# Unemployment Insurance and Unemployment Volatility


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### Abstract

We develop a search and matching model where idiosyncratic risk and liquidity constraints induce precautionary savings. In this economy, aggregate TFP shocks induce fluctuations in the stochastic discount factor by affecting idiosyncratic uncertainty. This propagation mechanism successfully generates sufficient volatility in unemployment rates to match the US data, along with a unit elasticity of both wages and opportunity cost of work to productivity. The model generates two key predictions that are in contrast with those obtained in search and matching models with standard amplification mechanisms: first, the model successfully replicates the fact that fluctuations in the market value of firms are mostly driven by discount factors rather than cashflows. Second, it predicts that higher unemployment insurance smooths the impact of shocks in recessions. Evidence based on a panel of OECD countries validates the hypothesis that unemployment benefits operate as automatic stabilisers.



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# 1 Introduction

The debate on the determinants of unemployment fluctuations initiated by Shimer (2005) is still far from being resolved. Prominent solutions to the unemployment volatility puzzle based on the assumption of sticky wages have been criticized by Pissarides (2009) and Haefke, Sonntag, and van Rens (2013) on the grounds that they violate the cyclicality of the wages for the new hires, which is the only margin that matters to generate volatile employment in search and matching models. More recently, Karabarbounis and Chodorow-Reich (2014) provide evidence that the opportunity cost of employment is highly procyclical. Under their central estimate of a unit elasticity to productivity shocks, all of the most successful mechanisms of amplification proposed in the literature collapse. Finally, Hall (2015) notices that all mechanism of amplification proposed so far in the literature produce volatile unemployment dynamics by generating volatility in asset prices, which in turn, is driven by volatility in profits. Similar conclusions are reached by Ljungqvist and Sargent (2015), who show that any mechanism of amplification can be thought of as a way to reduce the fundamental surplus of a match, which in turn makes the surplus and the profits highly volatile. As noted by Hall (2015), all these mechanism violate the consensus in the finance literature that asset price volatility is driven by the discount factor, not by profits (see Cochrane (2011)).

We introduce risk-aversion, idiosyncratic risk and liquidity constraints in the spirit of Guerrieri and Lorenzoni (2009) into an otherwise standard search and matching model; the combination of these three ingredients is necessary to generate endogenous fluctuations in the discount factor. A nice feature of our framework is that in the special case where workers are risk neutral, the models boils down to the textbook model. The model generates substantial volatility in asset prices, in spite of a relatively large surplus calibration and small volatility in profits. In turn, fluctuations in asset prices generate sufficient volatility in unemployment to match the US data. These results are obtained under the assumption of a unit elasticity of the opportunity cost of work to productivity and an elasticity of the wages for newly hired workers that is in line with the data.

A testable implication of the model is that unemployment insurance operates as an automatic stabilizer, that is, it reduces the sensitivity of unemployment, consumption and output to adverse shocks. This prediction is in contrast with the results that arise in the canonical search and matching framework, where higher unemployment benefits make unemployment more sensitive to either expansionary or contractionary productivity shocks. Using quarterly panel data for 20 OECD countries over the period 1975Q1-2014Q2, we show that higher benefit replacement ratios decrease the impact of recessions on the unemployment rate, output and consumption. Recent work by Di Maggio and Kermani (2015) also provides evidence in this direction exploiting heterogeneity in unemployment insurance across US regions and variation in the industrial composition.

Our paper is related to Hall (2015), with whom we share the conclusion that volatility in unemployment rates is driven by the discount factor. A key difference with respect to Hall (2015), is that volatility in the discount factor follows an exogenous stochastic process in his model, while it arises endogenously in our setup. Endogenizing fluctuations in the discount factor has profound implications on the propagation of shocks to the discount rate. Hall (2015) shows that an exogenous shock to the discount factor in the baseline search and matching model produces large effect only insofar as wages are very rigid. In our framework, volatility in the discount factor arises with perfectly flexible wages, and is therefore compatible with evidence on the volatility of the wages for newly hired workers. In addition, because fluctuations in the discount factor are driven by idiosyncratic risk in our model, unemployment benefits operate as automatic stabilizers, whereas in Hall (2015) unemployment benefits operate as in the standard search and matching model, by reducing the steady state surplus.

The reminder of the paper is as follows: Section (2) presents the model, Section (3) presents the empirical analysis, and Section (4) concludes.

## 2 Model

The economy is populated by a unit measure of workers; an equal measure of potential firms (referred to as "islands"); and one government. The government takes no other actions than administrating the unemployment insurance system. Time is discrete and the planning horizon is infinite, $t = 0, 1, 2, \ldots$ As in Guerrieri and Lorenzoni (2009), each time period is divided into three sub periods, $s = 1, 2, 3$. An arbitrary time/sub period pair is denoted $(t, s)$. The single commodity produced in the economy is used for consumption and investment, and is perishable across time periods, but storable within time periods (i.e. across sub periods).

**Households** A representative household enters period $(t, 1)$ with resources $y_{t,1}$. Each choice variable is dated in accordance with the timing of its action. The household derives no utility from consumption in this time/sub period pair so $c_{t,1} = 0$. She observes all aggregate shocks and spends her resources on either liquid assets, $m_{t,1}$, at a price normalized to one, or on illiquid assets, $q_{t,1}$, at price $J_{t,1}$. Ownership of illiquid assets are claims to the dividend stream generated by a diversified portfolio of islands.[1] The budget constraint in period $(t, 1)$

[1] As a consequence there is no idiosyncratic investment risk.

is straightforwardly given by

$$y_{t,1} = J_{t,1}q_{t,1} + m_{t,1}. \tag{1}$$

In period $(t, 2)$ the households travels to a randomly chosen island. A measure $n_{t,2}$ of islands are *active*, while the complementary measure, $1-n_{t,2}$ are *idle*. If the household travels to an active island she has the possibility of working and producing $z_{t,2}$ units of the output good, earning net wages $w_{t,2}(1-\tau_{t,2})$. The island then makes profits $z_{t,2} - w_{t,2}(1-\tau_{t,2})$, which is paid out to firm owners in period $(t, 3)$, $d_{t,3}$. If the household instead travels to an idle island, there are no production possibilities and the household instead receives unemployment benefits $\mu \times w_{t,2}$, $\mu \in [0, 1)$. We assume that the law of large numbers holds such that a household travels to an active island with probability $n_{t,2}$, and an idle island with probability $(1-n_{t,2})$. In period $(t, 2)$ the household may consume, trade the liquid asset, but, importantly, she may not trade the illiquid asset. The budget constraints in period $(t, 2)$ are therefore,

$$y_{t,2} = c_{t,2} + m_{t,2}, \tag{2}$$

$$m_{t,2} \geq 0 \tag{3}$$

with $y_{t,2} = m_{t,1}(1 + r_{t,2}) + w_{t,2}$ if the household travelled to an active island, and $y_{t,2} = m_{t,1}(1 + r_{t,2}) + \mu w_{t,2}$ if the island happened to be idle.

In period $(t, 3)$ the household may again trade the liquid asset $m_{t,3}$, and consume $c_{t,3}$. The budget constraint is therefore

$$y_{t,3} = c_{t,3} + m_{t,3}, \tag{4}$$

with $y_{t,3} = m_{t,2}(1+r_{t,3})+q_{t,1}d_{t,3}$, and where $d_{t,3}$ denotes dividend payments from investments in the illiquid asset, which, to reiterate, equal island profits. Thus income in the beginning of period $t + 1$ is given by, $y_{t+1,1} = m_{t,3}(1 + r_{t+1,1}) + q_{t,1}J_{t+1,1}(1-\delta)$, where $\delta$ represents a "separation rate" by which the household's diversified portfolio depreciates.

The household makes investment and consumption decisions to maximize the objective function

$$E\sum_{t=0}^{\infty} \beta^t \{u(c_{t,2}) + \psi c_{t,3}\}. \tag{5}$$

Before we derive the first order conditions associated with the above optimization problem, a few remarks are in order concerning the underlying assumptions. First, as islands, and not workers *per se*, are either active or idle, the distribution of a household's future employment status is independent of the household's current employment status. Thus from the household's perspective unemployment spells are *iid*. Second, even though idiosyncratic unemployment risk poses a serious threat to a household (and possibly instills a precautionary saving motive), the fact that utility is linear in consumption in $s = 3$ implies, together with the first remark, that the wealth distribution will be degenerate across, but not within, time periods (cf. Lagos and Wright (2005)). This assumptions allows us to analyze the consequence of idiosyncratic employment risk while still maintaining a very tractable framework. Lastly, as illiquid assets are not liquidatable across sub periods, any rise in idiosyncratic risk will (likely) manifest itself as a rise in demand for liquid assets, and a fall in demand for illiquid assets. This is the main source of propagation in the model.

The first order conditions are given by

$$\psi = \beta E_t u'(c_{t+1,2})(1 + r_{t+1,1}), \tag{$m_t, 3$}$$

$$u'(c_{t,2}) = \psi(1 + r_{t,3}) + \lambda_{t,2}, \tag{$m_t, 2$}$$

$$1 = (1 + r_{t,2}), \tag{$m_t, 1$}$$

$$J_{t,1} = \frac{\psi}{E_t[u'(c_{t,2})]} d_{t,3} + \beta E_t \frac{u'(c_{t+1,2})}{u'(c_{t,2})} J_{t+1,1}(1 - \delta), \tag{$q_t, 1$}$$

where $\lambda_{t,2}$ is the Lagrange multiplier associated with the non-negativity constraint on $m_{t,2}$.

**Entrepreneurs** In period $(t, 1)$ an entrepreneur has the possibility of activating an idle island by paying a fixed cost, $\kappa$. By doing so an idle island will become active with probability $h_{t,1}$. The island remains active in the subsequent time period with probability $(1 - \delta)$. The entrepreneur may then sell the claims to the dividend stream of the island at price $J_{t,1}$. Free entry ensures that

$$\kappa = h_{t,1} J_{t,1}. \tag{6}$$

Thus, since entrepreneurs make zero profits they do not interfere with the equilibrium other than to arbitrage away non-Marshallian profits. The total number of fixed costs paid in the economy is denoted $v_{t,1}$.

**Islands** In the beginning of period $(t, 1)$ there is a measure of $\hat{u}_{t,1} = 1 - n_{t-1,2} + \delta n_{t-1,2}$ idle islands. Given $v_{t,1}$, the measure of successfully activated islands is given by the constant returns to scale matching function

$$H_{t,1} = H(v_{t,1}, \hat{u}_{t,1})$$

Thus, the probability of an entrepreneur successfully activating an island is given by

$$h_{t,1} = h(\theta_{t,1}) = \frac{H_{t,1}}{v_{t,1}}, \quad \text{with} \quad \theta_{t,1} = \frac{v_{t,1}}{\hat{u}_{t,1}}.$$

The measure of active islands in period $n_{t,2}$ is therefore given by

$$\begin{aligned} n_{t,2} &= H_t + (1-\delta)n_{t-1,2}, \\ &= f(\theta_{t,1})\hat{u}_{t,1} + (1-\delta)n_{t-1,2}. \end{aligned}$$

**Wage setting** In order to determine wages, $w_{t,2}$, we will define two asset values, $V_{t,1}$ and $U_{t,1}$ as,

$$\begin{aligned} V_{t,1} &= \frac{\psi}{E_t[u'(c_{t,2})]} w_{t,2}(1-\tau_{t,2}) + \beta E_t \frac{u'(c_{t+1,2})}{u'(c_{t,2})}((1-\delta+\delta f(\theta_{t+1,1}))V_{t+1,1} + \delta(1-f(\theta_{t+1,1}))U_{t+1,1}), \\ U_{t,1} &= \frac{\psi}{E_t[u'(c_{t,2})]} \mu w_{t,2} + \beta E_t \frac{u'(c_{t+1,2})}{u'(c_{t,2})}(f(\theta_{t+1,1}))V_{t+1,1} + (1-f(\theta_{t+1,1}))U_{t+1,1}). \end{aligned}$$

Wages are then set to maximize the Nash product

$$J_{t,1}^{1-\eta}(V_{t,1} - U_{t,1})^{\eta} \tag{7}$$

where $\eta$ denotes the "worker's" bargaining power.

It should be emphasized here that $V_{t,1} - U_{t,1}$ is not the surplus accruing to a household from working in period $(t, 2)$. Since employment status is *iid* the actual surplus is quite trivially given by $u(c^e_{t,2}) - u(c^u_{t,2})$, where $e$ denotes employment, and $u$ unemployment. However, since unemployment benefits are given as a fraction of the wage earned when working, *any* wage is in the worker's "bargaining set". And the wage that satisfies (7) will by construction ensure that $J_{t,1} \geq 0$. Thus the wage protocol derived from (7) satisfies bilateral rationality. In addition, and as will become apparent later, this wage-setting protocol has the salient feature of yielding an almost unit elasticity of wages with respect to productivity (Pissarides (2009)), and, therefore, an equal elasticity of the worker's "outside option", $\mu w_{t,2}$ (Karabarbounis and Chodorow-Reich (2014)).

**Equilibrium** A competitive equilibrium is a sequence of prices $\{J_{t,s}, r_{t,s}, w_{t,s}\}_{t,s}$, allocations $\{n_{t,s}, \theta_{t,s}, c_{t,s}, v_{t,s}, q_{t,s}, m_{t,s}\}_{t,s}$, and taxes $\{\tau_{t,s}\}_{t,s}$ such that given prices

*(i)* The allocation $\{c_{t,s}, q_{t,s}, m_{t,s}\}_{t,s}$ solves the household's problem.

*(ii)* Employment follows the law of motion

$$n_{t,2} = H_t + (1-\delta)n_{t-1,2}.$$

*(iii)* Wages satisfy $\eta J_{t,1} = (1-\eta)(V_{t,1} - U_{t,1})$.

*(iv)* Free entry, $\kappa = h(\theta_{t,1})J_{t,1}$.

*(v)* Equity markets clear, $q_{t,1} = n_{t,2}$.

*(vi)* Liquid asset markets clear, $m_{t,3} = 0$.

*(vii)* Taxes are given by

$$\tau_{t,2} = \frac{(1-n_{t,2})}{n_{t,2}}$$

To see that market clearing is achieved notice that $r_{t,3} = 0$, since the output good is storable across sub periods. Consolidating the household's budget constraints yields, in expectation,

$$J_{t,1}q_{t-1,1}(1-\delta) = J_{t,1}q_{t,1} + E_t[c_{t,2} + c_{t,3}] - z_{t,2}n_{t,2}$$

Since $q_{t,1} = n_{t,2}$, and since $J_{t,1} = v_{t,1}\kappa/H_{t,1}$, it follows that

$$y_t = E_t[c_{t,1} + c_{t,2}] + i_t,$$

with $i_t = \kappa v_{t,1}$. Thus Walras law implies that goods markets clear.

**Calibration** The model is calibrated to target the US economy at a quarterly frequency. The discount factor, $\beta$, is set to $1.03^{-1/4}$ which corresponds to a 3 percent annual real interest rate. The logarithm of productivity $\ln z_t$ follows an AR(1) process according to

$$\ln z_t = \alpha \ln z_{t-1} + \varepsilon_t, \quad \varepsilon \sim \mathcal{N}(0, \sigma^2) \tag{8}$$

We set $\alpha$ to 0.9 and $\sigma$ to 0.009. The utility function is given by

$$u(c) = \frac{c^{1-\gamma} - 1}{1 - \gamma},$$

and the elasticity of intertemporal substitution, $1/\gamma$, is set to 1/3.

The matching function is of a standard Cobb-Douglas type, and given by $H(v_t, \hat{u}_t) = \varphi \hat{v}_t^{\omega} \hat{u}_t^{1-\omega}$. The elasticity of job finding with respect to labor market tightness, $\omega$, is set to 0.6.[2] The efficiency of the matching function, $\varphi$, is such that the steady state unemployment rate is 5.83 percent. As a consequence, the associated job finding probability, $f(\theta_s s)$, is equal to 62 percent, implying an expected "island idle duration" of around 7.5 weeks.[3] The separation rate, $\delta$, is equal $4 \times 0.034$ which is in line with the average found in the data.

The replacement rate is set to 50% as in Chetty (2008). The workers' bargaining power, $\eta$, is set to 0.4, which satisfies the Hosios condition. The resulting steady state wage is around 0.9 yielding a quite high profit margin of about 10%.

Given a labor market tightness normalized to one, the cost of posting a vacancy $\kappa$ is set to $h(1)J_{ss}$, which implies a value of $\kappa$ of 0.6.[4]

Lastly, the marginal utility in sub period 3, $\psi$, is set to satisfy three conditions. The first two are the inequalities

$$u'(y^e_{t,2}) > \psi > u'(y^u_{t,2}),$$

which ensure that the borrowing constraint is always binding for unemployed households, but never binding for the employed. The third condition to pin down $\psi$ is to set it such that $\psi = u'^g \mu w_{ss} - i_{ss}$. In the calibration we set $g$ equal to 0.5, resulting in $\psi = 4.32$.[5]

The calibrated parameter values are summarized in Table 2.

[2] An elasticity of 0.6 is somewhere in between numbers commonly used in the literature (see Petrongolo and Pissarides (2001) for a survey). Hall (2005) uses an elasticity of 0.765, Hagedorn and Manovskii (2008) use an elasticity of around 0.55, and **?** of 0.28.

[3] According to the Bureau of Labor Statistics, the median unemployment duration in the United States averages to 8.5 weeks over the years 1967 to 2014, and 7.1 weeks excluding the financial crisis.

[4] Notice that it is possible to multiply the steady state value of $\theta$ with a factor of 2 and $\varphi$ with a factor of $2^{\omega}$ without altering the steady state values of $f$ and $n$. The steady state value of $h$ and $\kappa$ are then halved. Thus, as in Shimer (2005), the steady state value of $\theta$ is intrinsically meaningless and can be normalized.

[5] This implies a drop in consumption upon unemployment of around 37%. This is high relative to the data, which suggests levels of $10 - 15\%$. However, the drop in consumption in the data is very persistent, and virtually unchanged even after an individual has found a new job. Since the expected duration of unemployment in the model is one quarter only, a drop of 37% does not appear unreasonable.

Table 1: Calibrated parameters

| Parameter | Interpretation | Value | Source/steady state target |
|---|---|---|---|
| $\gamma$ | Inverse of EIS | 3 | Convention |
| $\beta$ | Discount factor | 0.993 | Annual real interest rate of 3% |
| $\varphi$ | Efficiency of matching | 0.622 | Unemployment rate of 5.83% |
| $\delta$ | Separation rate | 0.102 | Literature/JOLTS |
| $\omega$ | Workers bargaining power | 0.4 | Steady state profit margin of 3.3% |
| $\eta$ | Elasticity of $f(\theta)$ | 0.6 | Literature |
| $\kappa$ | Vacancy posting cost | 0.595 | Steady state $\theta$ normalized to one |
| $\psi$ | Linear utility function | 4.32 | $\psi = u'(e^{0.5}\mu w_{ss} - i_{ss})$ |
| $\mu$ | Replacement rate | 0.5 | Chetty (2008) |

*Notes.* This table lists the parameter values of the model. The calculations and targets are described in the main text. One period in the model corresponds to one quarter.

The main equations of the model are given by (dropping $s$ notation)

$$
\begin{aligned}
J_t &= \frac{\psi(z_t - w_t)}{n_t\psi + (1-n_t)u'(c_t^u)} + \beta E_t\left[\frac{(n_{t+1}\psi + (1-n_{t+1})u'(c_{t+1}^u))}{(n_t\psi + (1-n_t)u'(c_t^u))}(1-\delta)J_{t+1}\right],\\
S_t &= \frac{\psi w_t(1-\mu/n_t)}{n_t\psi + (1-n_t)u'(c_t^u)} + \beta E_t\left[\frac{(n_{t+1}\psi + (1-n_{t+1})u'(c_{t+1}^u))}{(n_t\psi + (1-n_t)u'(c_t^u))}(1-\delta)(1-f(\theta_{t+1}))S_{t+1}\right],\\
S_t &= \frac{\eta}{(1-\eta)}J_t,\\
\ln z_t &= \alpha \ln z_{t-1} + \varepsilon_t,\\
\kappa &= h(\theta_t)J_t,\\
n_t &= (1-n_{t-1}+\delta n_{t-1})f(\theta_t) + (1-\delta)n_{t-1},
\end{aligned}
$$

with $c_t^u = \mu w_t - \kappa v_t$, and $S_t = V_t - U_t$.

If $\gamma$ is set to zero then $u'(c_t^u) = \psi = 1$ and the above equations collapse to

$$
\begin{aligned}
J_t &= z_t - w_t + \beta E_t\left[(1-\delta)J_{t+1}\right],\\
S_t &= w_t(1-\mu/n_t) + \beta E_t\left[(1-\delta)(1-f(\theta_{t+1}))S_{t+1}\right],\\
S_t &= \frac{\eta}{(1-\eta)}J_t,\\
\ln z_t &= \alpha \ln z_{t-1} + \varepsilon_t,\\
\kappa &= h(\theta_t)J_t,\\
n_t &= (1-n_{t-1}+\delta n_{t-1})f(\theta_t) + (1-\delta)n_{t-1},
\end{aligned}
$$

which is the standard DMP model.

**Results** Figure 2 illustrates the impulse responses of macroeconomic aggregates with respect to a standard deviation shock to labor productivity. The solid line depicts the benchmark case outlined above, while the dashed line the conventional case in the literature with $\gamma = 0$.

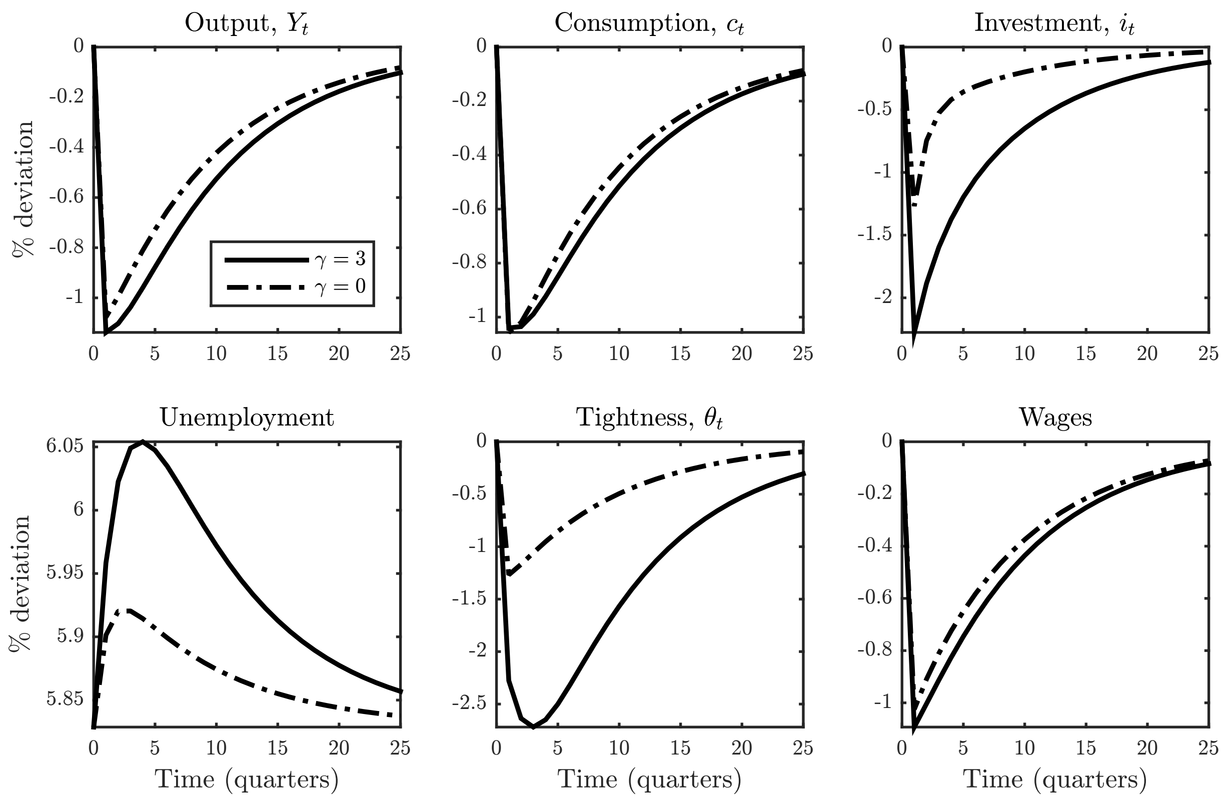


Figure 1: Impulse response of the economy with respect to a standard deviation shock.

## 3 Empirical analysis

A testable implication of the model is that unemployment benefits operate as automatic stabilizers, that is, they smooth the reaction of key macroeconomic variables to adverse shocks. This prediction is in contrast with those obtained in any version of the standard search and matching framework where amplification is achieved through a small surplus calibration. Indeed, as noted by Ljungqvist and Sargent (2015), any successful amplification mechanism proposed so far in the literature can be represented and understood as a means to reduce what they call the 'fundamental surplus'.

We investigate how the generosity of unemployment benefits affects the response of unemployment rates, as well as aggregate output per capita and consumption per capita in

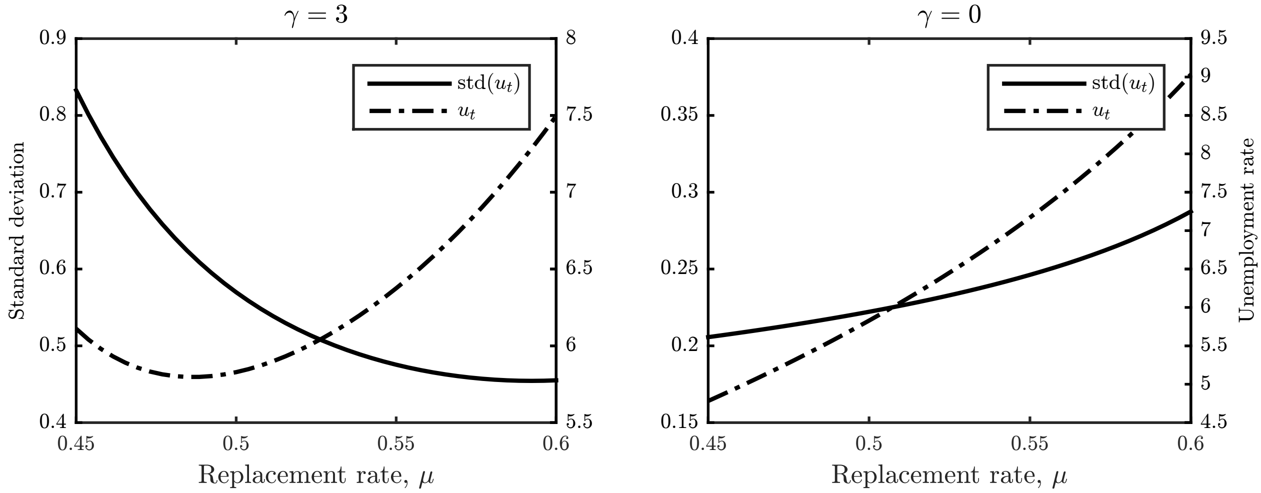


Figure 2: Unemployment rate (solid line, right axis) and unemployment volatility with respect to the replacement rate, $\mu$.

recessions, using a dataset that comprises quarterly time series for 20 OECD countries from 1975Q1 to 2014Q2.[6] Specifically, we test for the sign and significance of an interaction term between a recession dummy and the level of unemployment benefits, which is fixed throughout recessionary episodes to the value that preceeds the start of the each recession. The reason for fixing the level of unemployment benefits is because we don't want the estimated interaction coefficient to be confounded by the endogenous response of benefits to the evolution of unemployment in recessions. We measure recessions as times in which real GDP has been contracting for at least two consecutive quarters. If any two recessionary episodes are separated by less than a year of real GDP growth (double-dip recession), we keep the level of benefits fixed at value that precedes the start of the first recession. We count a total of 127 recessions in our sample and 424 associated quarters of contraction in economic activity.

In accordance with the model, we measure the generosity of the benefits system by the gross replacement ratio, which is defined as the ratio of gross benefits payments over previous gross earnings. We control for other shocks affecting all countries at a time by means of year time dummies. We also control for time variation in other labor market institutions, which is a source of heterogeneity that, if omitted, could potentially confound our results. Specifically, these control variables include the duration of unemployment benefits, employment protection legislation, union coverage, union density and coordination in wage bargaining. Finally, we control for unobserved heterogeneity and its potential time-variation using country fixed effects and two-year country-specific time dummies. We emphasize that

[6]The countries in the sample are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States.

by saturating the model with two-year country-specific time dummies, we are imposing a very demanding specification, which operates as semi-parametric detrending. Because the unemployment time series typically exhibits large persistent swings about the mean and the consumption and GDP series exhibit persistent fluctuations around their trend, this way of detrending effectively minimizes serial correlation in the residuals.

The baseline regression takes the form:

$$X_{it} = \alpha_i + \delta_1 RR_{it} + \delta_2 REC_{it} + \delta_3 (REC \times RR\_inst)_{it} + \delta_4 Z_{it} + \delta_y + \zeta_{i,2y} + \epsilon_{it},$$

where $X_{it}$ captures the main dependent variable, $i = \{1, ..., 20\}$ denotes a country, $t$ denotes a one-quarter time interval, $RR$ denotes the gross replacement rate, $REC$ denotes a recession dummy, $REC \times RR\_inst$ captures the interaction between the recession dummy and the level of unemployment insurance in the quarter preceding the recession, $Z$ is a vector of control variables, $\alpha_i$ is the fixed effect for the $i^{th}$ country, $\delta_y$ are year time-dummies, $\zeta_{i,2y}$ is a country specific two-year time dummy and $\epsilon_{it}$ is an error term. Sources and details about the construction of the data series are relegated to the appendix. Identification of the causal effect of benefits in recession, $\delta_3$, is based on the assumption that recessions are 'random' conditional on the unobservable country fixed-effects and the vector of additional controls.

**Remark 1.** *Some thoughts on how strong the identification assumption is. Once we control for country-specific trends and institutions, what is left to explain are unemployment deviations from trend at some (high) frequency. Now, the state of the cycle will correlate with the incidence of recessions, with recessions being more likely to occur when the business cycle is at the peak of an expansionary phase. So recessions cannot be random conditional on this set of controls. Yet we also control for one or two lags of gdp growth in some specifications, which should carry over information on the state of the business cycle. I would argue that it is mostly these gdp controls that lead validity to the identification of the causal effect.*

### 3.1 Regressions

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABLES | urate | | | | ln(cons/pop) | | | | ln(GDP/pop) | | | |
| benefits | 0.847* | 0.971** | 0.906* | 0.955** | -0.004 | -0.011 | -0.011 | -0.011 | -0.057*** | -0.069*** | -0.070*** | -0.068*** |
| | (0.449) | (0.468) | (0.465) | (0.467) | (0.015) | (0.015) | (0.015) | (0.015) | (0.013) | (0.014) | (0.013) | (0.012) |
| interaction term (inst.) | -0.371*** | -0.349*** | -0.350*** | -0.405*** | 0.009** | 0.009** | 0.009** | 0.011*** | 0.005 | 0.007* | 0.007* | 0.007** |
| | (0.120) | (0.120) | (0.120) | (0.122) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.003) |
| recession dummy | 0.063* | 0.062* | 0.061* | 0.091** | -0.005*** | -0.005*** | -0.005*** | -0.006*** | -0.007*** | -0.007*** | -0.007*** | -0.007*** |
| | (0.036) | (0.037) | (0.036) | (0.037) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Labor mkt institutions | no | yes | yes | yes | no | yes | yes | yes | no | yes | yes | yes |
| Lag 1 of gdp growth | | | -0.001 | -0.658 | | | 0.009 | 0.031* | | | 0.104*** | 0.190*** |
| | | | (0.396) | (0.460) | | | (0.016) | (0.018) | | | (0.016) | (0.017) |
| Lag 2 of gdp growth | | | | -1.384*** | | | | 0.051*** | | | | 0.189*** |
| | | | | (0.460) | | | | (0.017) | | | | (0.017) |
| Countries FE | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Years FE | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Country-I 2-year dummies | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Constant | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Observations | 3,160 | 3,160 | 3,140 | 3,120 | 3,160 | 3,160 | 3,140 | 3,120 | 3,160 | 3,160 | 3,140 | 3,120 |
| Number of countries | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 3: Standard errors are robust to heteroskedasticity and first order serial correlation at the country level.

Table 2 reports regression results using the level of the unemployment rate, the log of GDP per capita and the log of consumption per capita as dependent variables. We obtain variables per capita dividing by the working age population. This is a standard way to remove low-frequency variations in the data that are related to population growth, which is assumed to be zero in the theoretical model.

The first four columns report unemployment regressions, starting with a simple specification that includes a limited number of independent variables, namely unemployment benefits, recessions and the interaction coefficient, controlling for country fixed effects as well as aggregate and country-specific time effects. This simple specification shows that unemployment benefits significantly increase the long run unemployment mean, in line with the predictions of the model. Furthermore, the average unemployment rate is significantly higher in recessions, and the interaction coefficient is negative and significant at the 1% confidence level. The second column shows that these results remain substantially unchanged when adding a vector of control for labor market institutions. The only difference is that the positive effect of unemployment insurance on the long run unemployment rate increases its significance to the 5% confidence level.

A negative interaction coefficient implies that unemployment increases by less in recessions, when countries enter recessions with higher unemployment benefits. This could be because of a causal effect, i.e., benefits stabilise the economy, or it could just be that unemployment benefits happened to be lower at times when recessions have been more severe, in which case, the negative interaction coefficient is confounding the effect of some omitted variable. To rule out this possibility, we build on this second specification by adding one and two lags of GDP growth as a control. The results, reported in the third column, show that the estimated interaction coefficient is still negative and significant, and bigger in magnitude, suggesting that the effect captured by the estimated interaction parameter is indeed causal. We also note in the fourth colum that only the second lag of gdp growth is significant, and in this specification the positive effect of recessions on the rate of unemployment becomes significant at the 5% confidence level. Taking this model as our favourite specification, we conclude that the cyclical component of the rate of unemployment is approximately 0.1 percentage points higher at times when GDP is contracting. Increasing the replacement ratio by 10 percentage points, which is approximately equal to one standard deviation in our sample, would lessen the increase in the unemployment rate in recessions by about 0.04 percentage points.

Columns 5 to 8 report regressions for the log of consumption per capita as a dependent variable. In the theoretical model, unemployment benefits attenuate the increase of unemployment in recessions by smoothing the fall in consumption. So we can empirically test for this mechanism by inspecting the sign and significance of the coefficients associated with the recession dummy and the interaction variable discussed above. In analogy with the previous unemployment regressions, we report again four specifications building gradually on the number of controls. In all the regressions, recessions are found to lower the average level of consumption by about half a percentage point, and these results are always significant with 1% confidence. Most importantly, consumption decreases by less in recessions if the benefits replacement ratio is higher. This result is statistically insignificant at the 5% confidence level in the simplest specification of column 5, and when adding controls for labor market institutions and one lag of gdp growth. The significance of this result increases to 1% when controlling for two lags of GDP growth in column 8. Quantitatively, a 10 percentage point increase in the replacement ratio reduces the detrimental impact of recessions on the level of consumption by about 20%. Finally, we note that across all specifications, unemployment benefits appear to reduce the level of consumption per capita, although the estimated coefficients do not attain statistical significance at conventional confidence levels.

The last four columns show similar results when GDP per capita is used as dependent variable. A higher replacement ratio is associated with a lower long-run average of GDP, and this effect is always significant at the 1% confidence level. Recessions have negative and significant effect on the cyclical component of GDP, which are lessened by higher replacement ratios. Quantitatively, the average level of GDP decreases by somewhat less than a percentage point in recessions, and a 10 percentage point increase in the replacement ratio offsets around 10% of this effect. The interaction term is not significant in the simplest specification in column 9, but becomes significant at the 10% level when adding controls for labor market institutions, and at 5% when controlling for two lags of GDP growth.

To sum up, the regressions highlight a consistent pattern: the point estimates of the coefficient on the benefits replacement ratio suggests that more generous unemployment insurance is associated with a higher long-run level of the unemployment rate, lower GDP and consumption in line with the predictions of the model. Recessions increase unemployment, and decrease both consumption and GDP, but this effect decreases with the level of unemployment insurance, i.e., unemployment benefits operate as automatic stabilisers.

Our results are in line with those obtained by Di Maggio and Kermani (2015), who test the hypothesis that unemployment benefits operate as automatic stabilizers, by exploiting the heterogeneity in unemployment insurance across US regions. They construct a local labor demand index by interacting cross-sectional differences in industrial composition with national changes in industry employment shares. This generates a 'Bartik' shock, which can be interpreted as exogenous, under the identifying assumption that changes in industry shares at the national level are uncorrelated with unobservable city-level labor supply shocks. The authors find that the interaction between the Bartik shock and the unemployment insurance generosity index is negative, which implies that counties with more generous unemployment benefits tend to react less to adverse shocks. More in particular, more generous unemployment insurance reduces the elasticity of the unemployment rate to the Bartik shock, as well as the elasticity of employment growth in the non-tradable sector, earnings, wages and car sales, as a proxy for consumption.

## 4 Conclusions

To be written.

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# 5 Appendix

## A1. Data sources

*Unemployment rate*: Data series are constructed using harmonized unemployment rates whenever possible. Harmonized unemployment rates are not available since 1975 for all countries. The unemployment rate series for Ireland is constructed splicing harmonized unemployment rates available since 1982 with data on the level of registered unemployed available quarterly since 1967. The harmonized unemployment rate for Italy is available starting in 1979Q4. Our unemployment rate series is extended by splicing onto the harmonized series, unemployment rate data computed by the Italian Institute for Statistics, (ISTAT), and available starting in 1977Q1. Unemployment rates from 1975Q1 to 1976Q4 are constructed using a survey on the level of unemployed workers, implicitly assuming that the change in the level of unemployed maps into the same percentage change in the rate of unemployment. Portuguese harmonized data are available starting in 1983. Our series is extended back to 1975 exploiting quarterly changes in the level of registered unemployed workers. Data for Spain are available starting in 1983, and we extend the series back to 1975 using quarterly survey data on the level of unemployed workers. When quarterly unemployment series are extended exploiting information on the change in the level of unemployed workers, we check that the contructed series nicely interpolates official annual rates of unemployment constructed by statistical agencies, whenever such data are available. Source: all data are taken from OECD Main Economic Indicators.

*Gross Domestic Product*: GDP, million of US dollars, volume estimates, fixed PPP, seasonally adjusted, quarterly observations. Availability of the indicator: 1975Q1-2014Q2. Data Source: OECD Quarterly National Accounts.

*Population*: Total working age population, 15-64. Data are available on annual basis, and each entry reflects official estimates at 30 June (mid year). We therefore impute the annual estimate to the second quarter of each year and interpolate between quarters. Data source: OECD Labour Force Statistics. Availability of data: 1975 to 2014.

*Trade union density*: the ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners. High unionization is interpreted as an indication for a strong bargaining position of unions. Data source: ICTWSS. Availability of the indicator: 1975 to 2011. It is assumed that in the period 2012Q1-2014Q2 data on union density remain constant at the 2011 level.

*Union coverage*: the ratio of employees covered by wage bargaining agreements as a proportion of all wage and salary earners in employment with the right to bargaining. Data source: ICTWSS database. Availability of the indicator: 1975 to 2011. We assume that in the period 2012-2014Q2 data on union coverage remain constant at the 2011 level.

*Coordination of wage setting*: summary index reflecting whether wage negotiations take place at national, industry or firm level. The indicator ranges from 1 to 5 where higher values indicate a higher level of coordination. Data source: ICTWSS database. Availability of the indicator: 1975 to 2011. It is assumed that in the period 2012Q1-2014Q2 data on union density remain constant at the 2011 level.

*Permanent Employment Protection Legislation*: synthetic indicator of the strictness of regulation on dismissals. The indicator used is the indicator for regular employment and it measures the strictness of regulation of individual dismissal of employees on regular/indefinite contracts. The indicator ranges from 1 to 5: high values are associated with countries having a high degree of employment protection, while low values indicate relative ease in dismissing employees. Data source: CEP-OECD institutions dataset (see Nickell (2006)) interpolated with OECD data. CEP-OECD data on employment protection are available for the period 1975-2003, while OECD data are available for the period 1985-2013. We assume that EPL values measured in 2013 remain unchanged in the first two quarters of 2014.

*Unemployment benefit replacement rates*: We use OECD statistics on the gross replacement rates (GRRs), which express gross unemployment benefit levels as a percentage of previous gross earnings. This OECD summary measure is defined as the average of the gross unemployment benefit replacement rates for two earnings levels, three family situations and three durations of unemployment, and is meant to quantify the generosity of unemployment insurance programs. This indicator is available for all 20 countries in our panel in the period 1961 to 2005; they are computed every two years and we assume that they remain constant between measurements. This series has been discountinued in 2005 because their computation required use of the average production worker wages series (APW), which is no longer available after 2005. However, the OECD also produced an alternative series for GRRs, available from 2001 to 2011, with measures of benefits also available every other year, which is based on average wages (AW). To get a long run of data we splice the more recent AW based GRRs onto the old APW based GRR series, and assume the last measurement (2011) remained unchanged untill the end of our sample (2014Q2). Data on net replacement rates are only available since 2001, so we cannot use them in the empirical work. Because the GRR data are only available for odd year, data for even years are obtained by interpolating between odds years. The data source is the OECD Benefits and Wages statistics and is available online at http://www.oecd.org/els/benefitsandwagesstatistics.htm. Details on the calculations of OECD replacement rates are available at OECD (1994), 'the OECD Jobs Study', chapter 8 and Martin, J. (1996), 'Measures of Replacement Rates for Purposes of International Comparison', OECD Economic Studies No.26.