Unemployment Insurance Union

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Abstract

A European unemployment insurance scheme has gained increased attention as a new and ambitious common fiscal instrument which could be used for temporary cross-country transfers. Part of the national stabilizers composing unemployment insurance schemes would be transferred to the central level. Unemployed are then insured by both layers. When a country is hit by an asymmetric shock, it would receive positive net transfers from the central fund in the form of reduced taxes and increased benefits, providing risk-sharing for the whole union.

We build a two-country DSGE model with supply, demand and labor market shocks in order to capture the recent national insurance system and the unemployment insurance union (UIU) design. The model is calibrated to the euro area core and periphery data and matches the empirically observed cyclicality of the net replacement rate, the wage and unemployment dynamics. This baseline scenario is then compared to an optimal unemployment insurance union with passive and active benefit policies. For all underlying shocks, we find that the UIU reduces the fluctuation of consumption and unemployment while it increases the fluctuations of the trade balance. In case of a positive domestic government spending shock the UIU reduces the negative crowding out effect on private consumption and investment. The model will be used to analyze the effects of national and supranational benefit policies on labour market patterns and welfare.

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1 Introduction

A monetary union of heterogeneous members needs mechanisms to deal with asymmetric shocks. This relates to the seminal theory of optimal currency areas (Mundell, 1961; McKinnon, 1963; Kenen, 1969): monetary and exchange rate policies are transferred to the central level when sharing a currency, where they cannot be tailored to country-specific needs. This is not a problem if alternative adjustment mechanisms are strong. For example, high factor mobility, price and wage flexibility or a common budget that can organize transfers allow for macroeconomic stabilization and risk-sharing among member countries. In Europe, although labour mobility strongly reacted during the crisis, it might still be too low to adjust quickly to idiosyncratic shocks.[1] Also, wage flexibility can be an ineffective stabilization channel if wage cuts do not translate into price decreases, yielding no competitiveness gains.[2]

This observation calls for some sort of fiscal capacity at the European level where a common budget could transfer funds from booming to busting regions in the event of idiosyncratic shocks. Indeed, the sovereign debt crisis showed that while in normal times national stabilizers bring enough stabilization, in bad times they can be pro-cyclical in some countries due to the fiscal rules in place and the loss of market access to issue debt. Hence transferring part of the existing automatic stabilizers to a supranational level can be considered as a way to improve stabilization and risk-sharing. Bringing fiscal federalism to the euro area is not a new idea, dating back to the MacDougall report (1977) and more recently in the Four presidents report (2012). But what form should it take?

A European unemployment insurance scheme has gained increased attention as a new and ambitious common fiscal instrument which could be used for cross-country transfers.[3] Part of the national stabilizers composing unemployment insurance schemes (labor taxes paid by workers and benefits paid to the unemployed for instance) would be transferred to the central level. Unemployed are then insured by both national and European layers. When a country is hit by an asymmetric shock which makes its number of unemployed rise, it would receives positive net transfers from the central fund through increased benefits.

This mechanism offers several advantages. It would react automatically to overall economic

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[1] See Beyer and Smets (2015).

[2] This is the case if the monetary policy is stuck at the zero lower bound and prices are sticky. See a recent study by Gali and Monacelli (2015).

[3] See Artus et al. (2013); Beblavỳ et al. (2015); Bénassy-Quéré et al. (2016); Dullien and Fichtner (2013).

conditions, as unemployment is closely linked to activity. The mechanism would deliver stabilization without lag. Then, it is counter-cyclical, acting as a stabilizer: decreasing taxes and increasing benefits mitigate the recessive effects of a shock. Finally, although this is outside the scope of the paper, it would further European integration by extending it to social issues.

However, there are significant caveats. First, as in every risk-sharing arrangements, moral hazard issues arise. National governments may be disincentivized to implement policies that reduce structural unemployment if they know that they will receive transfers in the event of shocks. Second, Europe is characterized by highly heterogeneous unemployment insurance schemes in terms of replacement rates, eligibility criteria and entitlement durations. Setting up a common regime that respects national characteristics is then an issue. Third, permanent transfers, where more efficient countries finance less efficient ones over the cycle must be ruled out. Otherwise, the scheme is not one of stabilization but one of redistribution.

In this paper, we build a two-country RBC model with job market frictions. The union is composed of two asymmetric members, where goods are imperfect substitutes and are traded across countries. Labour is immobile and financial markets are incomplete, because some households have access to financial markets and some are constraint. Workers flow in and out of employment. We distinguish between short and long term unemployment in order to mimic the situation on European labour markets. A benchmark consisting of national unemployment agencies only is set as a reference for calibration. The calibrated version of our model is able to replicate key facts of the euro area core and periphery data. It matches the empirically observed cyclicality of the net replacement rate, the wage and unemployment dynamics and reproduces aggregate business cycle and labour market facts in the steady state and over the cycle.

Then, we plug a European Unemployment insurance (EUI) into existing national agencies which remain active, so that unemployment insurance is multi-layered as a second scenario. It is financed by lump sum taxes on labor and provides benefits to the unemployed across the economy. We also consider rules so that transfers only happen when countries deviate from their steady-state equilibrium. Finally, we create a third scenario where the supranational entity can issue debt on international financial markets to finance the temporary transfers. Fiscal claw-backs insure non-permanent transfers in this case. We compare these scenarios to analyze the stabilization functions of the scheme in case of typical supply, demand and labour market shocks. Additionally we compare cases where governments target constant and optimal insurance policies (in terms of benefits and entitlement duration). The latter consists in computing the optimal supranational policy for the EUI as well as the optimal top-ups and entitlement duration of the

national governments. The model is be used to analyze the effects of national and supranational benefit policies on labour market patterns and welfare.

In this paper we build an original design for a European unemployment insurance scheme, which is novel to the literature. Then, we quantitatively assess the potential stabilization gains offered by the system, and show that temporary transfers, by transferring part of the national stabilizers to the central level, improve risk-sharing in the union. Simulations of our model show the interaction of the net replacement rate with aggregate and labour market variables in response to the shocks. We confirm results from the literature that in case of a productivity shock supranational unemployment insurance makes the benefit policy more counter-cyclical through increasing risk sharing. Furthermore, in the event of a positive domestic government spending shock, the EUI reduces the negative crowding out effect on private consumption. Overall, the EUI stabilizes the fluctuation of consumption and unemployment for all underlying shocks while it increases the fluctuation of the trade balance.

The paper is structured as follows: Section 2 reviews the literature on unemployment insurance and the euro area business cycle, and theoretical foundations of unemployment insurance systems in search and matching models. Section 3 describes the theoretical model, Section 4 discusses the baseline calibration and the model results with respect to the impact of parameters, the dynamic responses and the correspondence with business cycle facts. Finally, Section 5 concludes.

2 Motivation

2.1 Literature review

This paper draws mainly on two strands of literature. The first deals with risk-sharing in federal systems while the second focuses on optimal unemployment insurance in frictional labour markets.

The issue of risk-sharing among members of different provinces or countries has been widely investigated. In a seminal paper, Asdrubali et al. (1996) find that 75% of the shocks to per-capita state gross product in the US from 1963 to 1990 are smoothed, including 13% through the federal budget, 23% through credit markets and 39% through capital markets. Later, Sørensen and Yosha (1998) show that for European and OECD countries, only 43% of the shocks to GDP from 1966 to

1990 are smoothed, half by government spending and half by private savings. Afonso and Furceri (2008) conduct an analysis on EU-25 countries and show that only 37% of the shocks to GDP from 1998 to 2005 are smoothed, with the largest part provided by social benefits. More recently, Furceri and Zdzienicka (2015) find that risk-sharing mechanisms in the Eurozone are ineffective (only 30% of the shocks are smoothed) compared to the U.S. and Germany (75% and 80% respectively). They also point out that the degree of risk-sharing among Eurozone countries is lower in recession, precisely when needed the most. Finally, they suggest that a supranational scheme, such as a centralized transfer mechanism based on automatic rules, amounting to between 1.5 and 2.5% of total GNP would significantly improve stabilization.

The importance of common fiscal tools as alternative risk-sharing mechanisms roots in the seminal theory of optimal currency areas (Mundell, 1961; Kenen, 1969). Farhi and Werning (2017) show that sharing a currency implies significant uninsurable effects due to nominal rigidities, hence that fiscal unions organizing transfers are inherent to viable monetary unions. Then how should transfers be designed? Evers (2012) studies different federal transfer rules to redistribute funds automatically in the event of an asymmetric shock. In the analysis, rules targeting consumption spending and labour income gaps are the most effective at increasing welfare. Engler and Voigts (2013) back this analysis by showing first that the implementation of a common currency by member countries with no labour migration, incomplete financial markets and partial integration in trade (hence with weak private risk-sharing channels) strongly increases consumption and employment volatility. Then, a transfer system between members reduces this volatility, in a more effective way than national fiscal stabilization policies as these are hampered by Ricardian equivalence effects and rising risk-premia.

A European unemployment insurance system as a cross-country transfer scheme has been given increased attention. Namely, Moyen et al. (2016) analyze the welfare effects of a European unemployment insurance (EUI). They find that in case of negative country-specific productivity shocks, the EUI makes the replacement rate more counter-cyclical because of international risk-sharing. Apart from this working paper, most studies on EUI consist in empirical simulations aimed at providing a rough assessment of the potential stabilization gains and transfers. For example, Dolls et al. (2015) present a hypothetical EUI based on counterfactual simulations of European data from 2000 to 2013. Their common scheme replaces part of the national insurance policies with a 50% replacement rate, 12 months entitlement duration and a broad coverage ratio. They find a sizable stabilization gains of 12% for households, however some countries are net contributors or debtors to the scheme. Lellouch and Sode (2014), using the same characteristics for the common system while adding claw-backs, also find counter-cyclical net transfers amount

from -0.6% to 1.4% of GDP.

Since we consider a common unemployment insurance scheme for the Eurozone, its effects on labour market stability must be discussed. In general, the unemployment agency faces a trade-off between the provision of insurance and incentive effects. In Baily (1978)'s framework, the optimal level of insurance increases with workers' risk-aversion but decreases with the elasticity of search effort with respect to benefits. Chetty (2008) decomposes the effect of unemployment benefits between liquidity and moral hazard effects: an increase in benefit allows to uphold consumption while unemployed but also reduces search effort, increasing the unemployment duration. The liquidity effect of insurance is particularly important when individuals are liquidity-constrained.

Moreover, when there are search frictions on labor markets, matching unfilled vacancies from firms with unemployed workers is modeled as a costly process. This is due to positive between-group externalities and negative within-group congestion effects: when a firm posts a vacancy, it increases workers' probability to find a job but it is harder for firms to have their vacancy filled. Conversely, when an additional worker looks for a job, workers' chances to exit unemployment are decreased but firms' probability to fill their vacancy are improved. The social optimum, characterized by the right 'blend' of positive externalities and congestion effects, is reached when the bargaining power of the worker equals the elasticity of the matching function with respect to unemployment (Hosios, 1990). Depending on how far from this condition the labour market settles, a benefit policy can address some of the frictions by affecting the outside option for the worker.

In a dynamic setting, the topic of whether benefits should be increased, decreased or kept constant over the unemployment spell has gained attention.[4]. For example, Hopenhayn and Nicolini (1997, 2009) build the case for a tapering profile of benefits over time, with benefits decreasing with the length of the spell. As for their time sequencing over the cycle i.e. should they be increased or not in bad times, Kroft and Notowidigdo (2011) find that the moral hazard cost of insurance is lower in times of high unemployment while the consumption-smoothing effect is acyclical. This suggests that optimal benefits should be counter-cyclical. Similarly, Landais et al. (2013) highlight that in recessions, the elasticity of unemployment with respect to benefits is lower so that the moral hazard effect is reduced. Mitman and Rabinovich (2015) show that optimal state-contingent unemployment benefits would smooth cyclical fluctuations and deliver substantial welfare gains. Albertini and Fairise (2013) investigate the optimal unemployment scheme under real wage rigidities and show that unemployment benefits schemes reduce welfare

[4]See Fredriksson and Holmlund (2006) for a review.

costs resulting in inefficient separations. In a subsequent paper Albertini and Poirier (2015) use a New Keynesian model to study the effect of the US unemployment benefit extension on the labour market under a zero lower bound. They find evidence of wage and inflationary pressure resulting from the benefit extension which reduces unemployment at the ZLB. While most of the papers focus on an optimal unemployment insurance scheme for the US, Moyen and Stähler (2014) also include Europe. They show that the issue of time-sequencing for the entitlement duration of benefits depends on the relation mentioned above between the bargaining power of the worker and the matching elasticity. Namely, in the US unemployment is too low in bad times relative to the Hosios condition (as the bargaining power is relatively low), hence benefit duration should increased in recessions while it is the opposite in Europe.

While existing studies rely on counter-factual analysis and simulations, we present an original DSGE model of multi-layered unemployment insurance in the presence of search and matching frictions, implementing transfer rules and claw-back which prevent permanent transfers. Once calibrated, we are able to assess quantitatively the stabilization gains offered by the system while considering different types of shocks.

2.2 Empirical facts

In the following we want to give a short insight into the heterogeneity of euro area countries national unemployment insurance systems and the underlying labour market conditions. This does not only deliver empirical motivation for our research question but also establishes the key facts that our stylized model should be able to replicate in order to compare the status quo with hypothetical union-wide benefit policies.

In order to compare the euro area countries with respect to their unemployment insurance scheme we have to define central characteristics. In general, most euro area economies have in common that their national unemployment insurance system can be roughly divided into the two segments of (premium) unemployment benefits and social assistance. In most euro countries a newly unemployed worker is eligible to receive premium unemployment benefits for a given period, the so called entitlement duration. The premium benefit is usually a share of the previously earned net income. When the entitlement duration ends, the unemployed worker gets social assistance, which can be understood as minimum level for social existence. While the structure of the insurance system is pretty similar, there are differences with respect to the average entitlement

duration as well as the average size of premium benefit and social assistance amounts.[5]
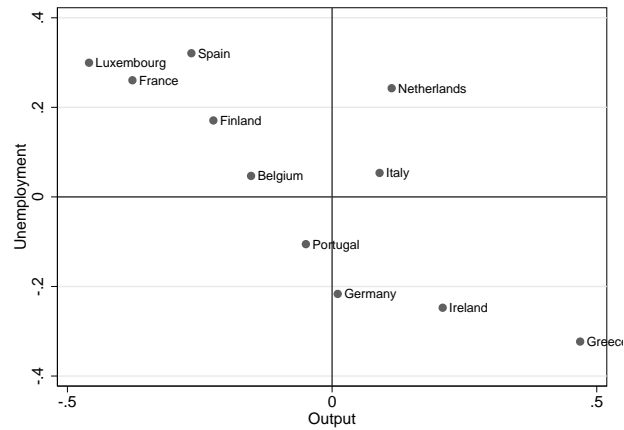

Figure 1: Cyclical correlation between the net replacement rate and Output (vertical axis) and Unemployment(horizontal axis)*

*Vertical axis: Cyclical correlation between net replacement rate and unemployment
Horizontal axis: Cyclical correlation between net replacement rate and output.

Source: OECD.

To investigate the stabilizing effects of benefit policies in the euro area countries we compile a data set with labour market and macroeconomic variables.[6] The data set contains observations for the years 1980-2008 and covers the euro area economies. Due to the stabilizing function of a common unemployment insurance we split up the sample into two different regions: The first country group consists of Austria, Belgium, Finland, France, Germany, Luxemburg and Netherlands. Spain, Greece, Ireland, Italy and Portugal are in the second country group. In accordance with the literature and the geographic position, the first group is called the core and the second group is referred to as periphery. Due to the lack of availability for quarterly key labour market data as net replacement rates, vacancies and relative long-term unemployment we rely on annual data from the OECD Employment and Labour Market Statistics. The data series

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[5]The initial conditions for eligibility of premium unemployment benefits are themselves related to some criteria. In most euro area countries workers have to be registered as unemployed, seeking for a job and meeting the work requirements. Additionally, they have to be employed for a specific duration in a reference period before they became unemployed. This fraction of workdays per week differs between euro area countries. For example, in France a single person is eligible to premium benefits ("Allocation d'aide au retour à l'emploi") if he worked on 122 days out of 28 months, which makes a ratio of around 4 workdays per month. A single person in Germany gets premium unemployment benefits ("Arbeitslosengeld") if he was liable to insurance deductions in at least 12 months during the reference period of two years, which is a ratio of roughly a 15 workdays per month.

[6]See Appendix 6.1 for a description of the data.

for the macroeconomic variables real GDP, real consumption, unemployment rate, employment, labour force, real wage, price inflation, wage inflation, and trade balance were drawn from the AMECO database. All variables are in real terms and are composed as deviation from the trend.[7]

Figure 1 depicts the cyclical correlation of the net replacement rate with output and unemployment for the 12 EA countries. The net replacement here is defined as the share of benefits on net income for an average production worker. The vertical axis represents the cyclical correlation between net replacement rate and unemployment, the horizontal axes measures the cyclical correlation between the net replacement rate and output. Interestingly, the cyclicality of the benefit policy is heterogeneous across the average EA-12 corridor. Intuitively, this can be driven by two channels, since the EA countries have an almost constant gross replacement rate (benefit). First, positive output leads to higher wages which - by definition - reduces the net replacement rate. Second, higher output also increases tax income which is used to transfer via the benefit system. However, the cause of the output change and the interplay with key macro and in frictional labour market can only be observed by richer model structure that incorporates the labour market as well as the fiscal policy.

3   Model

We construct a two-country dynamic stochastic general equilibrium model with search and matching frictions, as well as national and supranational fiscal policies.[8] The structure of both economies is symmetric.[9] Each country consists of households, firms and a national government. We name the first country Home, inhabited by ω households and the second Foreign, inhabited by $(1 - \omega)$ so that the size of the union is normalized to one. In order to analyze the possible outcomes of a union-wide unemployment insurance, we additionally include a federal planner that wants to maximize the union-wide utility.

In both economies exists a continuum of households of which a measure $\lambda \in [0, 1]$ have no access to financial markets. Therefore, in each period its household members, referred to as Rule-of-Thumb (denoted in this paper with a *R*), are restricted to consume their total disposable income.[10] Members of the remaining households, the optimizers (denoted with an *O*), are able

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[7]The cyclical component is extracted by using standard HP Filer with a smoothing parameters of $\lambda = 400$. The results are robust to variations in the smoothing parameter $\lambda = 100$ and $\lambda = 6.25$.

[8]See Ljungqvist and Sargent (2007), Mitman and Rabinovich (2015), Moyen and Stähler (2014) and Moyen et al. (2016).

[9]Due to the symmetry assumption all equations are derived for the home economy. They analogously apply to the foreign economy. If needed, we denote Foreign variables with an asterisk.

[10]In the literature those households are called Non-Ricardian, Rule-of-Thumb or financially constrained households.

to pool their income against idiosyncratic risk through their access to financial markets. Therefore, they are able to smooth consumption optimally over time and insure themselves against idiosyncratic unemployment risk.

Each household consists of a continuum of members who can either be employed or be unemployed in the domestic country. Employed members supply their labor and earn a wage determined in bilateral Nash bargaining. Unemployed members can either be short- or long-term unemployed. In short-term unemployment the member is entitled to premium benefits. These payments last for a duration set by a national government, after which the worker flows to long-term unemployment. When it does, the worker gets a flat amount from the national government that guarantees a minimum of social insurance once all premium benefits expire. Each household consumes an aggregate consumption good which is produced by either domestic or foreign firms. These firms post vacancies to workers and are subject to hiring costs. They hire workers in a frictional labor market and separate from them at an exogenous rate. The national government issues bonds and collects taxes which are used to finance the unemployment benefits, social insurance and public expenditures. We introduce financial integration by assuming that asset markets are incomplete and governments in each country issue risk-free bonds denominated in the same currency.[11]

3.1 Labor markets

The labor markets in both countries are subject to search and matching frictions which create costs for households and firms. In order to form a new employment relationship, aggregate unemployed workers of both household types at the end of last period u_{t-1} search in the domestic labor market for a job. We assume a constant search effort and a fixed number of hours worked, and all unemployed workers search for a job.[12] Firms do not discriminate between household types and post the same vacancies v_t for both. The number of matches m_t is given by a Cobb-Douglas matching function:

$$m_t = \kappa^E v_t^{1-\eta} (u_{t-1})^{\eta} \tag{1}$$

where $0 < \kappa^E < 1$ measures the matching efficiency. It captures structural factors such as relocation costs. $0 < \eta < 1$ is the matching elasticity with respect to unemployment.

Because the total labor force is normalized to one, the number of total employed workers is $n_t = 1 - u_t$ and can be interpreted as aggregate employment rate. We define the labor market

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[11]See Melitz and Ghironi (2005).
[12]We abstract from job-to-job transition, as this issue is not relevant for our research question.

tightness in efficiency units as $\theta_t \equiv \frac{v_t}{u_{t-1}}$ which measures the slope of the Beveridge curve.[13] The characteristics of the Cobb-Douglas matching function implies that firms fill their posted vacancies with probability $q_t \equiv \frac{m_t}{v_t} = \kappa^E \theta_t^{-\eta}$. Similarly, workers find a job with the probability $f_t \equiv \frac{m_t}{u_{t-1}} = \kappa^E \theta_t^{1-\eta} = \theta_t q_t$. The evolution of the aggregate employment rate is

$$n_t = (1 - s_t)n_{t-1} + m_t, \tag{2}$$

where matches are dispersed at the separation rate $s_t \in [0,1]$. Recent evidence points to the important role of separation fluctuations as determinant of employment over the cycle.[14] We follow Christoffel et al. (2009) by including separation rate changes via a shock which log follows an AR-1 process $\log(s_t) = \rho_s \log(s_{t-1}) + \epsilon_{s,t}$ with persistence parameter $0 < \rho_s < 1$ and a white noise process $\epsilon_{s,t}$ with zero mean and constant variance σ_s^2.

Breaking down to household types, we define $n_t^i = 1 - u_t^i$ as the employment rate for a type-i household with $i = (O, R)$ which follows:

$$n_t^i = (1 - s_t)n_{t-1}^i + f_t u_{t-1}^i,$$

Then, the aggregate unemployment rate u_t^i can be distinguished between the short-term $u_t^{S,i}$ and the long-term unemployment rates $u_t^{L,i}$. Short-term unemployed workers get premium benefits according to a replacement rate of their former wage.[15] To allow for multi-layered unemployment insurance, defined further on, we split the overall short-term unemployment into two consecutive segments: $u_t^S = u_{1,t}^S + u_{2,t}^S$ for a total of three possible unemployment status. This original design allows us to plug the federal insurance over the first segment, which can be extended by national governments over the second segment. Unemployed in tiers 1 and 2 receive premium benefits, $b_{1,t}$ and $b_{2,t}$ respectively. Long-term unemployed receive unemployment assistance z which is assumed to be a constant fraction of steady state consumption.[16]

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[13]The Beveridge curve explains the relationship between frictional and business cycle unemployment. $\theta = 1$ suggests that unemployment is a frictional phenomenon. See Benati and Lubik (2014).

[14]For example, Fujita and Ramey (2012) find that the separations are countercyclical and contribute to a large part of fluctuations in unemployment in the US.

[15]We abstract from eligibility criteria issues in our analysis although they are highly heterogeneous across countries and would therefore be an issue in designing a common unemployment insurance scheme. We assume that workers who become unemployed are immediately eligible to premium benefits once their match separates. Hence, the coverage ratio is 1 for both countries.

[16]Thus, short-term benefits fluctuates more over the cycle than long-term assistance. This allows us to capture that most unemployment insurance schemes feature decreasing benefits over the spell of unemployment, with premium benefits eventually decreasing to a lower amount of insurance past some entitlement duration.

Short-term unemployed in the first segment at time t are those who were already in this pool at $t-1$ excluding those who find a job or move to the second segment. We also add workers employed last period whose match separates:

$$u_{1,t}^{S,i} = (1 - f_t - \phi_1)u_{1,t-1}^{S,i} + s_t n_{t-1}^i, \tag{3}$$

where $0 < \phi_1 < 1$ is equal in both countries and measures the fixed entitlement duration for tier 1 benefits $b_{1,t}$.[17] With probability ϕ_1, the unemployed moves out of the first segment to the second.

Accordingly, the pool in the second segment of short-term unemployment consists of those who were in this pool last period, excluding those who find a job or lose their eligibility to tier 2 benefits, as well as those flowing from the first segment:

$$u_{2,t}^{S,i} = (1 - f_t - \phi_{2,t})u_{2,t-1}^{S,i} + \phi_1 u_{1,t-1}^{S,i}, \tag{4}$$

where $0 < \phi_{2,t} < 1$ is the probability that an unemployed worker eligible for tier 2 benefits $b_{2,t}$ becomes ineligible in the next period, moving to long term unemployment. It is determined by the benefit policy of the national government.

Finally, long-term unemployment amounts to the long-term unemployed from last period minus those who do not find a job in the previous period plus those who flow from the second pillar of the insurance system:

$$u_t^{L,i} = (1 - f_t)u_{t-1}^{L,i} + \phi_{2,t}u_{2,t-1}^{S,i}, \tag{5}$$

A long-term unemployed regains eligibility for premium benefits only if he finds a job with probability f_t.[18].

The aggregate employment and unemployment rates are weighted sums of household-specific rates $n_t = (1 - \lambda)n_t^O + \lambda n_t^R$, $u_t = (1 - \lambda)u_t^O + \lambda u_t^R$, $u_{1,t}^S = (1 - \lambda)u_{1,t}^{S,O} + \lambda u_{1,t}^{S,R}$, $u_{2,t}^S = (1 - \lambda)u_{2,t}^{S,O} + \lambda u_{2,t}^{S,R}$ and $u_t^L = (1 - \lambda)u_t^{L,O} + \lambda u_t^{L,R}$.

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[17] Hence the entitlement duration for the tier 1 benefits is $\frac{1}{\phi_1}$.

[18] We assume that all unemployed face the same job finding rate f_t regardless of which unemployment pillar they are in.

3.2 Households

Each household $i = O, R$ maximizes the expected lifetime utility:

$$V^i = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t u(c_t^i, c_{t-1}^i, n_t^i) \right\} \tag{6}$$

where E_0 denotes the expectation formed in period 0 and $\beta \in [0,1]$ is the discount factor. c_t^i denotes consumption of a basket made of home and foreign products which are imperfect substitutes. The intratemporal utility function is assumed to be CRRA-utility $u(c_t^i, c_{t-1}^i, n_t^i) = \frac{(c_t^i - h c_{t-1}^i)^{1-\gamma}}{1-\gamma} - \frac{\kappa^N (n^i)_t^{1+\varphi}}{1+\varphi}$ where γ is the elasticity of intertemporal substitution, $\gamma > 0, \gamma \neq 1$ and $h \in [0,1)$ is an external habit parameter. $0 < \kappa^N < 1$ is a scale parameter for labor disutility and $\varphi > 0$ is the inverse Frisch elasticity.

The home consumption basket c_t^i of household type i is a CES aggregate of the Foreign and Home produced goods:

$$c_t^i = \left(\psi (c_{H,t})^{\sigma} + (1-\psi) c_{F,t}^{\sigma} \right)^{\frac{1}{\sigma}}, \tag{7}$$

where $c_{H,t}$ is the amount of Home produced good consumed in the Home country and $c_{F,t}$ the amount of Foreign produced good consumed at Home, hence imported.[19] Then, $0 < \psi < 1$ is the degree of home bias in the domestic economy and $0 < \sigma$ is the inverse elasticity of substitution between the Home and the Foreign goods. We set the home-produced good as numeraire and define p_t as the price of the Foreign produced good in units of domestically produced good. By solving the utility-maximization problem of the household we can write the relative demand function for the home good as well as P_t, the home consumer price index (CPI) as follows:

$$c_{H,t}^i = \left(\frac{\psi p_t}{1-\psi} \right)^{\frac{1}{1-\sigma}} c_{F,t}^i, \quad P_t = \left(\psi^{\frac{1}{1-\sigma}} + (1-\psi)^{\frac{1}{1-\sigma}} p_t^{-\frac{\sigma}{1-\sigma}} \right)^{-\frac{1-\sigma}{\sigma}}. \tag{8}$$

The employed members of both households earn a labor income $w_t n_t^i$, while the unemployed receive social benefits according to their unemployment status. Short-term unemployed in the first and second segments receive premium benefits, $b_{1,t}$ and $b_{2,t}$ respectively. Long-term ones receive a flat amount of social assistance z. We can write the average benefit from unemployment insurance as:

$$b_t = \frac{u_{1,t}^{S,i}}{u_t^i} b_{1,t} + \frac{u_{2,t}^{S,i}}{u_t^i} b_{2,t} + \frac{u_{1,t}^{L,i}}{u_t^i} z.$$

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[19]Conversely, $c_{H,t}^*$ denotes the amount of Home produced good consumed in the Foreign country, hence exported by Home, and $c_{F,t}^*$ the amount of Foreign produced good consumed in the Foreign country.

Note that we can drop household type subscripts for the average benefit since unemployment rates are the same for both optimizing and RoT households. Indeed, they face the same separate and job finding rates as well as entitlement durations.

There exists a private insurance market but only the $1 - \lambda$ optimizing households have access to it. We assume that workers from optimizing households pool their labor income in order to insure each other and consume the same average consumption level (Andolfatto, 1996; Merz, 1995). Namely, they can save and borrow through bond holdings, where $d^O_{H,t}$ and $d^O_{F,t}$ denote per Home optimizing household holdings of bonds issued by the Home and Foreign government respectively.[20] These bonds pay, as the two countries form a monetary union, the same risk-free rate i_t.

Optimizers also rent capital, which depreciates at rate δ, to firms at the real rate r^K_t. Per optimizer investment follows:

$$j^O_t = k^O_{t+1} - (1 - \delta)k^O_t, \tag{9}$$

where k^O_t denotes per optimizer capital. The household is subjected to portfolio adjustment costs Φ_t, with:

$$\Phi_t(d^O_{H,t+1}, d^O_{F,t+1}, k^O_t) = \frac{\kappa^d}{2}\left(d^O_{H,t+1} - \bar{d}^O_H\right)^2 + \frac{\kappa^d}{2}\left(d^O_{F,t+1} - \bar{d}^O_F\right)^2 + \frac{\kappa^d}{2}\left(k^O_t - \bar{k}^O\right)^2,$$

with $\kappa^d > 0$, where $\bar{d}^O_H$, $\bar{d}^O_F$ and $\bar{k}^O$ are the steady-state levels of bond holdings and capital. Finally, they pay a lump-sum tax τ to finance the unemployment agency and own the firms from which they receive profits Π^O_t.

Hence optimizing households have the following budget constraint:

$$P_t c^O_t + j^O_t + d^O_{H,t+1} + p_{t+1}d^O_{F,t+1} = (1 + i_t)(d^O_{H,t} + p_t d^O_{F,t}) + r^K_t k^O_t + w_t n^O_t + b_t u^O_t - \tau_t + \Pi^O_t - \Phi_t, \tag{10}$$

The λ RoT consumers also pool their income. So there is risk-sharing within the a type-R household, but without access to financial markets its members are not able to save and borrow against their idiosyncratic income risk. Therefore, their budget constraint determines the consumption level in each period:

$$P_t c^R_t = w_t n^R_t + b_t u^R_t. \tag{11}$$

The disposable income of a RoT household consists of the labor income and the unemployment

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[20]$d^O_{F,t}$ is denominated in units of foreign good.

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benefits that are financed by taxes on the optimizing households.

Optimizing households maximize their lifetime utility (6) taking as given their type-specific budget constraint (10) and the laws of motion for employment (2) and unemployment (3), (4), (5). The first order conditions for the optimizing households with respect to the choice variables consumption, capital accumulation and government bonds of country $k = (H, F), \{c_t^O, k_t^O, d_{k,t+1}\}$ imply:

$$\lambda_t^O = \frac{(c_t^O - hc_{t-1}^O)^{-\gamma}}{P_t} - \beta h \frac{(E_t c_{t+1}^O - hc_t^O)^{-\gamma}}{E_t P_{t+1}}, \tag{12}$$

$$\lambda_t^O = \beta(1 + r_t^K - \delta)\lambda_{t+1}^O, \tag{13}$$

$$\lambda_t^O = \frac{\beta(1 + i_{t+1})}{1 + \kappa^d \left(d_{k,t+1}^O - \bar{d}_k^O\right)} \lambda_{t+1}^O. \tag{14}$$

Marginal utility for the RoT households writes:

$$\lambda_t^R = \frac{(c_t^R - hc_{t-1}^R)^{-\gamma}}{P_t} - \beta h \frac{(E_t c_{t+1}^R - hc_t^R)^{-\gamma}}{E_t P_{t+1}}. \tag{15}$$

Similarly to aggregation of employment, aggregate consumption, profits, bonds, investment and capital accumulation is a weighted average of their type-specific values.

$$c_t = (1 - \lambda)c_t^O + \lambda c_t^R, \qquad \Pi_t = (1 - \lambda)\Pi_t^O, \qquad k_t = (1 - \lambda)k_t^O,$$

$$d_{H,t} = (1 - \lambda)d_{H,t}^O, \qquad d_{F,t} = (1 - \lambda)d_{F,t}^O.$$

3.3 Firms

In each country, the production process is separated in two stages. There is a continuum of intermediate firms indexed by j producing an intermediate good in a monopolistically competitive market using capital and labor as input factors. Then, retail firms operate in a perfectly competitive environment and produce the final good used for consumption, investment and government expenditures. The final good is a composite of the intermediate good bundle $y_t(j)$, with the following production function:

$$y_t \equiv \left(\frac{1}{\omega} \int_0^\omega y_t(j)^{\frac{\epsilon-1}{\epsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}}$$

where $\epsilon > 1$ denotes the elasticity of substitution between intermediate goods.

We use the aggregate domestic producer price (PPI) as the numeraire and set it equal to one. Therefore, expenditure minimizing subject to the CES-aggregate yields demand functions for intermediate inputs as well as the composite producer price index:

$$y_t(j) = (\tilde{p}_t(j))^{-\epsilon} y_t, \qquad\qquad 1 = \frac{1}{\omega} \int_0^\omega \tilde{p}_t(j)^{1-\epsilon} dj \qquad (16)$$

where $\tilde{p}_t(j)$ denotes the intermediate input price for the corresponding firm.

The intermediate firm j has quadratic price adjustment costs and uses the following production technology:

$$y_t(j) = a_t k_t^\alpha(j) n_t^{1-\alpha}(j), \qquad (17)$$

where $0 < \alpha < 1$ denotes the partial production elasticity of capital. a_t is the country specific exogenous aggregate technology and its logarithm follows an AR(1) process $\log(a_t) = \rho_a \log(a_{t-1}) + \epsilon_{a,t}$ with persistence parameter $0 < \rho_a < 1$ and a white noise process $\epsilon_{a,t}$ with zero mean and constant variance σ_a^2. $\int_0^1 k_t(j)dj = k_t$ and $\int_0^1 n_t(j)dj = n_t$ are intermediate firm-specific shares of the aggregate capital and employment stock. The evolution of employment at the firm level corresponds to that of aggregate employment. Since each firm j can decide about the vacancies for a given vacancy filling rate, the law of motion of employment can be written as:

$$n_t(j) = (1 - s_t)n_{t-1}(j) + q_t v_t(j), \qquad (18)$$

For every posted vacancy each firm pays the same cost κ_t^V that is linear with respect to the number of vacancies posted. As in Christoffel et al. (2009), this vacancy cost is defined as an exogenous variable which logarithm follows an AR-1 process $\log(\kappa_t^V) = \rho_\kappa \log(\kappa_{t-1}^V) + \epsilon_{\kappa,t}$ with persistence parameter $0 < \rho_\kappa < 1$ and a white noise process $\epsilon_{\kappa,t}$ with zero mean and constant variance σ_κ^2. Modeling vacancy costs as such allow us to consider an increase of vacancy costs for some firms.

Each firm j maximizes its present value of discounted profit flows $\Pi_t(j)$ subject to the expected intermediate good demand function (16), the production function (17) and the law of motion for

employment (18):[21]

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t^O}{\lambda_0^O} \left[\tilde{p}_t(j) y_t(j) - w_t n_t(j) - r_t^k k_t(j) - \kappa_t^V v_t(j) - F - \frac{\kappa^d}{2} \left(\pi_t^Y(j) - 1 \right)^2 y_t(j) \right], \qquad (19)$$

where F are fix costs. Firms discount profits by the factor β_{t+1}^O with the time-varying discount factor $\beta_{t+1}^i \equiv \beta^t \frac{\lambda_{t+1}^i}{\lambda_t^i}$ because they are owned by the optimizing households. κ^d denotes a price adjustment cost parameter and the producer price inflation is defined as $\pi_t^Y(j) = \frac{\tilde{p}_t}{\tilde{p}_{t-1}}$. Capital demand of the firm satisfies $r_t^k = \alpha \frac{y_t(j)}{k_t(j)}$. As all firms choose the same price, employment and number of vacancies, index j cancels and the corresponding first-order conditions for those variables are, respectively:

$$\frac{\kappa_t^V}{q_t} = \mathcal{F}_t, \qquad (20)$$

$$\mathcal{F}_t = mc_t(1-\alpha) \frac{y_t}{n_t} - w_t + E_t(1-s_t)\beta_{t+1}^O \mathcal{F}_{t+1}, \qquad (21)$$

$$\pi_t^Y \left(\pi_t^Y - 1 \right) = \frac{1-\epsilon}{\kappa^d} + \frac{\epsilon}{\kappa^d} mc_t + E_t \beta_{t+1}^O \pi_{t+1}^Y (\pi_{t+1}^Y - 1) \frac{y_{t+1}}{y_t}, \qquad (22)$$

where $\mathcal{F}_t$ is the Lagrangian multiplier on the law of employment i.e. the marginal value of a filled job for the firm. Equation (20) is the free entry condition for vacancy posting: at equilibrium the average cost of posting a vacancy equals the marginal value of having it filled, $\mathcal{F}_t$. In turn, according to equation (21), this marginal value of vacancy filling equals the marginal product of an additional worker minus the wage he receives, plus the continuation value of this filled job for next period provided the match does not separate. Equation (22) describes the New Keynesian Phillips curve with the marginal cost mc_t for each firm. It states that an increase in producer price inflation is the result of increasing input costs, expected above average price inflation or raising real growth expectations.

Combining equations (20) and (21) gives the job creation condition:

$$\frac{\kappa_t^V}{q_t} = mc_t(1-\alpha) \frac{y_t}{n_t} - w_t + E_t \beta_{t+1}^O \left\{ (1 - s_{t+1}) \frac{\kappa_{t+1}^V}{q_{t+1}} \right\}, \qquad (23)$$

which is an arbitrage condition for job creation stating that firms increase vacancies until the benefit from employing an additional worker is equal to the cost of posting a vacancy.

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[21] As stated above, we normalize the home producer price index to one. Therefore all other prices are relative to the home producer price.

3.4 Nash bargaining

The firm and newly hired workers determine the wage w_t according to a Nash bargaining solution. Wage bargaining is centralized for both household types and all unemployment stages, which means that the obtained bargained wage may differ over the cycle from what would have resulted from a household-specific bargaining. Indeed, marginal utility of employment differs between unemployed in the different unemployment tiers, and members of the two household types do not have the same discount rate β_{t+1}^R and β_{t+1}^O. See Moyen and Stähler (2014) for a detailed analysis of this issue.

The Nash bargaining solution splits the overall surplus of a match in order to maximize the Nash product given by

$$\max_{w_t}(\mathcal{H}_t)^\zeta (\mathcal{F}_t)^{1-\zeta}, \tag{24}$$

where $0 < \zeta < 1$ represents the bargaining power of the worker. $\mathcal{H}_t$ denotes the marginal surplus of a match for the worker and $\mathcal{F}_t$ the marginal surplus of a filled vacancy for firms. $\mathcal{F}_t$ is given by equation (23), while $\mathcal{H}_t$ is the marginal surplus of working net of the marginal surplus of being unemployed for an average household member:

$$\mathcal{H}_t = (1-\lambda)(\mathcal{W}_t^O - \mathcal{U}_t^O) + \lambda \left(\mathcal{W}_t^R - \mathcal{U}_t^R \right). \tag{25}$$

where

$$\mathcal{W}_t^i = w_t - \frac{\kappa^N (n_t^i)^\phi}{\lambda_t^i} + E_t \beta_{t+1}^i \left\{ (1 - s_{t+1})\mathcal{W}_{t+1}^i + s_{t+1}\mathcal{U}_{1,t+1}^{S,i} \right\}, \tag{26}$$

$$\mathcal{U}_{1,t}^{S,i} = b_{1,t} + E_t \beta_{t+1}^i \left\{ (1 - f_{t+1} - \phi_1)\mathcal{U}_{1,t+1}^{S,i} + \phi_1 \mathcal{U}_{2,t+1}^{S,i} + f_{t+1}\mathcal{W}_{t+1}^i \right\}, \tag{27}$$

$$\mathcal{U}_{2,t}^{S,i} = b_{2,t} + E_t \beta_{t+1}^i \left\{ (1 - f_{t+1} - \phi_{2,t+1})\mathcal{U}_{2,t+1}^{S,i} + \phi_{2,t+1}\mathcal{U}_{t+1}^{L,i} + f_{t+1}\mathcal{W}_{t+1}^i \right\}, \tag{28}$$

$$\mathcal{U}_t^{L,i} = z + E_t \beta_{t+1}^i \left\{ (1 - f_{t+1})\mathcal{U}_{t+1}^{L,i} + f_{t+1}\mathcal{W}_{t+1}^i \right\}, \tag{29}$$

are, respectively, the per household member marginal utility of employment, of short-term unemployment in the first and second segments and of long-term unemployment. These value functions are obtained through derivation of (6) taking into account the household-type specific budget constraint ((10) or (11)) as well as labor market laws of motions (equations (2) to (5)). The corresponding average marginal utility of unemployment writes:

$$\mathcal{U}_t^i = \frac{u_{1,t}^{S,i}}{u_t^i}\mathcal{U}_{1,t}^{S,i} + \frac{u_{2,t}^{S,i}}{u_t^i}\mathcal{U}_{2,t}^{S,i} + \frac{u_t^{L,i}}{u_t^i}\mathcal{U}_t^{L,i}) \tag{30}$$

Hence the difference between (26) and (30) writes:

$$\mathcal{W}_t^i - \mathcal{U}_t^i = w_t - \frac{\kappa^N (n_t^i)^\phi}{\lambda_t^i} - b_t + E_t \beta_{t+1}^i \left\{ \mathcal{W}_{t+1}^i - f_{t+1} \left(\mathcal{W}_{t+1}^i - \mathcal{U}_{t+1}^i \right) + s_{t+1} \left(\mathcal{U}_{1,t+1}^{S,i} - \mathcal{W}_{t+1}^i \right) \right.$$

$$\left. - \phi_1 \frac{u_{1,t+1}^{S,i}}{u_{t+1}^i} \left(\mathcal{U}_{2,t+1}^{S,i} - \mathcal{U}_{1,t+1}^{S,i} \right) - \phi_{2,t+1} \frac{u_{2,t+1}^{S,i}}{u_{t+1}^i} \left(\mathcal{U}_{t+1}^{L,i} - \mathcal{U}_{2,t+1}^{S,i} \right) - \frac{u_{t+1}^{L,i}}{u_{t+1}^i} \mathcal{U}_{t+1}^{L,i} \right\} \quad (31)$$

The first three terms represent the wage that the worker obtains when hired net of the disutility costs from working and the average benefit it loses from exiting the unemployment pool. The fourth term is a continuation value that accounts for the fact that the worker may or may not change employment status in the future. This term includes the marginal value of staying employed in the next period minus the marginal net value of exiting the unemployment pool times the job finding probability (since the newly hired worker cannot exit unemployment next period). Also, the marginal value of flowing into the first segment of unemployed times the probability of match separation. Next, it accounts for the net marginal utilities of changing unemployment status that the unemployed could have obtained if it had stayed unemployed. We denote this fourth term by cv_t^i. Aggregating over the two household types, we can use equation (31) to rewrite (25) as:

$$\mathcal{H}_t = w_t - \left(\frac{1-\lambda}{\lambda_t^O} + \frac{\lambda}{\lambda_t^R} \right) \kappa^N (n_t)^\phi - b_t + E_t cv_{t+1} \quad (32)$$

where $cv_t = (1-\lambda)cv_t^O + \lambda cv_t^R$. Maximization of (24) with respect to the wage yields the wage bargaining rule:

$$\mathcal{H}_t = \frac{\zeta}{1-\zeta} \mathcal{F}_t. \quad (33)$$

By inserting the marginal value of a filled job (23) and the net marginal surplus of becoming an employed worker (32) into the wage bargaining rule (33), we finally get the wage equation:

$$w_t = \zeta \underbrace{\left[mc_t(1-\alpha) \frac{y_t}{n_t} + E_t \beta_{t+1}^O \left\{ (1-s_{t+1}) \frac{\kappa_{t+1}^V}{q_{t+1}} \right\} \right]}_{\text{surplus from match}} + (1-\zeta) \underbrace{\left[b_t + \left(\frac{1-\lambda}{\lambda_t^O} + \frac{\lambda}{\lambda_t^R} \right) \kappa^N (n_t)^\phi - E_t cv_{t+1} \right]}_{\text{outside option}}.$$

$$\quad (34)$$

The above equation shows that the worker obtains a fraction that the firm gets from a match plus a share of the outside option $b_t + \left(\frac{1-\lambda}{\lambda_t^O} + \frac{\lambda}{\lambda_t^R} \right) \kappa^N (n_t)^\phi - E_t cv_{t+1}$, depending on its bargaining power. This outside option depends on the benefit policy and the labor disutility net of the continuation value included in the net marginal utility of becoming employed.

3.5 Monetary policy

The monetary sector is simplistically modeled by a central bank that supplies a monetary asset.[22] The central bank can influence the nominal interest rate by changing the interest rate of the monetary asset. We assume that the central bank wants to stabilize the price inflation and the output gap but cannot reduce the rate under the zero lower bound:

$$1 + i_t = (1 + i_{t-1})^{\varphi_i} \left[\frac{1}{\beta} \left(\frac{\pi_t^U}{\overline{\pi}^U} \right)^{\varphi_\pi} \left(\frac{y_t^U}{\overline{y}^U} \right)^{\varphi_y} \right]^{1-\varphi_i}, \tag{35}$$

where $y_t^U = \omega y_t + (1 - \omega) p_t y_t^*$ is the average output growth of both countries. $\pi_t^U = \omega \pi_t^C + (1 - \omega) \pi_t^{C*}$ is the harmonized consumer price inflation rate measured as the weighted average of country-specific inflation rates. The consumption inflation rate of the domestic economy can be derived using the growth rate of the aggregate price level (8):

$$\pi_t^C = \pi_t^Y \frac{P_t}{P_{t-1}}. \tag{36}$$

Finally, φ_i, φ_π and φ_y are positive parameters measuring the weighting of the central bank for interest smoothing, as well as average price inflation and output growth targeting.

3.6 Government

Governments each run an unemployment agency. A national insurance policy at time t consists of a set $(b_{1,t}^n, b_{2,t}, \phi_{2,t})$. $b_{1,t}^n$ and $b_{2,t}$ are benefit for the first and second segments of short-term unemployment respectively. $\phi_{2,t}$ relates to the entitlement duration for premium benefits. Since most European countries do not have a proactive insurance policy we set all variables to constant values (b_1^n, b_2, ϕ_2) in order to target existing average EA unemployment schemes.[23] Automatic stabilizers are then triggered by rising unemployment which mechanically increases the amount of benefits.

We define the national tax as τ_t^n and assume it follows a counter-cyclical ad-hoc fiscal rule, where the government reduces the lump-sum tax if actual production or debt levels are under-

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[22]The monetary asset is a contract between the central bank and the agents of the economy. Everyone is legally obligated to hold one unit of that good on which the central bank pays an interest. In a complete banking system with private banks this concept of monetary asset could be either the minimum or voluntary reserve holdings of privates. This *clearing-balance contract* assumption can be motivated by the linking function of a stable money supply. Without it, a central bank would not be able to influence the market rates.

[23]For example a rule-based policy that extends replacement rate or entitlement duration in bad times.

neath their steady state values, $\bar{y}$ and $\bar{d}$:

$$\tau_t^n = \bar{\tau}^n + \phi_y \left(y_t - \bar{y} \right) + \phi_d \left(d_t - \bar{d} \right). \tag{37}$$

where $\phi_y, \phi_d > 0$ are weighting parameter for the two targets variables.

The national government issues debt d_t, therefore its budget constraint follows:

$$(1 - \lambda)\tau_t^n + d_{t+1} = g_t + b_{1,t}^n u_{1,t}^S + b_{2,t} u_{2,t}^S + z u_t^L + (1 + r_t)d_t. \tag{38}$$

where g_t is government expenditure. g_t has its logarithm following an AR(1) process $\log(g_t) = \rho_g \log(g_{t-1}) + \epsilon_{g,t}$ with persistence parameter $0 < \rho_g < 1$ and a white noise process $\epsilon_{g,t}$ with zero mean and constant variance σ_g^2. $b_{1,t}^n u_{1,t}^S + b_{2,t} u_{2,t}^S + z u_t^L$ are the total unemployment benefits of the national entity.

Scenario 1. Status quo: In this baseline case, only national agencies insure against unemployment. Namely, we impose:

$$b_{1,t} = b_1^n = b_2 = b, \tag{39}$$

$$\tau_t^n = \tau_t \tag{40}$$

Hence, in this baseline scenario, premium benefits come solely from the national agency. We also impose that they have the same amount for unemployed in both segments, denoted with b, so that insurance for short term unemployment takes the form of two identical consecutive tiers.[24]

Scenario 2. Insurance union We introduce in this case a supranational entity in addition to the national benefit systems. It plugs into the existing agencies which remain active so that unemployment insurance is multi-layered. To allow for heterogeneous insurance policies between the Home and Foreign governments in terms of benefits and entitlement duration, the challenge is to establish a base supranational insurance common to both countries while allowing them to extend it. The scheme is active over the first segment of short term unemployment (hence in every period t unemployed switch to a purely national government insurance with probability ϕ_1). First, because targeting short term unemployed only allows us to dodge moral hazard issues. Second, because it allows the national agency to extend the base insurance along two dimensions:

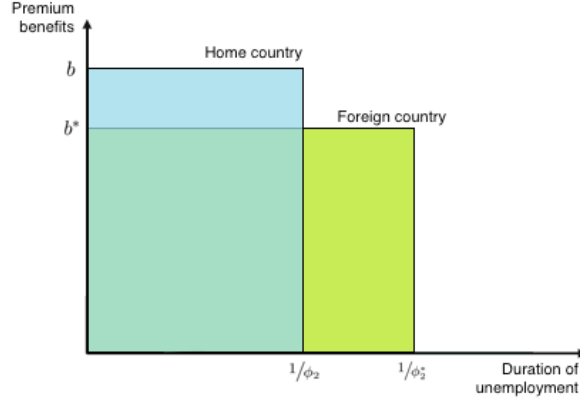[24]The probability to lose eligibility to first segment benefits can then take any value.

Figure 2: Baseline case*

*Example with higher benefit with shorter entitlement duration in Home country relative to Foreign.

it can keep insuring short term unemployed for a longer period through the second segment, and it can top-up the supranational benefits with extra national ones in the first pillar. Our two-tiered structure for premium benefits allows for the supranational insurance to be integrated into national ones sequentially and simultaneously.

The supranational insurance entity sets a benefit policy $(b_1^f, b_1^{f*}, \phi_1)$ and can impose lump-sum taxes (τ_t^f, τ_t^{f*}) to disburse unemployment benefits in the Home or in the Foreign economy.[25] The budget constraint for the entity writes:

$$\omega b_1^f u_{1,t}^S + (1 - \omega) p_t b_1^{f*} u_{1,t}^{S*} = \omega(1 - \lambda)\tau_t^f + (1 - \omega)(1 - \lambda^*) p_t \tau_t^{f*}, \tag{41}$$

Net transfers to the supranational scheme are defined as the difference between what the country receives in terms of benefits from the fund and what it contributes in terms of taxes:

$$Tr_t = b_1^f u_{1,t}^S - (1 - \lambda)\tau_t^f \tag{42}$$

which is equivalent to writing the budget constraint (41) as $\omega Tr_t + (1 - \omega) p_t Tr_t^* = 0$.

We program the supranational insurance so that it is neutral in terms of insurance: the overall amount of premium benefits b remains unchanged compared to the baseline case. Hence we

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[25]As in the baseline case we focus to constant policy instrument i.e. constant benefits and entitlement duration over the cycle. Those are denominated in units of Home good, the numeraire.

designed a base supranational insurance that can be extended at the national level to respect each country's preferences in terms of insurance. We have:

$$b_{1,t} = b_1^n + b_1^f = b_2 = b,$$
(43)

$$\tau_t = \tau_t^n + \tau_t^f$$
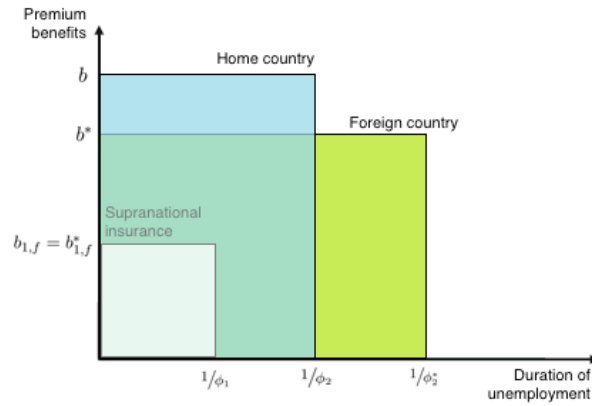(44)

Here b_1^n act as national top-up.[26]

Figure 3: Insurance union*

*Example with equal supranational benefits in Home and Foreign countries.

Finally, we set a transfer rule which triggers transfers as a function of relative output gaps in the Home and Foreign economy, bringing risk-sharing:

$$Tr_t = \phi_{rs} \left[(y_t^* - \bar{y}^*) - (y_t - \bar{y}) \right],$$
(45)

where $0 < \phi_{rs} < 1$ is a risk-sharing parameter.[27] This rule also ensures that transfers are zero at the steady-state, ruling out permanent transfers. This prevents cases where a country is a permanent net receiver or contributor to the scheme.

Scenario 3. Federal insurance In this scenario, the supranational entity, that we label as a

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[26]The national government sets its policies taking $(b_{1,t}^f, \phi_{1,t})$ as given, which are set by the supranational entity.

[27]Hence once the entity sets the amount of supranational benefits (b_1^f, b_1^{f*}), taxes (τ_t^f, τ_t^{f*}) adjust so that budget balances and transfers are disbursed according to the risk-sharing rule.

federal government, runs the same policy as scenario 2 but can issue debt d_t^E. It pays a risk-free rate i_t^E and is bought by optimizing households across the union:

$$d_t^E = \omega d_{E,t} + (1 - \omega) d_{E,t}^*, \tag{46}$$

where $d_{E,t}$ and $d_{E,t}^*$ denote Home and Foreign holdings of federal bonds, with $d_{E,t} = (1 - \lambda) d_{E,t}^O$ and $d_{E,t}^* = (1 - \lambda^*) d_{E,t}^{*O}$.

Each country has an account with respect to the fund and we can keep track of which country receives positive transfers: this is familiar a set-up to European countries and resembles the functioning of structural funds for example. Each country has a compartmentalized debtor or creditor position with respect to the federal agency, which follows:

$$\tilde{d}^E_{t+1} = Tr_t + (1 + i_t^E) \tilde{d}_t^E. \tag{47}$$

Accordingly, to finance the transfers when a country draws on its account, the fund issues federal debt d_t^E so that:

$$d_t^E = \omega \tilde{d}_t^E + (1 - \omega) d_t^{*E}. \tag{48}$$

An important issue that must be considered when designing the system is that it has to prevent permanent transfers, meaning that no country can be a permanent creditor or debtor. The following federal fiscal rules, or claw-backs, imply an increase in federal taxes when a country receives positive transfers, while allowing for some degree of counter-cyclicality:[28]

$$\tau_{f,t} = \bar{\tau}_f + \phi_y^E (y_t - \bar{y}) + \phi_d^E \left(d_t - \bar{d} \right). \tag{49}$$

where $\phi_y^E, \phi_d^E > 0$ are weighting parameter of the federal entity for the two targets variables. These rules ensure that transfers are zero at the steady-state because output and debt gaps are closed in both economies. Depending on those parameters, the federal entity can be more or less generous in how it distribute transfers. The Euler equation for union-wide bond holdings can be added to the households first-order conditions (14):

$$\lambda_t^O = \frac{\beta(1 + i_{t+1}^E)}{1 + \kappa^d \left(d_{E,t+1}^O - \bar{d}_E^O \right)} \lambda_{t+1}^O. \tag{50}$$

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[28]Compared to scenario 2, we take out the transfer rule (45) and have one additional endogenous variable which is the federal debt. This gives us two more degrees of freedom to design the insurance, corresponding to the Home and Foreign federal fiscal rules.

Additionally, the budget constraint of the optimizing household changes to:

$$P_t c_t^O + j_t^O + d_{H,t+1}^O + d_{F,t+1}^O + d_{E,t+1}^O =$$
$$(1 + i_t)(d_{H,t}^O + p_t d_{F,t}^O) + (1 + i_t^E) d_{E,t}^O + r_t^K k_t^O + w_t n_t^O + b_t u_t^O - \tau_t + \Pi_t^O - \Phi_t, \quad (51)$$

with $\Phi_t(d_{H,t+1}, d_{F,t+1}, d_{E,t+1}, k_t) = \frac{\kappa^d}{2}\left(d_{H,t+1} - \bar{d}_H\right)^2 + \frac{\kappa^d}{2}\left(d_{F,t+1} - \bar{d}_F\right)^2 + \frac{\kappa^d}{2}\left(d_{E,t+1} - \bar{d}_E\right)^2 + \frac{\kappa^d}{2}\left(k_t^O - \bar{k}^O\right)^2$.
Domestic and foreign household can now use union-wide bonds to insure against union-wide risks.

3.7 Goods and financial trade

Produced goods can be either used domestically or exported to the other economy. For Home, the trade balance in units of the domestically produced good is defined as the difference between exports and imports:

$$tb_t \equiv (1 - \omega)c_{H,t}^* - \omega p_t c_{F,t}. \quad (52)$$

Debt issued by a government can be bought by either Home or Foreign optimizing households, so that the bond market equilibria for the Home and Foreign debt write respectively:

$$\omega d_t = \omega d_{H,t} + (1 - \omega)d_{H,t}^*, \quad (53)$$
$$(1 - \omega)d_t^* = \omega d_{F,t} + (1 - \omega)d_{F,t}^* \quad (54)$$

The current account balance in units of the produced good is defined as the sum of the trade balance, the capital balance and transfers:

$$ca_t = tb_t + \omega i_t p_t d_{F,t} - (1 - \omega)i_t d_{H,t}^* + \omega Tr_t \quad (55)$$

The balance of payments is equal to zero and can be expressed as:

$$bop_t \equiv 0 = \omega\left[p_{t+1}d_{F,t+1} - p_t d_{F,t}\right] - (1 - \omega)\left[d_{H,t+1}^* - d_{H,t}^*\right] - ca_t, \quad (56)$$

which shows that the financial account must be equal to the opposite current account balance.

3.8 Equilibrium

Combining the government balanced budget with the households' resource constraint and the definition of the external balances we can write the aggregate resource constraint:

$$\omega y_t = \omega(c_{H,t} + j_t + g_t + \kappa_t^V + F + \Phi_t) + (1-\omega)c_{H,t}^*.$$

The above equation shows that the good produced at Home can be consumed domestically, exported to Foreign, spent on public expenditures, invested into the physical capital stock and used to cover vacancy and portfolio adjustment costs.

Imposing that domestic bonds are in zero net supply, we define an equilibrium as a sequence of domestic and foreign quantities:

$$\{\mathcal{X}\}_{t=0}^\infty = \left\{ y_t, c_{H,t}^i, c_{F,t}^i, c_t^i, j_t^O, k_t^O, v_t, n_t^i, u_{1,t}^{S,i}, u_{2,t}^{S,i}, u_t^{L,i}, f_t, \theta_t, q_t, m_t \right\},$$

$$\{\mathcal{X}^*\}_{t=0}^\infty = \left\{ y_t^*, c_{H,t}^{*,i}, c_{F,t}^{*,i}, c_t^{*,i}, j_t^{*,O}, k_t^{*,O}, v_t^*, n_t^{*,i}, u_{1,t}^{*S,i}, u_{2,t}^{*S,i}, u_t^{*L,i}, f_t^*, \theta_t^*, q_t^*, m_t^* \right\},$$

a sequence of domestic, foreign and international prices and wages:

$$\{\mathcal{P}\}_{t=0}^\infty = \{p_t, P_t, w_t\}, \ \{\mathcal{P}^*\}_{t=0}^\infty = \{P_t^*, w_t^*\}, \{\mathcal{P}^E\}_{t=0}^\infty = \{i_t, i_t^E\},$$

a sequence of national benefit policies:

$$\{\mathcal{B}\}_{t=0}^\infty = \left\{ \tau_{n,t}, b_{1,t}^n, b_{2,t}, \phi_{2,t} \right\}, \ \{\mathcal{B}^*\}_{t=0}^\infty = \left\{ \tau_{n,t}^*, b_{1,t}^{*n}, b_{2,t}^*, \phi_{2,t}^* \right\},$$

a supranational benefit policy $\{\mathcal{B}^E\}_{t=0}^\infty = \left\{ b_{1,t}^f, b_{1,t}^{*f}, \tau_{f,t}, \tau_{f,t}^*, Tr_t \right\}$, a transfer rule $E(Tr) = 0$ and a sequence of shocks: $\{\mathcal{S}\}_{t=0}^\infty = \{a_t, a_t^*, g_t, g_t^*, s_t, s_t^*, \kappa_t^V, \kappa_t^{*V}\}$,

(1) for a given price and wage sequence $\{\mathcal{P}\}_{t=0}^\infty, \{\mathcal{P}^*\}_{t=0}^\infty, \{\mathcal{P}^E\}_{t=0}^\infty$ a given realization of shocks $\{\mathcal{S}\}_{t=0}^\infty$ the sequence $\{\mathcal{X}\}_{t=0}^\infty, \{\mathcal{X}^*\}_{t=0}^\infty$ satisfies first order conditions for domestic and foreign households and firms.

(2) for a given sequence of quantities $\{\mathcal{X}\}_{t=0}^\infty, \{\mathcal{X}^*\}_{t=0}^\infty$ a given realization of shocks $\{\mathcal{S}\}_{t=0}^\infty$ the price sequence $\{\mathcal{P}\}_{t=0}^\infty, \{\mathcal{P}^*\}_{t=0}^\infty, \{\mathcal{P}^E\}_{t=0}^\infty$ guarantees international labor, goods and financial market equilibrium conditions.

4 Results

4.1 Calibration

The calibration of the baseline scenario follows the literature on open economy DSGE models with search and matching and empirical observations.[29] We calibrate the model on quarterly data of the core (Austria, Belgium, Finland, France, Germany, Luxemburg and Netherlands) and the periphery (Spain, Greece, Ireland, Italy and Portugal).[30] We set the relative country size equal to $\omega = 0.61$ in order to match the share of the labor force that participates in the core countries. Although we have an asymmetric corridor, we assume the structural parameters to be equal in both countries. Therefore, we set the discount factor to $\beta = 0.98$ consistent with an annualized interest rate of four percent. The partial production elasticity of capital α is set to the conventional value one third and the quarterly depreciation rate of physical capital is $\delta = 0.025$. We assume the degree of openness to be $\psi = 0.584$ in the core economy and $\psi^* = 0.412$ in order to match the share of private domestic consumption on GDP. We assume that both regions are characterized by frictional labor market, that stems from a difference between wage bargaining power and the matching elasticity. The matching elasticity $\eta = 0.5$ is equal in both regions, the wage bargaining power ζ is different from 0.5, such that the Hosios condition does not hold. The exogenous separation rate s measures the transition probability between the employment and the unemployment status and differs between regions. Christoffel et al. (2009) find quarterly fitted values of 3 percent for the Euro are countries on average. The long-term replacement rate is $\frac{z}{wn} = 0.23$ in the core and $\frac{z^*}{w^*n^*} = 0.28$ according to empirically observed values. We further target three key characteristics of the relation between labor market variables in the EA-12 countries. We jointly set the vacancy posting costs to $\kappa^V = 0.3$, the initial unemployment benefits equal to $b = 0.5$ in both regions and the separation rate to 0.02 in the core and 0.0428 in the periphery in order to match the values for the steady state job finding of 0.3, the initial net replacement rate of 0.75 in the core and 0.71 in periphery economy and the unemployment rates in both regions.

We document the status quo in our steady state calibration in Table 1. We explicitly model physical capital investment and government expenditures which account in sum 36% of the GDP in the core country and 32% of the periphery countries GDP. Therefore, the consumption share in the periphery is slightly higher than in the core country.[31]The remainder of 3.3% arises from

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[29]See e.g. Christoffel et al. (2009), Mitman and Rabinovich (2015), Albertini and Fairise (2013), Moyen and Stähler (2014).

[30]See Moyen et al. (2016).

[31]The contribution of the trade balance is almost zero in both regions. Therefore and in line with the zero trade balance steady state of our model the ratios of consumption, investment and government expenditure sum up to one.

the vacancy cost share.

Macroeconomic variables		Core	Periphery
Relative size	ω	0.61	0.38
Consumption share	$\frac{\bar{c}}{\bar{y}}$	0.61	0.65
Investment share	$\frac{\bar{j}}{\bar{y}}$	0.182	0.182
Government spending share	$\frac{\bar{g}}{\bar{y}}$	0.18	0.16
Vacancy cost share	$\frac{\kappa\bar{v}}{\bar{y}}$	0.004	0.006
Labor share in total output	$\frac{\overline{wn}}{\bar{y}}$	0.66	0.66
Labor market variables			
Unemployment rate	$\bar{u}$	0.079	0.129
Vacancies	$\bar{v}$	0.033	0.051
Relative Long-term unemployment rate	$\bar{u}^L$	0.28	0.3
Job finding rate	$\bar{f}$	0.3	0.29
Job filling rate	$\bar{q}$	0.71	0.73
Labor market policy			
Average replacement rate		0.61	0.58
Short-term replacement rate		0.754	0.719
Long-term replacement rate		0.249	0.295

Table 1: Calibration

Turning to the structural characteristics of both regions we find a 66% labor share in GDP which is slightly above the empirical observed values in the periphery. In steady state there is an unemployment rate gap between core and periphery of five percentage points. Therefore, the annual job finding rate in the core euro area is one percentage point higher than in the periphery while the filling rate is lower. Finally, our calibration matches the 5-year average replacement rate for both regions as well as the replacement rates for short-term (premium) benefits and long-term benefits (social assistance). The average annual standard deviation of all four shock are identified by our model assumptions and directly observable in the underlying data set. In order to get the characteristics of the technology shock, we calculated the cyclical component of the Solow residual from the production function. We than estimated the autoregressive parameter by applying the underlying AR(1) process. The characteristics of the government spending shock are directly calculated by estimating an AR(1) process with data from the AMECO database. The empirical shocks and persistence parameters for the vacancy costs and the separation rate are taken from Christoffel et al. (2009).

Finally, we assess the quality of the model by comparing the theoretical business cycle statistics of the calibrated model with the empirical facts presented in Table 2. To that end, we draw country-specific shocks from their distributions and simulate 1000 periods to extract the standard deviations conditional on all shocks and the correlations from the structural model.[32]

| | $\sigma(x)/\sigma(y)$ | | $\rho(x,y)$ | |
| | Core | Periphery | Core | Periphery |
Variable (x)	Model(Data)	Model(Data)	Model(Data)	Model(Data)
Real consumption (c)	0.73(0.72)	0.91(0.90)	0.87(0.77)	0.70(0.88)
Unemployment rate (u)	0.41(0.43)	0.27(0.47)	-0.75(-0.72)	-0.45(-0.73)
Real wage (w)	0.44(0.47)	0.72(0.85)	0.23(0.18)	0.78(0.51)
Net replacement rate	0.69(1.21)	0.31(1.33)	0.08(0.13)	-0.04(-0.06)

Model refers to the baseline calibration.

Table 2: Theoretical vs. empirical moments of the core and the periphery business cycle 1980-2008

Table 2 depicts the empirical and simulated relative standard deviations (column one and two) and correlations (columns three and four) of the EA core and the periphery business cycle for the period 1980-2008.[33] The model matches the empirical fluctuation relations and correlations quite well. Nominal and real rigidities would increase the fluctuation of quantities rather than prices and wages. This would also lower the correlation of the real wage with respect to the output over the cycle, especially in the periphery.

In this section we describe the effects of supply, demand and labor market shocks on the business cycle dynamics from the perspective of the domestic economy. Initially, we choose parameter values as defined in Table 3 in order to mimic a "status quo" and simulate the impulse response functions of domestic aggregate variables (Table 1). We distinguish the "status quo" (scenario 1) from two hypothetical scenarios. A scenario where the supranational entity provides an union-wide insurance (scenario 2).[34] In the second scenario we allow the federal entity to finance debt with an additional bond.

We analyze the impulse response functions with respect to the three scenarios. First, we inves-

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[32]In order to compare the theoretical model with the empirical unconditional standard deviations we simulate the time series including all shocks. Therefore, the reactions of macroeconomic variables are not conditional on a specific shock. To compare the true conditional reactions, we would have to compare the extracted theoretical standard deviations in case of a single shock with the empirical counterparts resulting from a structural VAR.

[33]The table compares quarterly theoretical statistics with annual data.

[34]We set the premium benefit share of the federal insurance to $b = 0.015$ and the share of national governments on premium insurances to b. The overall unemployment benefit stays exactly the same as in the status quo scenario, such that we can compare the two scenarios with respect to their welfare.

tigate the effects of typical supply, demand and labor market shocks on business cycle behavior.[35] Second, we are interested in how far a union-wide unemployment insurance can these business cycle fluctuation related welfare losses. Third, we want to analyze the effects of different benefit policies.

Domestic productivity shock

As can be seen in Figure 4 in the Appendix, in the baseline scenario (solid line) a negative domestic technology shock increases the cost of production and leads to an decrease in output, consumption and wages.[36] As a consequence of lower marginal value from job creation firms reduce their vacancy posting. Given their bargaining power workers have to reduce their wage claim and employment decreases. Furthermore, domestic firms become less productive than their foreign counterparts and the relative price (terms of trade) of domestic goods increases. Therefore, domestic and foreign consumer substitute away from home production and the trade balance deteriorates. With respect to the unemployment insurance policy, the average net replacement rate increases and is thus counter-cyclical. As the shock hits, both short and long-term unemployment increase but short-term relatively more while it reverses in the medium term. Indeed, reduced vacancies and matches lead to a relatively higher pool of short-term unemployed, as workers flow there before long-term unemployment. As a result, under a constant benefit and entitlement insurance policy, the average benefit rises since short-term unemployed are entitled to premium benefits, a point made in Moyen and Stähler (2014). It reverses in the medium term as workers flow relatively more into long-term unemployment and less into short-term decreasing the average benefit.[37] Moreover, the increase of short- and long-term unemployment will force the government to increase debt and at almost constant taxes today in order to finance the higher amount of total unemployment payments. Due to the fiscal rule, the government increases the tax in subsequent periods such that debt converges to zero. When the shock hits, with rising average benefits over decreasing wages and almost constant taxes, the net replacement will increase.

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[35]For a better visibility and comparability we normalize the shocks to one standard deviation

[36]It is well known from the business cycle literature that in case of sluggish prices and wages, productivity shocks can lead to a temporary decrease of employment. See Erceg et al. (2000), Galí (1999) and Gali (2010). We do not consider rigidities in this analysis in order to focus on the role of unemployment insurance policies.

[37]Increasing then decreasing average benefits also puts upward then downward pressure on the bargained wage through the outside option.

Government spending shocks

The government spending affects the intratemporal aggregate resource constraint and the government budget. The corresponding impulse response function can be found in Figure 5 in the Appendix. A positive government spending shock will increase the output and employment immediately. Firms post vacancies in order to produce the increasing public demand. But increasing government demand has to be financed by taxes or debt which is, according to the fiscal rule, future taxation. Since optimizing households and firms expect this tax payments today, they decrease vacancy postings, consumption and investment demand which translates into a reduction of the GDP after one year. Guler and Taskin (2013) provide empirical evidence for this crowding out effect of unemployment insurances. They interpret the empirical fact as a substitution between the two insurance mechanisms against loss of earnings during unemployment spells. Additionally, the increase of public demand will raise domestic relative to foreign prices which leads to a lower demand for domestically produced goods and a deterioration in the trade balance. As in the case of a negative productivity shock, the crowding out effect will lead to lower real wages. Short- and long-term unemployment stays almost constant. Therefore under constant benefits and duration, the net replacement rate is again counter-cyclical.

Labor market shocks

Besides classical supply (technology) and (government) demand shocks we also investigate a specific shocks to the labour market by assuming an increase in the vacancy costs and the separation rate (Figures 6 and 7).[38] A rising separation rate reflects the fact that job separations are endogenous to the business cycle.[39] Given productivity does not change an increase of the separation rate will decrease the output because workers quit their job due to external reasons. Therefore, rising unemployment means that output will drop and vacancies increase. Indeed, more unemployed workers increase the job filling probability of firms, which decreases their average cost of vacancy posting. Hence, separation shocks go along with a low fluctuation of labor market tightness and a shift of the Beveridge curve away from the origin. Higher separation rate lowers the net marginal value of being employed for workers, which drives up wages. This translates into higher producer prices and a real appreciation from the perspective of the domestic economy which again turns into a negative trade balance. Under constant benefits and eligibility durations

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[38]See Christoffel et al. (2009).

[39]Idiosyncratic shocks can lead to a single workers productivity lays under a certain threshold productivity such that she or he gets fired. See Fujita and Ramey (2012).

the net replacement appears to be counter-cyclical only in the first year after the separation rate increases, afterward it becomes pro-cyclical. This can be explained by the intertemporal pattern of taxes and wages. The increasing wages reduce the net replacement benefit and the raising tax, due to higher unemployment benefit financing, increases the net replacement rate. While the real wage converges back to the steady state after around two years, the time path of the tax is steeper in the long-run.

The vacancy cost shock captures variations in institutional settings and other time-varying factors except wages that have an effect on the hiring process of firms. Not surprisingly, an increase in vacancy costs will reduce vacancies, real wages and GDP since it reflects true costs that firms have to bear and what they partly consider for in the wage bargaining process. In contrast to the separation shock the increasing vacancy costs drives output, vacancies and real wages in the same direction. This will dampen the higher unemployment rate and reduce the marginal tax leading to a pro-cyclical net replacement rate.

4.2 Optimal national vs. union-wide benefit policy

Our next step consists in comparing the baseline scenario with two different union-wide unemployment insurance schemes. The first scenario is characterized by a insurance union that has a no-debt transfer rule. The no-debt transfer rule ensures that transfers do not flow permanently in one direction.[40] In order to compare the union-wide policy with the status quo we let all other parameters constant. In case of a negative productivity shock (Figure 4) one can see that the union-wide insurance is neutral to GDP and labor markets but will dampen the negative effects on consumption which translates into higher imports and a larger trade deficit. This will partly offset the negative effect from higher union-wide taxes in the foreign country. In contrast to the status quo, the union-wide agency will transfer income from the government of the foreign country which is not hit by the negative shock to the government of the domestic country. The domestic authority is now able to insure RoT households consumption partly. This will especially dampen the increase of the long-term unemployment rate. In the case of the government spending shock the union-wide insurance will reduce the crowding out of consumption and investment. The transfer outflow increases the consumption and import demand of the foreign economies RoT households. This reduces the negative trade balance. But it also shifts consumption from domestic optimizing households to the bond and investment demand of optimizing foreign households. Both effects have a positive impact on the time path of domestic output. The

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[40]See Moyen et al. (2016).

short- and long-term unemployment rates increase by less percentage points and the net replacement rate is counter-cyclical as in the baseline case. The union-wide insurance system will also reduce the cost of business cycle under increasing separations and vacancy costs. In both cases it will decrease the negative effects on consumption and output through the similar channels as before. In contrast to all other shocks under a union-wide insurance, vacancies react if the separation rate increases.

So far, we have seen that the hypothetical scenarios of union-wide insurance systems can lower welfare costs of business cycle fluctuations in comparison to the status. In a second step we want to evaluate these policies under two different concepts of optimality. First, we derive the Ramsey-optimal time path of the union-wide benefit policy. This however requires a policy that is proactive and reacts on the cycle. While in the United States such a policy is recently applied from 2008 to 2012, European politicians still remained passive not at least due to their austerity programs.[41] Therefore, the benefit policy in most European countries does not vary with the cycle. A more realistic way to derive optimal policy is to search over the parameter grids for the national $\{b_1^n, b_2, \phi_2\}$ and the union wide policy $\{b_1^f, \phi_1^f\}$ that minimize the welfare loss from business cycle fluctuations, which we call a static optimal policy.

In terms of national policy the status quo is compared with a scenario where size and length of premium unemployment benefits is optimized given the structure of the economy. Additionally, we compare the results with a optimized union-wide benefit policy. As can be seen in figure () the static optimized national policy

5   Conclusion

This paper studies the effects of implementing a unemployment insurance union between two countries. The design of the unemployment insurance union is characterized in an equilibrium model with imperfect financial markets and search externalities which give rise to national and supranational benefit policies. In order to prevent the unemployment insurance to be a vehicle for permanent transfers we include simple transfer rules that exclude steady state transfers which makes it rather a temporary supranational unemployment insurance mechanism.

We calibrate the model to the euro area core and periphery. By adding typical supply, demand and labour market shocks we find that the cyclical correlation of the benefit policy with output depends on the type of the underlying shock. While under supply (productivity) and demand (government spending) shocks the net replacement rate is counter-cyclical, labour market shocks

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[41]See Albertini and Poirier (2015).

tend to influence it pro-cyclically. This may explain the observed heterogeneous cyclical net replacement rate across EA countries. In a next step the actual situation (status quo) is compared with the a hypothetical budget-neutral supranational insurance union. In case of a negative domestic technology shock, we confirm the existing results from Moyen et al. (2016) who found that international risk sharing motives turn insurance policies more counter-cyclical. In case of a domestic expansionary fiscal policy the insurance union will reduce the negative effect of crowding. In contrast to a purely national system the temporary transfers through the unemployment union shifts income from domestic optimizing households to Rule-of-Thumb households in both countries. This will increase the foreign import demand and reduce the long-term unemployment rate. For all shocks the unemployment insurance union can reduce welfare costs of business cycle - measured by fluctuation in consumption and unemployment - under neutral output, labour market variables.

Although insightful, the model has some shortcomings that will guide our further direction of research. Emphasize in future work will be placed on endogenizing the optimal benefit policies of the national government and the union. This will allow us to analyze strategic interaction between both. Furthermore it would be interesting to analyze the effect of the temporary unemployment insurance union only when the central bank is at the zero lower bound or if national governments are debt constraint.

6 Appendix

6.1 Data description

Output: Gross domestic product at 2010 market prices per head of population (RVGDP) (2010=100) multiplied by total population (National accounts) (NPTD) (1000 Persons), AMECO database, OECD National Accounts, 2017.

Consumption: Total consumption at 2010 prices (OCNT) (in national currency 2010=100), AMECO database, OECD National Accounts, 2017.

Employment: Employment, persons: total economy (National accounts) (NETN) (1000 Persons), AMECO database, OECD National Accounts, 2017.

Labour force: Total labour force (Labour force statistics) (NLTN) (1000 Persons), AMECO database, OECD National Accounts, 2017.

Unemployment rate: Unemployment rate: total :- Member States: definition EUROSTAT (ZUTN), AMECO database, OECD National Accounts, 2017.

Real wages: Real compensation per employee, deflator GDP: total economy (RWCDV) (2010=100), AMECO database, OECD National Accounts, 2017.

CPI inflation: Percentage change of national consumer price index (All-items) (ZCPIN) (2010=100), AMECO database, OECD National Accounts, 2017.

Wage inflation: Percentage change of Compensation of employees: total economy (UWCD), AMECO database, OECD National Accounts, 2017.

Vacancies: Employer perception of labour shortages (total manufacturing), European Commission's Surveys of Business Confidence, Quarterly questionnaire, OECD National Accounts, 2017

Replacement rate: Share of benefit on net income for an average production worker, single person, Welfare State Entitlements Data Set, NEUJOBS Special Report No. 2, Leiden University and OECD National Accounts, 2017.

Symmetric structural parameter		Core	Periphery	Target
Economic size	n	0.61	0.39	Relative working-age population
Time preference	β		0.98	$\bar{i} \approx 2\%$ p.a.
Production elasticity	α		$\frac{1}{3}$	Capital-output ratio
Depreciation rate	δ		0.025	Investment share
Wage bargaining power	ζ		0.9	Frictional labour market
Substitution elasticity of matching	η		0.5	Tightness
Inverse trade elasticity	σ		0.904	
Openness	ψ	0.584	0.412	Consumption share
Risk aversion	γ		1.5	
Share of HoT consumers	λ		0.33	
Government spending	$\bar{g}$	0.18	0.16	EA average
Portfolio adjustment costs	κ^P		0.1	

Labour market		Core	Periphery	Target
Separation rate	s	0.0271	0.0487	Christoffel et al. (2009)
Match efficiency	κ^E		0.4583	Unemployment rate
Unemployment benefit	b	0.58	0.52	Average net replacement rate
National entitlement duration	ϕ_1^S		0.5	Short-term net replacement rate
Social assistance	z	0.38	0.45	Long-term net replacement rate
Vacancy costs	κ^V		0.3	Vacancy cost share

Shock parameter		Core	Periphery	Target
Persistence TFP	ρ_A	0.96	0.9	
Persistence government spending	ρ_G	0.79	0.75	
Persistence separation rate	ρ_S	0.75	0.75	
Persistence vacancy cost	ρ_V	0.65	0.45	St.derr W
SD TFP shock	σ_A	0.25	0.31	St.derr Y
SD government spending shock	σ_G	0.31	0.35	St.derr C
SD separation rate shock	σ_S	9.1	2.4	St.derr U
SD vacancy cost shock	σ_V	4.5	1.9	St.derr W

Table 3: Calibration

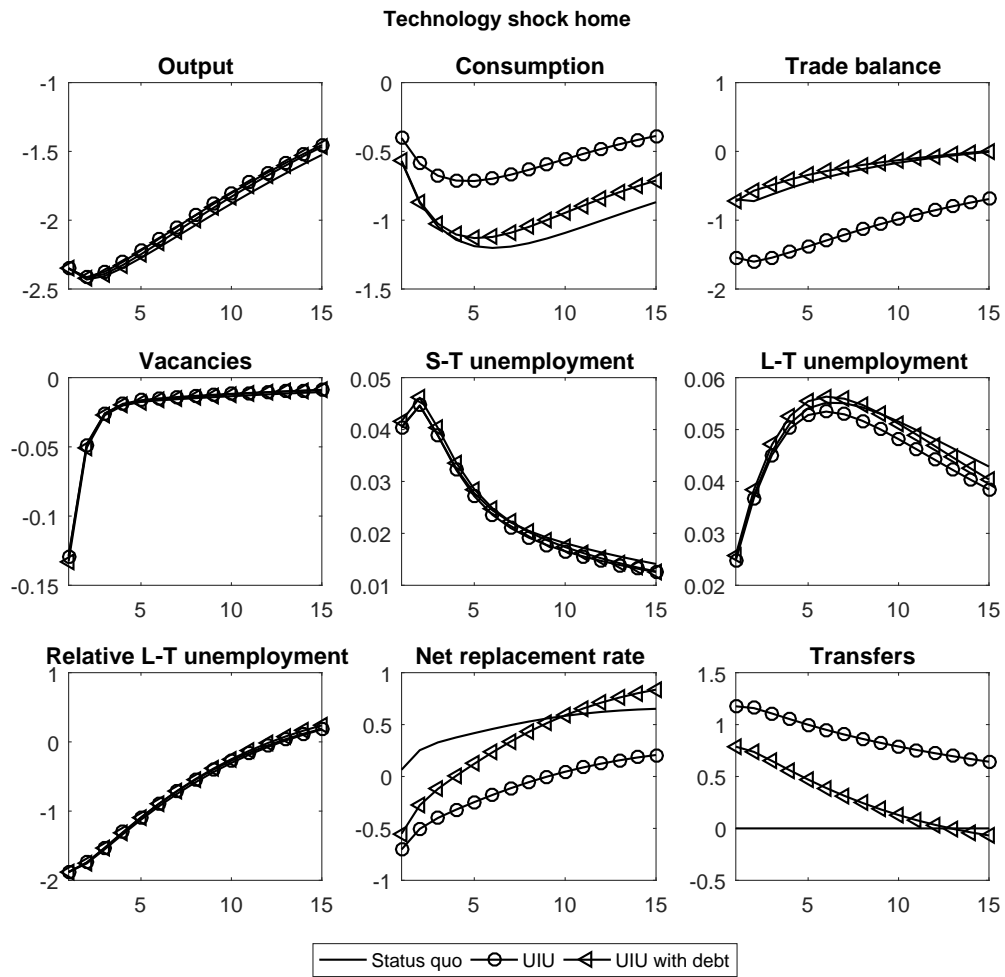Figure 4: Negative domestic technology shock (One SD)

Technology shock home

Figure 5: Positive domestic government spending shock (One SD)

Government spending shock home
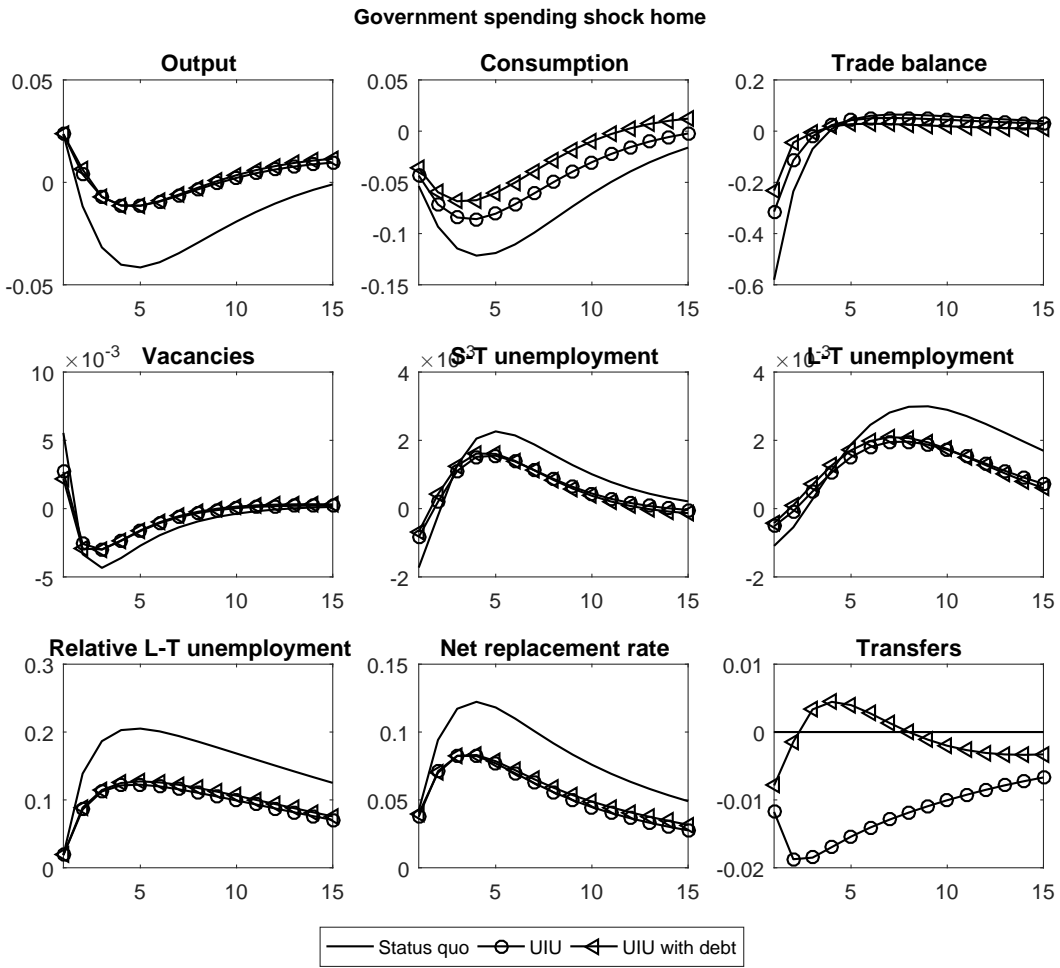
Figure 6: Positive domestic separation rate shock (One SD)

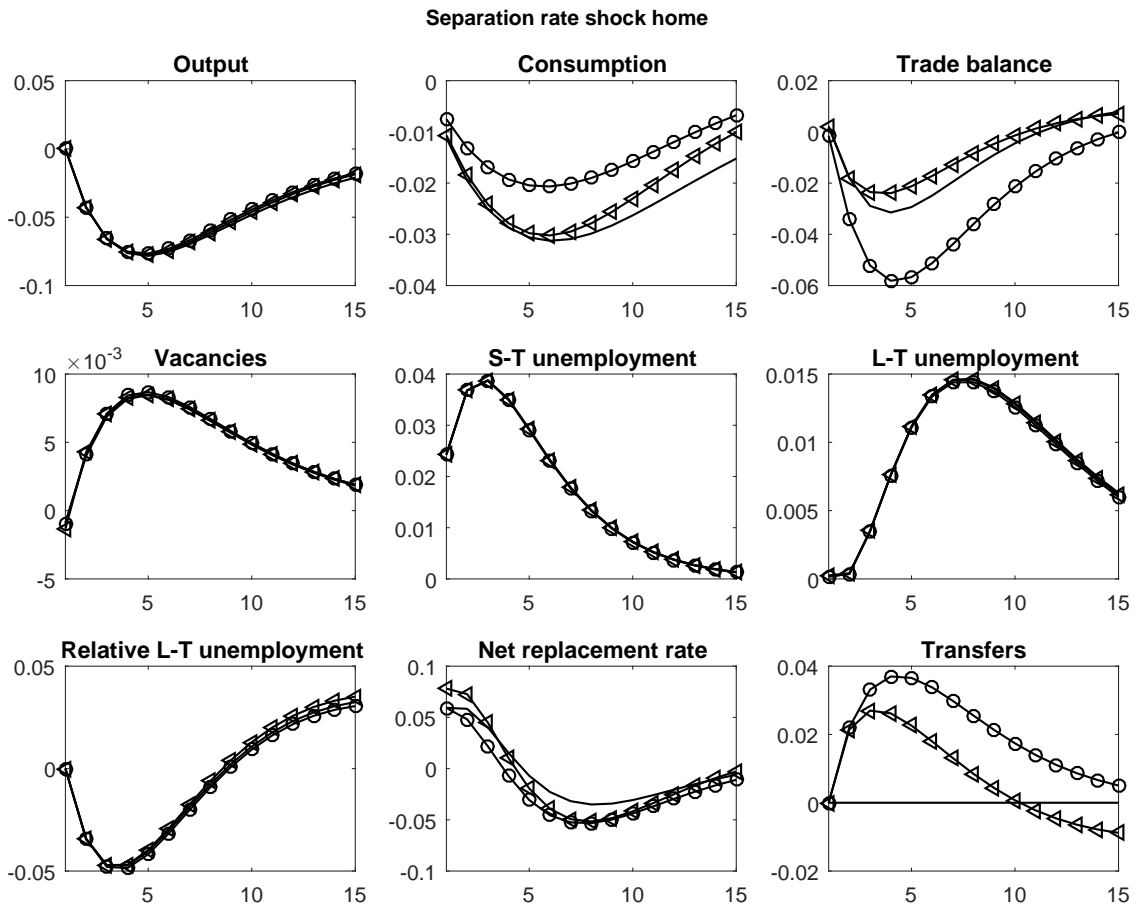**Separation rate shock home**

Figure 7: Positive domestic vacancy cost shock (One SD)
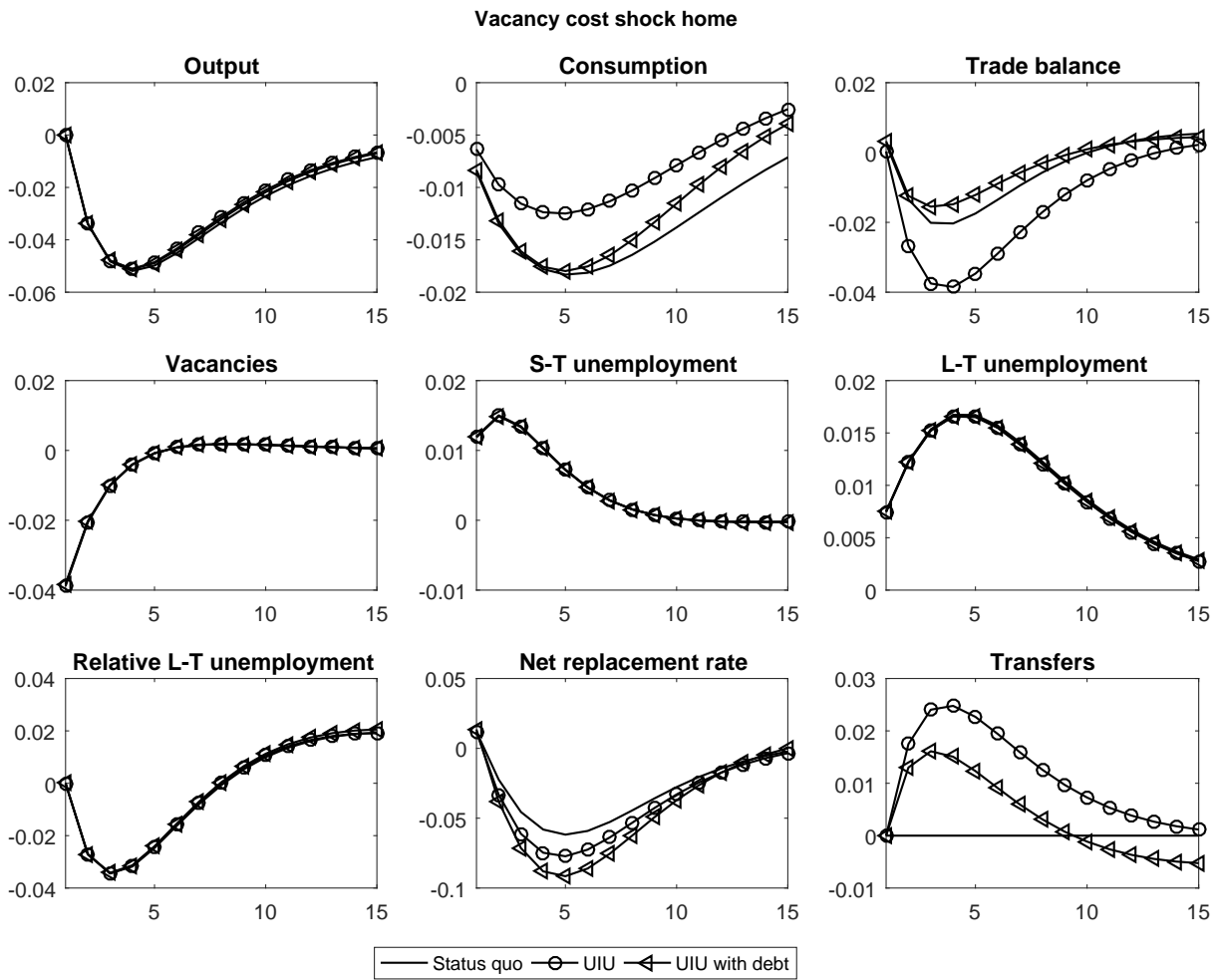
Vacancy cost shock home

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