVID shock. Right chart: PHs with an N-status when the shock is revealed in period 1. They immediately transitions to and stays with a U (plain line) or F-status (dashed line) when the shock hits in period 2. Horizon in quarters. Blue: Baseline model with anticipated shock. Red: No JRS. Dashed: PHs with F-status.

A.4. Matching consumption, hours, and inflation

While our simple model with two shocks matches the observed dynamics of many untargeted variables, it misses the observed inflation dynamics. In the euro area - as in other economies such as the US - inflation initially remained broadly stable. In 2020, the euro area recorded an inflation rate of 0.3%, which was 0.64 pp lower than its average over the 2013-2019 period, and 0.9 pp lower than its value in 2019. In contrast, our baseline model predicts an increase in inflation during the first year of the pandemic.

We perform a robustness analysis by targeting a fall of 0.9 pp in inflation - in addition to the observed fall in consumption and hours - using a third shock. To match the inflation dynamics, this new shock should have a strong and direct impact on this variable.

We consider two options. First, we relax the assumption that the fall in capital productivity is identical to the fall in labor supply. It is possible that the sectors affected by economic restrictions were less capital-intensive than the others, leading to an over-estimation of the fall in capital productivity, and an over-estimation of the inflationary pressures caused by our supply shock. Second, we consider a cost-push shock. During the early stages of the pandemic, commodity prices collapsed, which is a consideration missing in our model. A negative cost-push shock could capture this effect and generate the fall in inflation that our baseline model fails to reproduce.

Figure 14 shows that the model with a free capital-productivity shock reproduces the dynamics of consumption, hours and inflation and generates similar dynamics for other important macroeconomic variables, apart from the interest rate that falls following the drop in inflation. Crucially, the dynamics of consumption, employment, unemployment and the job-finding rate remain qualitatively unchanged. We reach a similar conclusion with a cost-push shock (results not reported).

The consequence is that the conclusions of our welfare analysis remain valid. In table 5, we show the welfare effects of the COVID shock and JRS to back this claim.

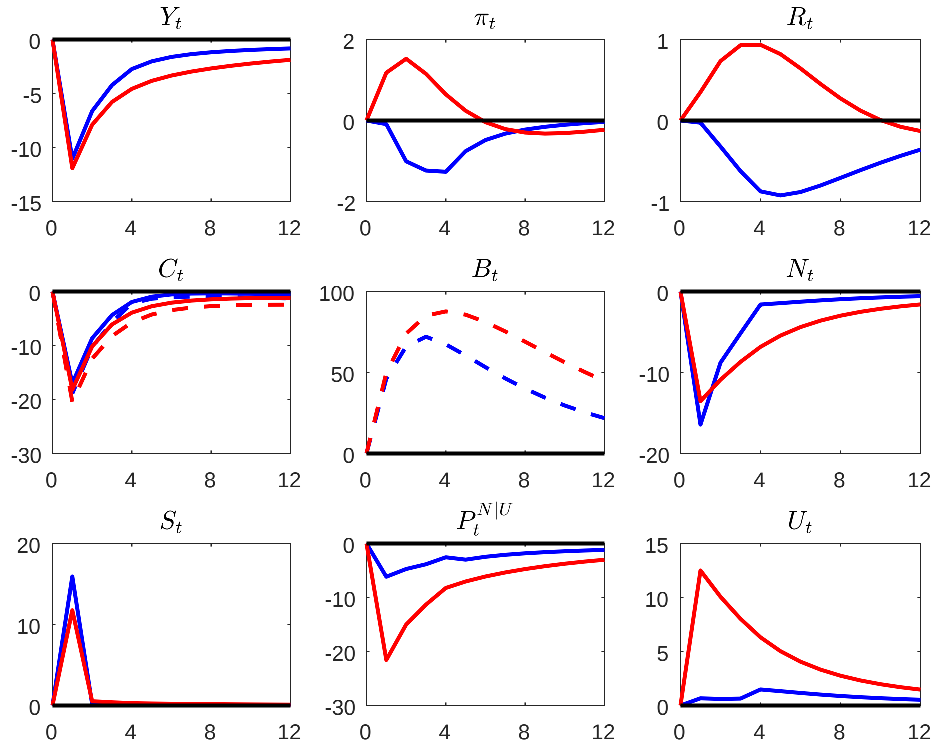

Figure 14: COVID shock with lower drop in capital productivity.
Notes: Variables expressed in percentage deviation from steady state. Inflation and interest rates annualized. Unemployment, separation and job-finding rate in percentage point deviation from steady state. Horizon in quarters. Blue: baseline model with lower drop in capital productivity. Red: No JRS. Dashed lines: PHs. Plain lines: macro aggregates.

Table 5: The welfare cost of the COVID shock and the insurance premium

	Baseline	No JRS	No shock
Lower drop in capital productivity			
RHs: welfare cost of COVID shock	0.59	0.92	-
PHs: welfare cost of COVID shock	1.03	1.76	-
PHs: idiosyncratic risk insurance premium	1.73	1.80	1.70
Cost-push shock			
RHs: welfare cost of COVID shock	0.62	0.98	-
PHs: welfare cost of COVID shock	0.83	1.61	-
PHs: idiosyncratic risk insurance premium	1.71	1.80	1.70

Note: Welfare cost (idiosyncratic risk insurance premium) expressed as the percentage of consumption that an agent would be ready to give up in every period to avoid the economic consequences of the COVID-19 outbreak (mute idiosyncratic labor income risks). See section 2.7.

A.5. JRS benefit generosity

In many countries, JRS benefits tend to be more generous than regular unemployment benefits. Here, we increase the replacement rate for workers covered by JRS by 15 pp (from 55 to 70%). This increase in transfers is targeted at furloughed workers (it does not affect the unemployed) and helps to protect their incomes. For furloughed workers, the combination of higher transfers and high odds of a quick return to employment encourages them to maintain a high level of consumption during the COVID shock (compared to the unemployed), as shown in figure 15. Their consumption losses are much smaller than in the baseline (with JRS but no increase in transfers generosity), as shown in figure 16. Comparing figure 7 and 16, we can see that an increase in furlough benefits only improves the situation of furloughed workers (in the short run).

The overall welfare effect of an increase in JRS benefit generosity depends on who is bearing its extra cost. In the baseline, the increase in public debt leads to an increase in lump-sum taxes that progressively brings the debt to its pre-crisis level. All households, independently of their types or employment status, pay the same tax. In that case, the overall welfare effect is small. PHs register a small gain, on average, as the favorable effect on furloughed workers is partially compensated by higher lump-sum taxes in the future, which has a small adverse effect on their consumption when unemployed. The welfare effect on RHs is virtually zero.

In contrast, if one assumes that RHs pay the cost of the increase in JRS benefit generosity, this policy has a strong welfare-improving effect for PHs: their welfare costs fall to 0.88% of consumption, compared to 0.94% in the baseline. The welfare cost for RHs rises to 0.69% of consumption, compared to 0.67% in the baseline.

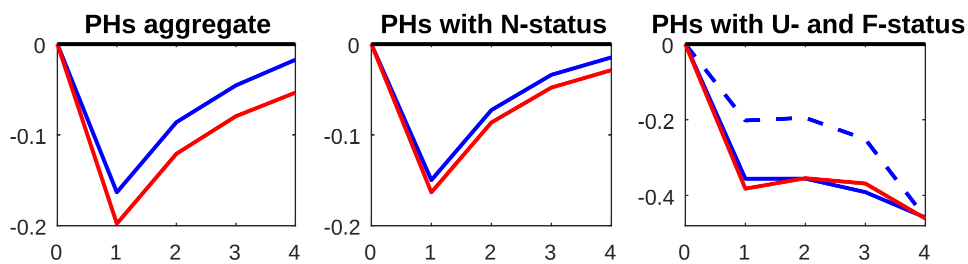

Figure 15: Dynamic response of PHs consumption with increased JRS benefit generosity.
Note: Variables expressed as a fraction of consumption before the shock. Left chart: PHs aggregate consumption. Center: PHs with an N-status during the first year following the COVID shock. Right chart: PHs with an N-status before the shock that immediately transitions to and stays with a U (plain line) or F-status (dashed line). Horizon in quarters. Blue: Baseline model (with increased JRS benefit generosity). Red: No JRS. Dashed: PHs with F-status.

Table 6: The welfare cost of the COVID shock with increased JRS benefit generosity

	Increased JRS generosity	Baseline
PHs and RHs pay more taxes in the future		
RHs: welfare cost of COVID shock	0.67	0.67
PHs: welfare cost of COVID shock	0.92	0.94
PHs: idiosyncratic risk insurance premium	1.71	1.72
RHs only pay more taxes in the future		
RHs: welfare cost of COVID shock	0.69	0.67
PHs: welfare cost of COVID shock	0.88	0.94
PHs: idiosyncratic risk insurance premium	1.70	1.72

Note: Welfare cost (idiosyncratic risk insurance premium) expressed as the percentage of consumption that an agent would be ready to give up in every period to avoid the economic consequences of the COVID-19 outbreak (mute idiosyncratic labor income risks). See section 2.7.

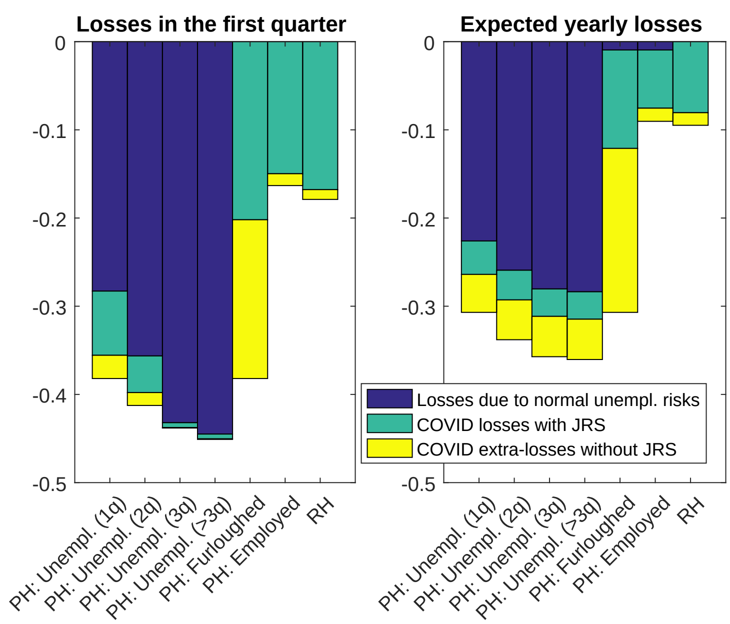

Figure 16: Consumption losses by employment status with increased JRS benefit generosity. LHS: consumption losses in the first quarter for PH and RH by employment status expressed as a fraction of employed PHs' or RHs' consumption at steady state. RHS: expected consumption losses of PHs and RHs over a one-year period (as a fraction of yearly consumption). These costs are conditional on a specific employment status (on the x axis) when the COVID shock hits the economy. Job transition probabilities are then used as weights to compute expected costs in the next three quarters.

A.6. Distortionary and targeted taxes

In our baseline analysis, we use lump-sum transfers paid by all households (independently of their types or employment status) to gradually bring the public debt to its equilibrium level. We perform two robustness checks based on different assumptions.

First, we assume that the government raises the labor tax rate following this simple rule: $\tau_{w,t} = \tau_w + \tau_{wb} B_t^G$. We calibrate the parameter τ_{wb} to generate a similar government debt dynamic than in the baseline analysis. An increase in the labor tax rate causes a slightly more persistent decline in employment. For RHs, this translates into a larger drop in consumption and a higher welfare cost (with and without JRS) when the government raises the labor tax instead of the lump-sum tax (table 7).

In contrast, PHs prefer an increase in the labor tax to an increase in the lump-sump tax. Distortionary labor taxes hurt all households by reducing employment but benefit PHs by decreasing consumption dispersion. The labor tax is paid by employed households only, and thus reduces the income gap between employed and unemployed PHs, which also reduces the idiosyncratic risk insurance premium.

Second, we assume that lump-sum taxes are paid by employed households only. While this may be an unrealistic assumption, it illustrates the fact that the favourable effect of distortionary labor taxes come from a drop in consumption dispersion for PHs. The fact that the idiosyncratic risk insurance premium (with an increase in the labor tax and JRS activated) is even lower than at its steady state may come as a surprise. There are two effects playing in opposite directions: (1) the fact that employed PHs cut consumption (with higher labor taxes) lowers consumption dispersion and (2) the fact that there are more furloughed/unemployed households on lower consumption levels increases consumption dispersion. When JRS are combined with an increase in the labor tax, the first effect dominates and the idiosyncratic risk premium diminishes (below its steady-state level).

Table 7: The welfare cost of the COVID shock and taxes

	With JRS	No JRS	No shock
Lump-sum taxes on all (baseline)			
RHs: welfare cost of COVID shock	0.67	1.02	-
PHs: welfare cost of COVID shock	0.94	1.70	-
PHs: idiosyncratic risk insurance premium	1.72	1.80	1.70
Distortionary labor tax			
RHs: welfare cost of COVID shock	0.70	1.07	-
PHs: welfare cost of COVID shock	0.88	1.58	-
PHs: idiosyncratic risk insurance premium	1.68	1.72	1.70
Lump-sum taxes on employed only			
RHs: welfare cost of COVID shock	0.68	1.04	-
PHs: welfare cost of COVID shock	0.87	1.56	-
PHs: idiosyncratic risk insurance premium	1.68	1.72	1.70

Note: Welfare cost (idiosyncratic risk insurance premium) expressed as the percentage of consumption that an agent would be ready to give up in every period to avoid the economic consequences of the COVID-19 outbreak (mute idiosyncratic labor income risks). See section 2.7.

A.7. Standard shocks

Here, we show the dynamic response of important macroeconomic variables to shocks to the job-separation rate (figure 17), aggregate demand (figure 18) and the monetary policy rate (figure 19). The results displayed below show that PHs are especially vulnerable to shocks on the labor market. An increase in the job-separation rate actually causes a much larger drop in PHs' consumption due to the combination of two effects: (1) a larger fraction of unemployed PHs earning lower incomes (a disposable income channel) and (2) a drop in consumption by employed PHs and unconstrained unemployed PHs triggered by worse employment prospects (a precautionary savings channel).

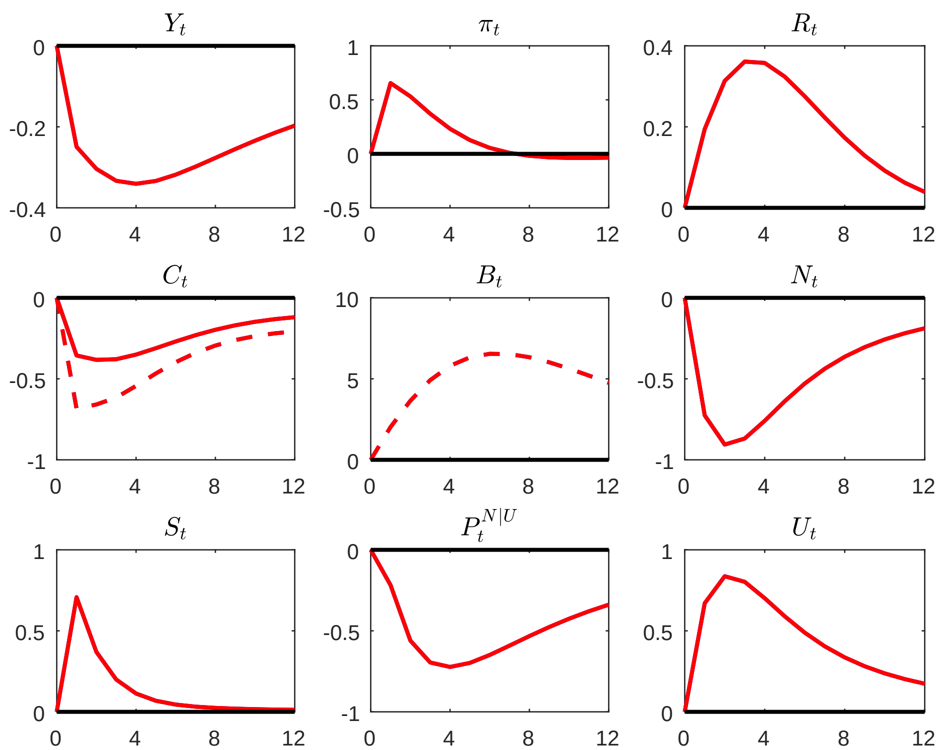

Figure 17: Job-separation rate shock.
Note: Variables expressed in percentage deviation from steady state, inflation and interest rates annualized. Unemployment, separation and job-finding rate in percentage point deviation from steady state. Horizon in quarters. Dashed lines: PHs. Plain lines: macro aggregates.

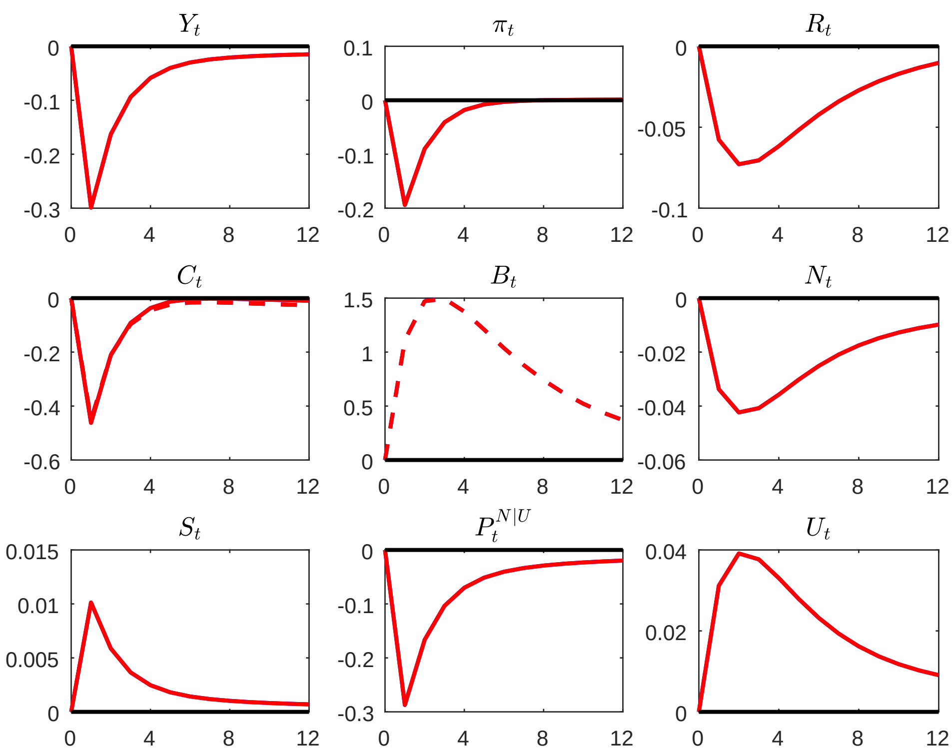

Figure 18: Demand shock.

Note: Variables expressed in percentage deviation from steady state, inflation and interest rates annualized. Unemployment, separation and job-finding rate in percentage point deviation from steady state. Horizon in quarters. Dashed lines: PHs. Plain lines: macro aggregates.

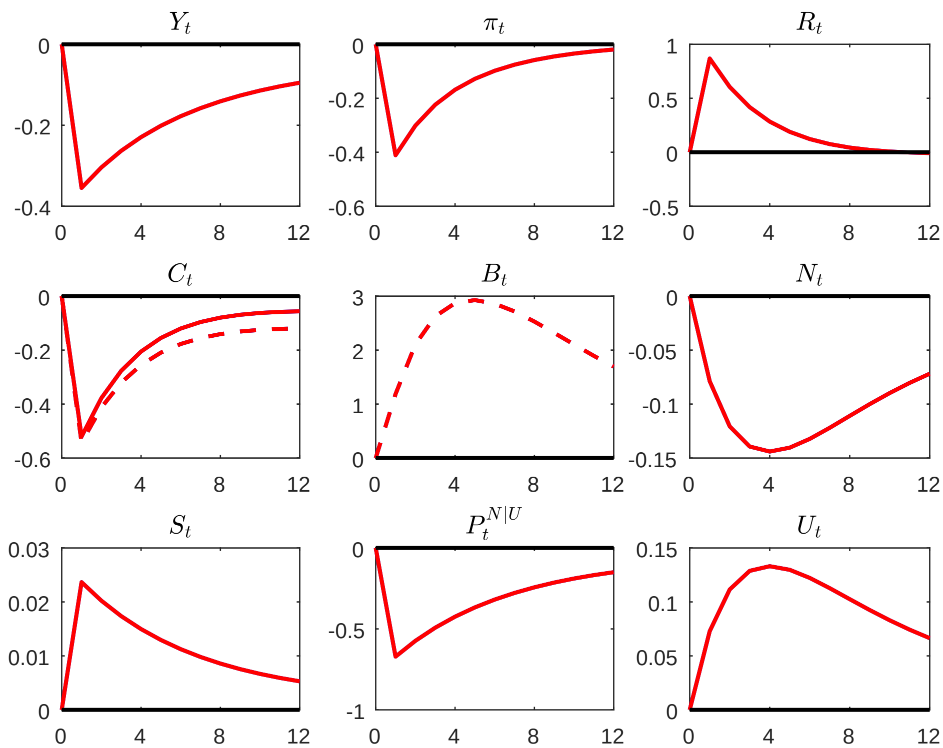

Figure 19: Monetary policy shock.

Note: Variables expressed in percentage deviation from steady state, inflation and interest rates annualized. Unemployment, separation and job-finding rate in percentage point deviation from steady state. Horizon in quarters. Dashed lines: PHs. Plain lines: macro aggregates.

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