Effects of a European Unemployment Insurance

—Preliminary and incomplete—

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Abstract

The recent euro crisis highlighted flaws in the design of the monetary union. As a reaction, policy makers have proposed the introduction of a European unemployment benefit scheme (EUBS). In this paper we assess to which degree such a scheme can enhance allocative efficiency. Specifically, we use a rich DSGE model, calibrated to the core and the periphery of the euro area, to analyze the changing dynamics and altered risk sharing that a EUBS brings about. Additionally, we employ a simple model to build intuition. We find that following supply shocks, a EUBS can stabilize consumption in the negatively affected countries. The transfer embodied in the unemployment benefits, however, is spent to a large degree on relatively inefficient production in the receiving countries, creating significant labor wedges. We show that this is a general result for monetary unions with sticky prices, incomplete markets, and home bias. After demand shocks, unemployment responses are relatively similar, due to the common monetary policy. The impact of the cross-country transfer is therefore limited.

Keywords: European business cycles, EMU, Optimum Currency Area, Structural reforms Unemployment insurance, Exchange rate regime, Cross-country spillovers

JEL-Codes: E21

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1 Introduction

After the creation of the Economic and Monetary Union (EMU) in 1992, European integration culminated in the introduction of the euro in 1999. Today, 19 countries in Europe share the same currency and delegate monetary policy for the euro area to the European System of Central Banks. The surrender of monetary autonomy at the member-state level involves the loss of a powerful capacity to stabilize the economy in the face of asymmetric shocks.[1]

The lack of a stabilizing mechanism became evident in the so-called 'euro crisis' that was characterized by strongly diverging developments among the member states, see Figure 1. As a result, many policy makers and academics have called for a completion of the euro zone to prevent this episode from happening again in the future (see, for example, Bénassy-Quéré et al., 2018). Various theoretical contributions propose risk-sharing mechanisms that are designed to compensate for the costs of a monetary union. Dixit and Lambertini (2003), Galí and Perotti (2003), and Galí and Monacelli (2008), among others, study the conduct of fiscal policy in monetary unions and the introduction of a fiscal authority at the European level. European fiscal unification, however, is currently not feasible from a political perspective. Hence, other mechanisms for automatic stabilization in the face of asymmetric shocks are on the agenda. The most prominent example is a European unemployment benefit scheme (EUBS in the following) to enable the member states to insure against asymmetric shocks. The role of an unemployment insurance for stabilization in a closed-economy setting is well documented in the literature[2]. The analysis of the mechanisms of cross-country unemployment risk sharing in an open-economy world, however, is still an open field.

In this paper, we evaluate the macroeconomic effects of the introduction of a EUBS. We particularly focus on the impact of the cross-country transfers induced by the scheme. First, using a simple two-country model of a monetary union with dynamic distortions, we show that sticky prices and incomplete markets give rise to a trade-off between consumption risk sharing and production efficiency that, if prices are fairly rigid and home bias is present, may cause the optimal transfer to flow out of the country hit by a negative technology shock. This is opposite to what a EUBS would implement. Second, we put forward a quantitative business cycle model to evaluate the effects in the specific context of the euro area. For the latter, we explicitly take into account the existing asymmetries in economic structures between core and periphery countries of the EMU. We find, in line with the intuition from the small model, that a EUBS increases international comovement of consumption and output, but aggravates the inefficient distribution of factor inputs and leads to more pronounced spillovers across countries. Moreover, the EUBS cannot be considered a substitute for a flexible exchange rate regime.

The existing literature is mostly restricted to simulation exercises based on micro data. For example, Beblavý et al. (2017) present a comprehensive report for the European Commission on the design features of a EUBS. The authors document legal and operational implications of

[1]This is the main argument of the so-called *Theory of Optimum Currency Areas (OCA)*, which was first coined by Mundell (1961) and McKinnon (1963). The OCA literature balances the costs of the surrender of flexible exchange rates with the benefits from lower transaction costs.

[2] See, for instance, Blanchard and Tirole (2008), Jung and Kuester (2015), or McKay and Reis (2016).

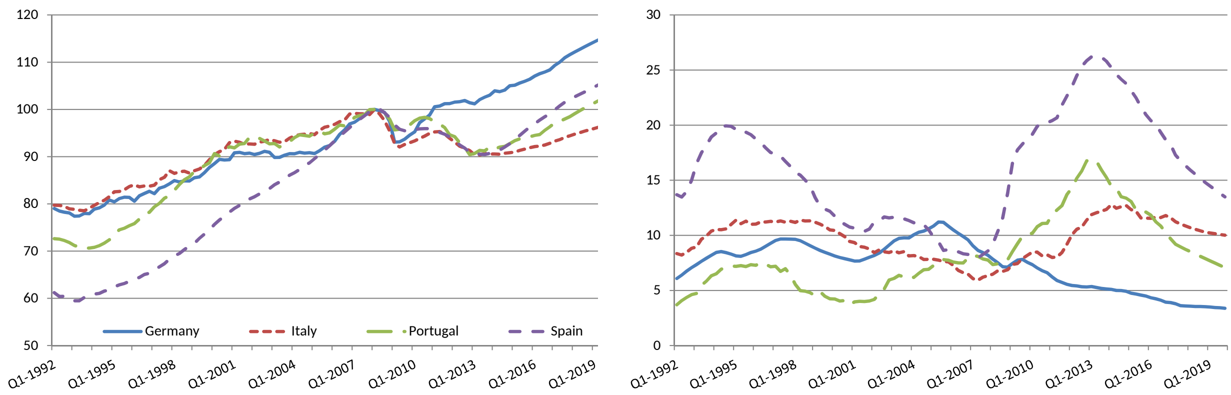

Figure 1: GDP and unemployment.
Left panel shows real GDP for Germany, Italy, Portugal, Spain, 2000=100. Right panel shows unemployment rate for the same countries. Data after 2017Q3 are OECD forecasts.

different schemes as well as their strengths and weaknesses. Based on micro-simulations, the report concludes that the introduction of a EUBS has potential for automatic stabilization. This is in line with the conclusions of other policy papers, for example Dullien and Fichtner (2013) and Andor et al. (2014). Dolls et al. (2015) and Jara et al. (2016) run quantitative simulations with micro data using the EUROMOD tax-benefit model and find that a EUBS could have provided significant risk sharing during the global financial crisis of 2008-2009.

These studies have in common that they use static models which do not account for aggregate dynamics and general-equilibrium effects of the introduction of a EUBS. Abrahám et al. (2017), instead, analyze the flows between employment, unemployment, and inactivity in a dynamic stochastic general equilibrium (DSGE) model with search frictions in the labor market, which is based on the model of worker flows set out in Krusell et al. (2011). The authors find only limited space for insurance at the European level and stress the role of country-specific labor market policies. Importantly, the analysis focuses only on the extensive margin of labor supply. Moyen et al. (2016) develop a two-country DSGE model with search-and-matching frictions and a cross-country unemployment insurance system. Besides deriving an analytical solution for a tractable two-period version, the authors run simulations in a calibrated dynamic version of the model. They find that sizeable cross-country transfers in a EUBS can stabilize consumption in the short-run. The production side of their model, however, does not account for capital formation or a non-tradable goods sector. Jung et al. (2017) study a federal unemployment insurance in a DSGE model featuring a union of small open economies and search-and-matching labor markets. Their focus is on a setting where the member states can adjust country-specific labor-market polices in response to the federal insurance scheme. They conclude that coordination of the federal and country-specific schemes could provide insurance against fluctuations and increase welfare. Their analysis abstracts from cross-country differences, the effects of monetary policy, and trade patterns.

Our contribution to this literature is twofold. First, we lay out a simple two-country model of a monetary union with internationally traded intermediate goods, incomplete financial markets, and sticky prices. We derive deviations of the first-order conditions from the corresponding social-planner solution, so-called 'wedges', and, similarly to Farhi and Werning (2017), establish a trade-off between consumption risk sharing and production efficiency induced by the transfer. We then show that this trade-off may dictate transfers that flow opposite to what a EUBS would imply. Second, we analyze the introduction of a EUBS in a comprehensive two-country DSGE model, drawing on Enders et al. (2013). We aim to capture the specific European situation in detail and to incorporate important aspects of the market structure that are likely to impact on risk sharing. That is, our model incorporates a more detailed goods market structure than the other models in the literature. Intermediate firms in both countries produce differentiated exports goods, which are traded within the union. In addition, we include a non-tradable intermediate goods sector in each country. Thus, we account for risk sharing (or amplification) via changes in relative purchasing power and movements in the terms of trade. A final goods firm, operating under perfect competition, bundles intermediate goods into a final good that is not traded across countries (see Chari et al., 2002; Stockman and Tesar, 1995). This allows us to replicate important cross-country correlations and the behavior of the real exchange rate. Monetary and fiscal policy are characterized by standard feedback rules. Moreover, we include a labor market with search-and-matching frictions along the lines of Mortensen and Pissarides (1994a) and credible wage bargaining following Hall and Milgrom (2008). The model is carefully calibrated to match key aspects of the data for European countries since the introduction of the euro. Given the detailed structure of the model, we incorporate many specifics of the euro area in its current state. As a drawback, we are not able to derive analytical solutions. We therefore see our paper as complementary to the above-mentioned studies.

We use the model to run different policy experiments. In the baseline case, we incorporate country-specific unemployment insurance schemes. In a counterfactual exercise, we introduce a EUBS and run simulations to explore the general-equilibrium effects. We find that a EUBS indeed increases cross-country correlations of output and consumption. This, however, comes at the cost of a misallocation of factor inputs. Following supply shocks, the less productive country receives a transfer via the EUBS. This boosts consumption, but a relatively large part of this additional demand is spent on inefficiently produced goods, that is domestic goods from the perspective of the receiving country. Capital and labor in this country are hence higher as under flexible exchange rates. The wedges between the decentralized equilibrium outcome and the social-planner solution confirm the finding that the EUBS leads to production inefficiencies and deviations from optimal risk sharing. Following demand shocks, i.e., government spending shocks in our context, the existence of a EUBS has no large effects. Due to the unchanged technology levels and relatively similar consumption paths in both countries, induced by the common monetary policy stance, unemployment rates are too similar to trigger a large transfer. Reactions with and without a transfer in the monetary union are hence close to each other.

The remainder of this paper is organized as follows. Section 2 presents the tractable two-country model. In Section 3, we introduce the quantitative model, with the calibration and model simulations being presented in Section 4. We discuss the effects of an introduction of a EUBS in Section 5. Section 6 concludes. Data sources are listed in the appendix.

2 A toy model

In this section, we derive a simple model of a monetary union, consisting of two symmetric countries. Only a fraction of price setters can react to shocks of the same period, where shocks occur only in the first period in the foreign country. By means of this simplified version of our full model in Section 3, we explore to what extent transfers between the two countries can mitigate the negative effects of the two dynamic distortions in the economy, rigid prices cum monetary union and incomplete markets. We will then show that the intuition obtained in this section carries over to the large model featuring a European unemployment benefit system.

Both countries are populated by a representative household each. We will outline only the domestic side of the model, with symmetric structures existing in in the foreign economy. Foreign variables are denoted with an asterisk. The household maximizes the utility function

$$U_t = \ln C_t - \frac{H_t^2}{2},$$

where C is consumption and H are hours worked in the production of the domestic good. The corresponding budget constraint is

$$W_t H_t + \Phi_t + \Upsilon_t = P_t C_t + R_t^{-1} \Phi_{t+1} + T_t,$$

with W denoting the nominal wage, Υ stands for potential profits or losses of the domestic firms, and T are transfers (if negative) or lump-sum taxes (if positive). The transfer considered in this context is a cross-country transfer, i.e., $T = -T^*$. The household can engage in lending or borrowing international bonds Φ, which pay one dollar in period $t+1$ and cost R^{-1} in period t. Finally, P is the price of the final consumption good in the domestic market. This consumption good consists of domestically produced, A, and imported goods, B, in the following way

$$C_t = \left(\omega^{\frac{1}{\sigma}} A_t^{\frac{\sigma-1}{\sigma}} + (1-\omega)^{\frac{1}{\sigma}} B_t^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

with ω determining the home bias, i.e. the fraction of total expenditure falling on domestic goods in case of equal prices, and σ the trade-price elasticity. Firms sell the amount A to the domestic market and export A^* to the foreign economy. Total output Y is produced according to a simple production function with labor and technology Z as the only input factors,

$$Y_t = Z_t H_t = A_t + A_t^*.$$

Price setting of the firms is constrained in the sense that only a fraction ξ of all firms in both countries can set a new price after observing potential shocks in period t (both economies are in steady state up until period t). In period $t+1$, all firms can adjust their prices freely. We hence obtain the following equations determining the price of the domestic good

$$P_{A,t} = \xi(\mathcal{MU} W_t / Z_t) + (1-\xi) P_{A,t-1}, \qquad P_{A,t+1} = \mathcal{MU} W_{t+1} / Z_{t+1},$$

where $P_{A,t-1}$ is the steady-state price, as we only consider shocks occurring in period t. The optimal markup $\mathcal{MU}$ depends on the elasticity of substitution between the goods of the individual firms. Given that it does not play a role for the linearized system analyzed below, we omit a more detailed discussion.

In order to close the model, we need to pin down inflation between the two periods. We do so by assuming that the central bank has perfect control of expected union-wide inflation, besides the nominal interest rate. Specifically, it sets both variables such that the real interest rate reflects expected changes in average productivity, with $\pi_{t+1} = \sqrt{P_{t+1}P^*_{t+1}/P_t P^*_t}$ being the aggregate rate of inflation[3]

$$R_t = E_t \pi_{t+1} \sqrt{Z_{t+1} Z^*_{t+1} / Z_t Z^*_t}.$$

We define deviations from the first-order conditions of the corresponding social-planner solution regarding the optimal labor input as 'wedges' (Farhi and Werning, 2017). In this context, we differentiate between several wedges. First, the difference between marginal utility costs of producing the Home good and the marginal utility derived from its consumption in the Home economy (the 'Home@Home' wedge), the difference between these costs and the marginal utility derived from the consumption of the Home good in the Foreign economy (the 'Home@Foreign' wedge), and the corresponding foreign wedges (called Foreign@Foreign and Foreign@Home wedges). Second, we can combine the Home@Home and the Home@Foreign wedges by calculating a quantity-weighted average of the marginal utilities derived of the Home good in both countries to obtain an overall Home labor wedge; similarly for Foreign. Finally, we also calculate the deviations from the so-called risk-sharing condition (Backus and Smith, 1993). This gives us the following wedges, with corresponding labor wedges for Foreign:

Home@Home:	$\dfrac{-U_H}{MP} - U_C C_A$
Home@Foreign:	$\dfrac{-U_H}{MP} - U^*_C C^*_A$
Overall Home:	$\dfrac{-U_H}{MP} - \left[\dfrac{A}{Y} U^\sigma_C C^\sigma_A + \dfrac{A^*}{Y} U^{*\sigma}_C C^{*\sigma}_A\right]^{\frac{1}{\sigma}}$
Risk Sharing:	$\dfrac{C^*}{C} - \dfrac{P}{P^*}$,

where U_C denotes marginal utility of consumption and C_A the derivative of the consumption bundle (1) with respect to good A. MP stands for the marginal product of labor and U_H for the marginal disutility of labor. The wedges are defined such that a positive value corresponds to 'too large' (relative to a closed wedge) values of hours worked and production, or 'too large' consumption in the foreign country in the case of the risk-sharing wedge. In the social-planner solution, these wedges are zero. Because of the frictions in the economy, this is not the case in the decentralized equilibrium. Below we will explore if a transfer scheme between the two

[3]This assumption minimizes the distortions stemming from monetary policy, given that monetary policy has only union-wide instruments at its disposal.

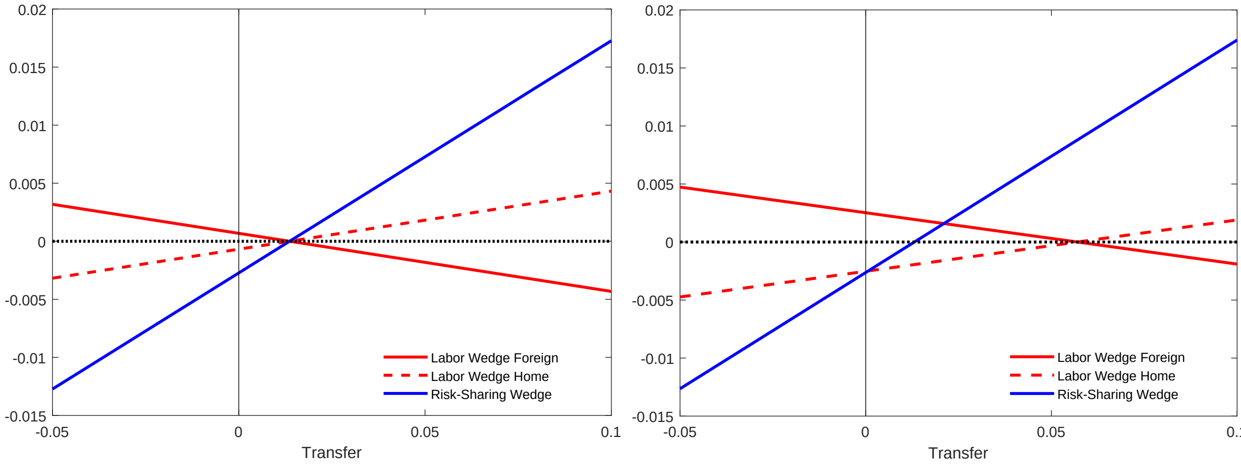

Figure 2: Labor and risk-sharing wedges. Notes: flexible prices ($\xi = 1$, left), $\xi = 0.9$ (right).

countries can alleviate the distortions introduced by the dynamic frictions.[4]

We solve the model by linearizing the relevant first-order conditions around the symmetric, zero-inflation steady state.[5] To generate figures 2 and 3, we set $\omega = 0.75$, i.e., a relatively high but realistic home bias. The steady-state interest rate is 10%, while σ, the trade-price elasticity is set to two.[6] We simulate a temporary shock of -5% to foreign technology Z_t^* for all figures. The x-axes of all figures denote a lump-sum transfer from Home to Foreign in the period of the shock, expressed in percentage of GDP of one country. Transfers in following periods are zero throughout; also technology in both countries returns to its steady-state level. All figures refer to period t, the period of the shock.

The left panel of Figure 2 shows the case of flexible prices. Given that $\sigma \neq 1$, together with the assumption of incomplete markets, the risk-sharing condition is violated in case of no transfers. The fall in Z_t^* causes firms in the foreign economy to increase prices. With $\sigma > 1$, quantities react relatively strongly to this price change, or, equivalently, Home obtains a relatively large share of world expenditure. Its marginal utility of consumption is hence too low, seen from a risk-sharing perspective (the risk-sharing wedge is negative). Marginal utility derived from consumption of the foreign good is therefore also relatively low, implying a positive Foreign@Home and overall foreign labor wedge (and vice versa for the home labor wedge). Shifting resources from the Home to the Foreign economy increases Home's marginal utility of consumption. At the point of a closed risk-sharing wedge, the ratio of the marginal utilities of consumption equals the ratio of the prices of the consumption goods in Home and Foreign, such that utility costs of production are in line with the associated gains in utility; both labor wedges are closed. That is, implementing the same transfer that would result from

[4]Due to monopolistic competition, labor wedges are not zero in steady state. To combat this distortion, however, other instruments than dynamic cross-country transfers should be employed. For this reason and to simplify the description of the analysis, although not entirely correct, below we refer to the situation with wedges at their steady-state values as optimal.

[5]We intend to solve the model analytically in future versions of this paper.

[6]Setting σ to unity has no effect on the qualitative conclusions. In this case, however, the risk sharing condition is reached with a zero transfer even for rigid prices (Cole and Obstfeld, 1991).

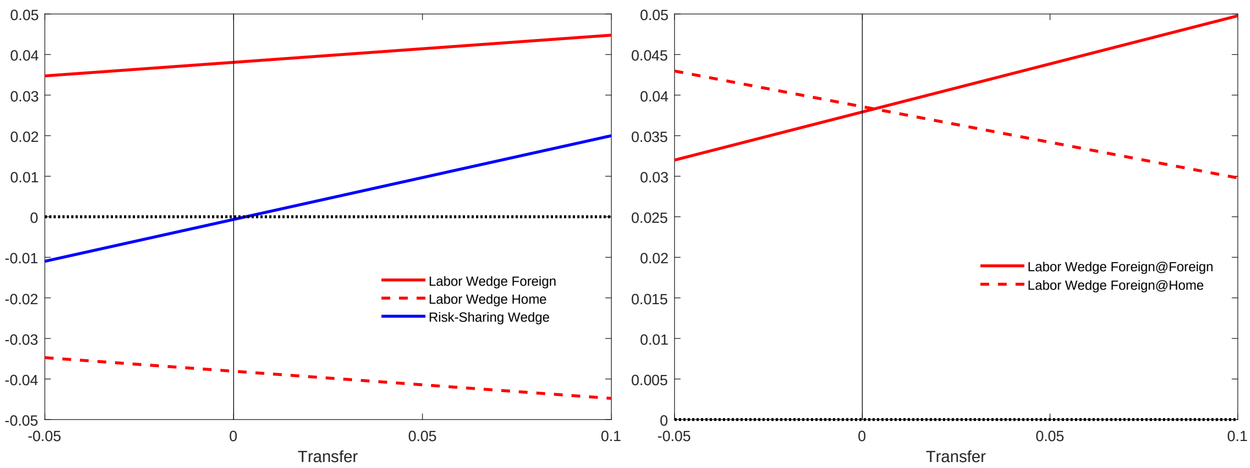

Figure 3: Labor and risk-sharing wedges. Notes: $\xi = 0.1$, individual wedges of foreign good (right).

the trade of a full set of state-contingent securities closes all wedges simultaneously, replicating the complete-markets solution.

This, however, is no longer possible with rigid prices. The right panel of Figure 2 depicts the outcome under relatively modest price rigidities ($\xi = 0.9$). As visible, a trade-off between closing the labor wedges (efficient allocation of production) and the risk-sharing wedge (efficient distribution of consumption) obtains.[7] The intuition is straightforward. Prices do not reflect the true costs of production anymore. Closing the risk-sharing wedge means that relative marginal utilities align with the relative costs of purchasing consumption in both countries. Given that the costs of purchasing consumption no longer move one-to-one with the costs of producing consumption goods, production is allocated inefficiently even with a closed risk-sharing wedge. In particular, the foreign price is 'too low' at this point, in the sense that due to price rigidities it rises by less than the increase in marginal costs. Hence, a positive labor wedge remains. Implementing a larger transfer closes the labor wedges, but violates the risk-sharing condition. The overall foreign labor wedge is closed primarily because the transfer decreases Home's consumption level, raising the marginal utility derived from consuming the foreign good until overall consumption utility from the foreign good equals its costs of production.[8]

Matters become even worse for higher price rigidities. First, depicted in the left panel of Figure 3, labor wedges open up much more, given the muted reaction of the relative price to the change in technology.[9] Second, the effect of the transfer reverses. The transfer still

[7] A very closely related observation was already made by Farhi and Werning (2017): under complete markets, which imply a closed risk-sharing wedge, the constrained optimum is generally not reached. One of several differences of our model to theirs is that we consider transfers which are financed by lump-sum, instead of distortionary taxation. This allows us to focus on the pure effects of the transfer.

[8] A different central-bank rule would not even allow to close labor wedges simultaneously. Remember also that 'closing the labor wedges' in this context refers to bringing the wedges back to their steady-state values, not to zero (see above).

[9] At the same time, the risk-sharing wedge is smaller. Consider the case of completely fixed prices as an example. Expenditure and hence income would be unaffected by the technology shock, such that consumption levels and the price ratio would remain at their steady-state values. Obviously, production would not be allocated efficiently in this case, visible in open labor wedges.

increases the marginal utility of Home, which, as before, reduces the Foreign@Home wedge, see the right panel of Figure 3. This improvement, however, is overturned by a counteracting effect in the foreign country. The transfer to Foreign is spent primarily on the foreign good because of the home bias and the muted reaction of prices. This pattern increases production costs of the foreign good, such that the Foreign@Foreign wedge rises and dominates the overall foreign labor wedge (its weight in the overall labor wedge rises with home bias).

As a comparison, with more flexible prices (Figure 2), the resulting price gain dampens the increase in production and the described effect. Hence, flexible prices and/or a bias towards foreign goods give the expected result: a transfer to the country with the negative productivity shock leads to a reduction of all considered wedges. For less than perfectly flexible prices (right panel of Figure 2), a trade-off between closing the labor wedges and the risk-sharing wedge remains. Relatively rigid prices (Figure 3) in combination with home bias, on the other hand, invert this relationship: labor wedges start to close if the transfer is conducted *away* from the country with the negative technology shock. The risk-sharing wedge, however, opens up even more in this case, aggravating the described trade-off. As a result, while the joint period-1 utility increases with a transfer towards Foreign after a negative technology shock in that country under relatively flexible prices and/or a foreign bias, the opposite is true under relatively rigid prices and home bias.

To summarize, our toy model shows that raising allocative efficiency by usage of an international transfer scheme may actually require transfers that are opposite of what a EUBS would imply. If home bias and sticky prices, both realistic features, are prevalent, a transfer to a country with a temporarily inferior production technology, although bringing consumption levels closer to each other, may actually decrease efficiency and welfare. The reason, as discussed above, is that this transfer leads to an increase in the consumption of the inefficiently produced good. In the following section, we will calibrate a quantitative business cycle model to the euro area and investigate the implications of this insight for a potential EUBS.

3 Quantitative model

In this section, we provide a formal exposition of the theoretical quantitative business cycle model. We mainly draw on the two-country model laid out in Enders et al. (2013). This model features several potential channels for risk-sharing (bonds, time-varying terms of trade with differentiated traded and non-traded goods) and search-and-matching labor market frictions. We add national unemployment insurance schemes and, in a counterfactual scenario, a EUBS. In the following, we discuss the problems of the representative household, the final good firm and the intermediate good firm as well as the frictional labor market. We close the model with unemployment insurance schemes and feedback rules characterizing monetary and fiscal policy. The 'Home' country in our model is a euro area Core aggregate, whereas the 'Foreign' country represents a euro area Periphery aggregate. As both countries have isomorphic structures, the exposition focuses on the Core aggregate. We refer to the Periphery aggregate by means of an asterisk. The relative size of the Core, i.e. its GDP divided by Periphery GDP, is denoted by n.

3.1 Representative household

A representative household chooses consumption expenditures for final goods, C_t, and supplies hours worked, H_t. Preferences are represented by the following lifetime utility function

$$E_0 \sum_{t=0}^{\infty} \beta_t \left(\frac{C_t^{1-\gamma} - 1}{1-\gamma} - \vartheta \frac{H_t^{1+\mu}(1-U_t)}{1+\mu} \right) \tag{2}$$
$$\beta_0 = 1, \quad \beta_{t+1} = \beta(C_t)\beta_t, \quad \beta(C_t) = (1+\psi C_t)^{-1},$$

where the function $\beta(C_t)$ ensures that the discount factor β_t decreases in response to a rise in average consumption.[10] The parameter $\psi > 0$ pins down the value of the discount factor in steady state. The measure of unemployed workers is denoted by U_t.

The employed measure of workers earns the hourly wage W_t, which is taxed at rate $\tau_{L,t}$, whereas the unemployed measure receives unemployment benefits b_t. The benefits are distributed by an unemployment insurance scheme, which we describe in more detail below. The capital stocks $K_{A,t}$ and $K_{N,t}$, which are owned by the household, are used in the production of intermediate traded and non-traded goods. We allow for trade in riskless one-period bonds, Θ_t and Θ_t^*, denominated in domestic and foreign currency. The budget constraint of the domestic household is therefore given by

$$\begin{aligned} & (1-\tau_{L,t})W_t H_t(1-U_t) + R_{A,t}K_{A,t} + R_{N,t}K_{N,t} + \Upsilon_t + \Theta_t + S_t\Theta_t^*/n + b_t U_t \\ = \; & P_{F,t}(C_t + T_t + X_t) + R_t^{-1}\Theta_{t+1} + R_t^{*-1}S_t\Theta_{t+1}^*/n \end{aligned} \tag{3}$$

where R_t and R_t^* denote domestic and foreign gross nominal interest rates, T_t measures lump-sum taxes and Υ_t denotes intermediate and labor market firms' profits.

Labor and capital are assumed to be immobile across countries. Following Christiano et al. (2005), we assume that adjusting the rate of investment is costly. Specifically, we assume the following law of motion for capital in each sector

$$K_{k,t+1} = (1-\delta)K_{k,t} + \digamma(X_{k,t}, X_{k,t-1}), \text{ with } \digamma = \left[1 - \frac{\kappa}{2}\left(\frac{X_{k,t}}{X_{k,t-1}} - 1\right)^2\right] X_{k,t}, \tag{4}$$

where k refers to the traded and non-traded goods sectors and $\kappa \geq 0$ measures the extent of adjustment costs. Total investment expenditures are given by $X_t = X_{A,t} + X_{N,t}$.

3.2 Final good firms

The final good, F_t, is composed of traded and non-traded intermediate goods produced by a continuum of monopolistically competitive intermediate goods firms in both countries. Operating under perfect competition, final good firms bundle domestically produced intermediate goods,

[10] This effect is not internalized by the household. The assumption of an endogenous discount factor induces stationarity of the model around a deterministic steady state, see Schmitt-Grohé and Uribe (2003) for details.

$A_t(j)$, imported intermediate goods, $B_t(j)$, and domestically produced non-traded goods, $N_t(j)$. The index $j \in [0,1]$ is used to indicate intermediate good firms and the corresponding varieties and prices. We assume that final good bundles are not traded across countries.

A representative final good firm minimizes expenditures subject to the demand for final goods subject and an aggregation technology. The constraint of the final good firm is given by

$$\begin{aligned} F_t &= C_t + X_t + G_t + \chi V_t \\ &= \left\{ \begin{array}{c} \upsilon^{\varrho+1} \left[\omega^{\varsigma+1} \left(\int_0^1 A_t(j)^{-\varepsilon} dj \right)^{\frac{\varsigma}{\varepsilon}} + (1-\omega)^{\varsigma+1} \left(\int_0^1 B_t(j)^{-\varepsilon} dj \right)^{\frac{\varsigma}{\varepsilon}} \right]^{\frac{\varrho}{\varsigma}} \\ +(1-\upsilon)^{\varrho+1} \left(\int_0^1 N_t(j)^{-\varepsilon} dj \right)^{\frac{\varrho}{\varepsilon}} \end{array} \right\}^{-\frac{1}{\varrho}}, \end{aligned} \tag{5}$$

where C_t, X_t, and G_t denote consumption, investment, and government spending, respectively. The resource loss resulting from the labor market frictions discussed below is captured by χV_t. The parameter $\sigma \equiv (1+\varsigma)^{-1}$ measures the trade price elasticity of substitution, $\epsilon \equiv (1+\varepsilon)^{-1}$ denotes the elasticity of substitution between intermediate goods of the same type, and $\eta = (1+\varrho)^{-1}$ measures the elasticity of substitution between tradeable and non-tradeable goods. The weight of traded goods in the final good bundle is denoted by υ, whereas the weight of domestically produced goods in traded goods is given by ω.

Expenditure minimization by final good firms in both countries implies the following demand functions for domestically produced tradable intermediate goods, $A_t(j)$ and $A_t^*(j)$, respectively

$$A_t(j) = \upsilon \left(\frac{P_{A,t}(j)}{P_{A,t}} \right)^{-\epsilon} \left(\frac{P_{A,t}}{P_{T,t}} \right)^{-\sigma} \left(\frac{P_{T,t}}{P_{F,t}} \right)^{-\eta} (1-\omega) F_t, \tag{6}$$

$$A_t^*(j) = \upsilon \left(\frac{P_{A,t}^*(j)}{P_{A,t}^*} \right)^{-\epsilon} \left(\frac{P_{A,t}^*}{P_{T,t}^*} \right)^{-\sigma} \left(\frac{P_{T,t}^*}{P_{F,t}^*} \right)^{-\eta} \omega F_t^*. \tag{7}$$

Demand for non-traded goods, denoted by $N_t(j)$, is given by

$$N_t(j) = (1-\upsilon) \left(\frac{P_{N,t}(j)}{P_{N,t}} \right)^{-\epsilon} \left(\frac{P_{N,t}}{P_{F,t}} \right)^{-\eta} F_t. \tag{8}$$

The price of the final good is

$$P_{F,t} = \left[\upsilon P_{T,t}{}^{1-\eta} + (1-\upsilon)\, P_{Nt}{}^{1-\eta} \right]^{\frac{1}{1-\eta}}, \text{ with } P_{T,t} = \left[\omega P_{A,t}{}^{1-\sigma} + (1-\omega)\;\, P_{B,t}{}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \tag{9}$$

where

$$P_{k,t} = \left(\int_0^1 P_{k,t}(j)^{1-\epsilon} dj \right)^{\frac{1}{1-\epsilon}} \text{ for } k \in A, B, N. \tag{10}$$

The index k denotes traded domestically produced, imported, and non-traded intermediate goods. In the following subsection, we discuss the problem of the intermediate goods producers, which gives rise to the prices of varieties, $P_{k,t}(j)$.

3.3 Intermediate goods firms

Intermediate goods are produced by monopolistically competitive firms according to the following production function

$$Y_{k,t}(j) = Z_{k,t} K_{k,t}(j)^{\theta} L_{k,t}(j)^{1-\theta}, \tag{11}$$

where $Z_{k,t}$ refers to technology in sector $k \in \{A, N\}$. The amount of capital and labor input used by firm j in sector k is denoted by $K_{k,t}(j)$ and $L_{k,t}(j)$, respectively. We assume that technology evolves according to the following sector-specific process

$$Z_{k,t} = \rho_k Z_{k,t-1} + \varepsilon_{k,t}, \tag{12}$$

where $\varepsilon_{k,t}$ is a technology shock and k represents both the traded and the non-traded goods sectors. We assume that capital and labor are not firm-specific and can be adjusted in each period. Cost minimization gives rise to the input-factor ratio

$$\frac{L_{k,t}(j)}{K_{k,t}(j)} = \frac{(1-\theta) R_{k,t}}{\theta P_{L,t}}, \tag{13}$$

where $P_{L,t}$ and $R_{k,t}$ denote the price of labor and capital, respectively. Note that the price of labor is assumed to be the same across sectors. Marginal costs are given by

$$MC_{k,t} = \frac{P_{L,t}^{1-\theta} R_{k,t}^{\theta}}{Z_{k,t} \theta^{\theta} (1-\theta)^{1-\theta}}. \tag{14}$$

Price setting follows a discrete-time version of Calvo (1983) pricing. The frequency of price changes is governed by the Calvo parameter ξ_k. Specifically, each intermediate goods firm can adjust its price with a given probability $1 - \xi_k$. We assume local currency pricing for producers of traded intermediate goods, i.e. firms set prices in the buyer's currency. As a consequence, the maximization problems of intermediate goods producers in the traded and non-traded goods sectors are different.

Traded goods firms face specific profit maximization problems for each market. Local currency pricing implies that firms set potentially different prices for the domestic and foreign markets. The frequency of price changes depends on the destination market of the product, not on the origin. For the domestic market, firms set domestic prices $P_{A,t}(j)$ to maximize the expected discounted flow of net profits

$$\max \sum_{l=0}^{\infty} (\xi_A)^l \, E_t \rho_{t,t+l} A_{t,t+l}(j) \left[P_{A,t}(j) - MC_{A,t+l} \right] / P_{F,t+l}, \tag{15}$$

subject to the demand schedule (6), the production function (11), and marginal costs (14). ξ_A measures the probability that the price cannot be changed. Demand in period $t + l$ is denoted by $A_{t,t+l}(j)$, given that prices have not been adjusted since period t. Since firms are owned by households, we assume that the pricing kernel $\rho_{t,t+l}$ used to discount profits is given by $\rho_{t,t+l} = \frac{\beta_{t+l} U_{C,t+l}}{\beta_t U_{C,t}}$, where β_t and $U_{C,t}$ denote the household's discount factor and the marginal utility of consumption, respectively.

For the foreign market, firms set foreign prices $P^*_{A,t}(j)$ are in order to maximize

$$\max \sum_{l=0}^{\infty} \left(\xi_A^*\right)^l E_t \rho_{t,t+l} A^*_{t,t+l}(j) \left[P^*_{A,t}(j) - MC_{A,t+l}\right] / P_{F,t+l}, \tag{16}$$

subject to the demand function (7), the production function (11), and marginal costs (14). ξ_A^* measures the probability that the price in the foreign market cannot be re-adjusted.

Firms in the non-traded goods sector maximize the expected discounted flow of net profits

$$\max \sum_{l=0}^{\infty} \left(\xi_N\right)^l E_t \rho_{t,t+l} N_{t,t+l}(j) \left[P_{N,t}(j) - MC_{N,t+l}\right] / P_{F,t+l}, \tag{17}$$

subject to the demand schedule (8), the production function (11), and marginal costs (14). The price in the non-traded goods sector remains unchanged with probability ξ_N. Finally, aggregate factor inputs used in the intermediate goods sectors, labor $L_{k,t}$ and capital $K_{k,t}$, are given by

$$L_{k,t} = \int_0^1 L_{k,t}(j)dj, \qquad K_{k,t} = \int_0^1 K_{k,t}(j)dj. \tag{18}$$

3.4 Labor market

The model features a non-Walrasian search-and-matching labor market à la Mortensen and Pissarides (1994b). Specifically, labor market firms meet total demand for labor by intermediate goods firms, $L_t = L_{A,t} + L_{N,t}$, where each firm represents a match between a single worker and single firm. Labor market firms operate under perfect competition and produce a homogenous labor good according to a linear production function in hours worked. We assume a symmetric equilibrium, i.e. all matches provide the same amount of labor. The final labor market good is given by the aggregate of individual matches, $L_t = (1 - U_t)H_t$. A standard Cobb-Douglas matching function maps the number of vacancies V_t and unemployed U_t into the number of matches M_t

$$M_t = sV_t^{\Psi} U_t^{1-\Psi}, \tag{19}$$

$$\frac{M_t}{V_t} \equiv \pi_{f,t} = s\left(\frac{V_t}{U_t}\right)^{\Psi-1}, \tag{20}$$

$$\frac{M_t}{U_t} \equiv \pi_{ue,t} = s\left(\frac{V_t}{U_t}\right)^{\Psi}, \tag{21}$$

where Ψ measures the matching elasticity, and s denotes a scaling constant. The probability of finding a worker from the firms' perspective is given by $\pi_{f,t}$, whereas $\pi_{ue,t}$ denotes the probability of finding a job from the workers' perspective. Real profits of a single firm J_t and the worker's surplus of the match $\tilde{V}_t$ are given by

$$J_t = \frac{P_{L,t}H_t - W_tH_t}{P_{F,t}} + E_t(1-f)\rho_{t,t+1}J_{t+1}, \tag{22}$$

$$\tilde{V}_t = \frac{W_tH_t - b_t}{P_{F,t}} - \frac{\vartheta}{U_{C,t}}\frac{H_t^{1+\mu}}{1+\mu} + E_t\rho_{t,t+1}(1-f-\pi_{ue,t})\tilde{V}_{t+1}, \tag{23}$$

where f denotes the exogenous separation rate of the match. The amount of posted vacancies depends on the wedge between productivity and the wage, i.e. the profits of the firm. Following Hall and Milgrom (2008) and Jung and Kuester (2011), we assume that the threat point of the worker in the bargaining process is given by the cost of delaying bargaining for one period rather then by the value of being unemployed used in standard Nash-bargaining. This yields the static bargaining solution for hours worked

$$\frac{\vartheta H_t^{\mu}}{U_{C_t}} = \frac{P_{L,t}}{P_{F,t}}, \tag{24}$$

implying an efficient choice of hours worked identical to the one obtained in the neoclassical limiting case. The wage setting equation is given by

$$W_t = \Omega P_{L,t} + (1-\Omega)\left[\frac{P_{L,t}}{1+\mu} + \widetilde{b}W\right], \tag{25}$$

where Ω denotes the bargaining power of the worker. The labor market friction implies that the wage is a convex combination of productivity and the outside option. The latter is given by the saved amount of leisure and the unemployment benefits $b_t = \widetilde{b}WH_t$, where $\widetilde{b} \in [0,1]$ expresses the replacement rate in percentage terms of the average (steady-state) wage per hour W, see Jung and Kuester (2011). The model replicates cyclical properties of a Walrasian labor market, where wages (almost) perfectly comove with productivity and movements in the unemployment rate are essentially shut down, for the case $\widetilde{b} = 0$. We assume free entry such that firms make on average zero profits when posting a new vacancy

$$\chi = \pi_{f,t}E_t\rho_{t,t+1}J_{t+1}, \tag{26}$$

where χ are real vacancy posting costs expressed in terms of the consumption good representing a resource loss for the economy, see aggregate resource constraint (5). The law of motion for the unemployment rate U_t is given by

$$U_{t+1} = U_t(1-f-\pi_{ue,t}) + f. \tag{27}$$

3.5 Government policies

The model is closed by specifying feedback rules for monetary and fiscal policy and two scenarios for unemployment benefits schemes. Since Core and Periphery form a monetary union, monetary policy sets interest rates at the union level. We assume that the interest rate reacts to inflation and the output gap in both countries according to the following standard feedback rule

$$\log R_t = \rho_r \log R_{t-1} + (1-\rho_r) E_t \left[\varpi + \varphi_\pi \log\left(\sqrt{\Pi_{t,t-4}\Pi^*_{t,t-4}}\right) + \varphi_y \log\left(\sqrt{\widetilde{Y}_t \widetilde{Y}^*_t}\right)\right] + \varepsilon_{r,t}, \quad (28)$$

where $\Pi_{t,t-4}$ refers to year-over-year inflation of final goods and $\widetilde{Y}_t$ denotes the output gap, i.e. the deviation of current output from its steady-state value. $\varepsilon_{r,t}$ denotes i.i.d. monetary policy shocks. The coefficients φ_π and φ_y determine the response of interest rates to inflation and the output gap.

Government spending is country-specific and can be characterized by the following rule

$$\log G_t = (1-\rho_g)\log G + \rho_g \log G_{t-1} + \phi_y \log\left(Y_{t-1}/Y_{t-2}\right) + \varepsilon_{g,t}, \quad (29)$$

where $\varepsilon_{g,t}$ denotes i.i.d. government spending shocks and variables without time subscripts refer to steady-state values. We assume that government spending reacts to lagged rather than current output growth (determined by the coefficient ϕ_y) due to lags in decision and implementation processes, as discussed by Blanchard and Perotti (2002). The government raises lump-sum taxes to balance its budget in every period: $G_t = T_t$. Both the feedback rules for monetary policy and government spending are estimated independently of the model, see subsection 4.1 for details.

In the baseline scenario, which captures the status quo of the EMU, both countries feature country-specific unemployment insurance systems. In each country, a national agency collects labor taxes and disburses unemployment benefits. Assuming a balanced budget in every period, the agency's constraint is given by

$$\tau_{L,t} W_t H_t (1-U_t) = b_t U_t. \quad (30)$$

In the counterfactual specification, we introduce a EUBS. Labor taxes raised in both countries are pooled at the European level and benefits are distributed to the unemployed workers in both countries. The constraint of the international agency (with a balanced budget) is as follows

$$\tau_{L,t} W_t H_t (1-U_t) + \tau^*_{L,t} W^*_t H^*_t (1-U^*_t) RX_t/n = b_t U_t + b^*_t U^*_t RX_t/n. \quad (31)$$

We consider two different implementations: First, we assume the equalization ofr labor tax rates across countries, i.e. $\tau_{L,t} = \tau^*_{L,t}$. This assumption leads to positive steady-state transfers, see discussion below. In a second scenario, we rule out steady-state transfers by holding the (multiplicative) spread between the two country-specific labor tax rates constant.

3.6 Market clearing and aggregation

In equilibrium, households maximize utility and firms maximize profits subject to their constraints, government policies, and intital conditions. We assume that in equilibrium only domestic currency bonds are traded in international financial markets. Markets clear at the level of intermediate goods in each sector. Following Galí and Monacelli (2005), we define an index for aggregate output in each sector $Y_{A,t} \equiv \left(\int_0^1 Y_{A,t}(j)^{-\varepsilon} dj\right)^{\frac{1}{\varepsilon}}$ and $Y_{N,t} \equiv \left(\int_0^1 Y_{N,t}(j)^{-\varepsilon} dj\right)^{\frac{1}{\varepsilon}}$. Substituting for $Y_{A,t}(j) = A_t(j) + A_t^*(j)/n$ and $Y_{N,t}(j) = N_t(j)$ in both expressions, using the demand functions given by (6)-(8), yields aggregate demand

$$\begin{aligned} Y_{A,t} &= \upsilon \left[\left(\frac{P_{A,t}}{P_{T,t}}\right)^{-\sigma} \left(\frac{P_{T,t}}{P_{F,t}}\right)^{-\eta} (1-\omega)F_t + \left(\frac{P_{A,t}^*}{P_{T,t}^*}\right)^{-\sigma} \left(\frac{P_{T,t}^*}{P_{F,t}^*}\right)^{-\eta} \omega F_t^*/n \right], \\ Y_{N,t} &= (1-\upsilon) \left(\frac{P_{N,t}}{P_{F,t}}\right)^{-\eta} F_t. \end{aligned} \tag{32}$$

Aggregate production is given by

$$\zeta_{k,t} Y_{k,t} = Z_{k,t} K_{k,t}^{\theta} L_{k,t}^{1-\theta}, \tag{33}$$

where $\zeta_{k,t} \equiv \int_0^1 \left(\frac{P_{k,t}(j)}{P_{k,t}}\right)^{-\epsilon} dj$ provides a measure for price dispersion at the level of intermediate goods in each sector. As a measure for real GDP, we define

$$Y_t \equiv C_t + X_t + G_t + \chi V_t + \frac{S_t P_{A,t}^*}{P_{F,t}} A_t^*/n - \frac{P_{B,t}}{P_{F,t}} B_t, \tag{34}$$

where exports and imports are defined as $A_t^* \equiv \left(\int_0^1 A_t^*(j)^{-\varepsilon} dj\right)^{\frac{1}{\varepsilon}}$ and $B_t \equiv \left(\int_0^1 B_t(j)^{-\varepsilon} dj\right)^{\frac{1}{\varepsilon}}$, respectively. Using (7) and the corresponding domestic counterpart to substitute for $A_t^*(j)$ and $B_t(j)$ gives in aggregate terms

$$A_t^* = \upsilon \left(\frac{P_{A,t}^*}{P_{T,t}^*}\right)^{-\sigma} \left(\frac{P_{T,t}^*}{P_{F,t}^*}\right)^{-\eta} \omega F_t^*, \quad B_t = \upsilon \left(\frac{P_{B,t}}{P_{T,t}^*}\right)^{-\sigma} \left(\frac{P_{T,t}}{P_{F,t}}\right)^{-\eta} (1-\omega) F_t. \tag{35}$$

Finally, we define the real exchange rate and the trade balance as follows

$$RX_t \equiv \frac{S_t P_{F,t}^*}{P_{F,t}}, \quad NX_t \equiv \frac{S_t P_{A,t}^* A_t^*/n - P_{B,t} B_t}{P_{F,t} Y_t}. \tag{36}$$

4 Model simulation

We solve the model based on a first-order approximation of the equilibrium conditions around the deterministic steady state and run simulations to study the properties of the model numerically.[11] In the following subsection, we discuss the calibration of the model. The empirical performance of the model is reported in subsection 4.2.

[11]We use the software platform Dynare to solve and simulate the model, see Adjemian et al. (2011)

4.1 Calibration

The two-country model is carefully calibrated to capture key characteristics of a Euro area *Core* aggregate (Austria, Belgium, Germany, Finland, France, Netherlands) relative to a *Periphery* aggregate (Greece, Ireland, Italy, Portugal, Spain).[12] This strategy allows us to compare the effects of a common unemployment insurance on two heterogeneous sets of countries that have been characterized by fundamental asymmetries over the last years. One period in the model corresponds to one quarter. We distinguish three sets of parameters: 1) structural parameters characterizing preferences, technology and the labor market; 2) parameters of the monetary and fiscal policy rules, and 3) parameters characterizing the exogenous technology process.

Table 1: Calibration: Structural parameters

Symmetric parameters		**Value**		**Calibration target/source**	**Value**	
Risk aversion	γ	1.00		Balanced growth		
Inverse Frisch elasticity	μ	2.00		Domeij and Flodén (2006)		
Utility weight of work	ϑ	33.6		Hours worked steady state	0.30	
Depreciation rate	δ	.014		I/Y	0.166	
Capital share	θ	0.34		Labor share	0.66	
Investment adjustment cost	κ	1.50		$\text{Std}(X_t)/\text{Std}(Y_t)$	Table 3	
Price elasticity	ϵ	6.00		Markup	0.20	
Trade price elasticity	σ	0.90		Heathcote and Perri (2002)		
Non-traded price elasticity	η	0.44		Stockman and Tesar (1995)		
Relative country size	n	1.75		GDP Core/Periphery		
Separation rate	f	.045		Jung and Kuhn (2010)		
Bargain parameter	Ω	0.50		Mortensen and Pissarides (1994b)		
Matching elasticity	Ψ	0.50		Petrongolo and Pissarides (2001)		
Asymmetric parameters		**Core**	**Periph.**	**Calibration target/source**	**Core**	**Periph.**
Replacement rate	$\widetilde{b}$	0.65	0.67	$\text{Std}(U_t)/\text{Std}(Y_t)$	Table 3	
Vacancy posting	χ	0.09	0.02	Unemployment steady state	0.079	0.117
Matching constant	s	0.52	0.34	Normalization V/U	1.000	1.000
Government share	G/Y	0.24	0.19	Government spending share	0.24	0.19
Elast. of discount factor	ψ	.017	.015	K/Y	12.00	12.00
Weight traded goods	υ	0.33	0.34	Production manuf./services	0.485	0.508
Weight domestic goods	ω	0.90	0.67	Import & export share Core	0.031	0.061
Price rigidity tradables	ξ_T	0.76	0.82	Price duration indust. goods	4.168	5.392
Price rigidity non-tradables	ξ_{NT}	0.84	0.86	Price duration services	6.289	6.891

Notes: Variables without time subscript refer to steady-state values. Parameters remain unchanged across simulations. See appendix A for description of the data used for the target values.

Preferences, technology and the labor market: Table 1 displays the first set of parameters. In the upper (lower) panel, we report the parameters which are symmetric (asymmetric) across countries. The right column of the table shows the sources or target values which were used to pin down the parameter values.[13]

[12]See appendix A for details on the aggregation.

[13]In general equilibrium, calibration targets typically depend on values of several parameters; nevertheless, it is possible to pin down specific parameter values by focusing on one particular target value.

We assume $\gamma = 1$, which is consistent with balanced growth. Following Domeij and Flodén (2006), we set $\mu = 2$, which implies a Frisch wage elasticity of labor supply of 0.5. Disutility of work ϑ is set such that hours worked in steady state are 0.3 for both countries. We target a steady-state investment-to-output ratio of 0.166 to pin down the depreciation rate δ. The capital share θ is set to match average wage shares of two thirds for Core and Periphery countries. Moreover, investment adjustment costs κ are determined to match the average relative volatility of investment, reported in Table 3 below. Following Rotemberg and Woodford (1993), we assume that the markup amounts to 20 percent to pin down ϵ. The trade price elasticity σ is set to 0.9, which is in line with the estimate reported in Heathcote and Perri (2002). We follow Stockman and Tesar (1995) and assume $\eta = 0.44$. The relative country size n is set according to the ratio of Core GDP relative to Periphery GDP. In line with the estimates reported in Jung and Kuhn (2010), we choose a separation rate $f = 0.045$. Following Mortensen and Pissarides (1994b) and Petrongolo and Pissarides (2001), we set the bargaining parameter Ω and the matching elasticity Ψ to 0.5, respectively.

In order to account for important heterogeneities across countries, we allow for a comprehensive set of asymmetric parameters. We target the average relative unemployment volatility reported in Table 3 below to pin down the replacement rate of unemployment benefits $\widetilde{b}$. Vacancy posting costs χ are determined by targeting the average unemployment rate, which amounts to 7.9 percent for Core and 11.7 percent for Periphery. The number of posted vacancies is normalized to pin down values for the matching constant s. Government spending for Core and Periphery amount on average to 24 and 19 percent of GDP, respectively, which allows us to set the steady-state shares of government spending accordingly. We target a steady-state capital-to-output ratio of 12 to determine the elasticity of the discount factor ψ.

A last set of parameters pins down the weight of traded and non-traded goods and the degree of nominal rigidities. The weight of traded goods in total output υ is set to match the average ratio of output in the manufacturing sector relative to output in services. This ratio is 0.485 for Core and 0.508 for Periphery. Given the weight of traded goods υ, the import and export shares in steady state are determined by ω. We set ω such that Core imports from Periphery amount to 3.1 percent of GDP, while Core exports to Periphery amount to 6.1 percent of GDP. The Calvo parameters ξ_T and ξ_N are set to match average price durations reported in Dhyne et al. (2006). For the traded and non-traded goods sector, we use data for non-energy industrial goods and services, respectively.[14] Price rigidity is higher in the Periphery, while in general prices of non-traded goods are more rigid than prices of traded goods.

Policy rules: The behavior of monetary and fiscal policy is governed by the feedback rules specified in equations (28) and (29). First, since Core and Periphery are assumed to form a monetary union, we estimate a common monetary policy rule for both countries. Following

[14] Aggregation follows Baharad and Eden (2004). We assume that price durations for domestically produced traded intermediate goods and for imports are the same within each country (i.e., $\xi_A^* = \xi_B$ and $\xi_A = \xi_B^*$); hence there is one value for price stickiness for each sector (ξ_T and ξ_N) in each country.

Clarida et al. (1998), we employ a two-stage least squares approach, using year-over-year CPI-inflation, the short-term interest rate, the oil price, and the output gap as instruments in the first step of the procedure. The estimates are reported in the upper panel of Table 2. We find strong interest rate smoothing and a considerable response of the interest rate to economic activity, measured by the output gap.

Second, we estimate country-specific fiscal policy rules for Core and Periphery, reflecting fiscal sovereignty of each country.[15] The results are summarized in the middle panel of Table 2. The persistence of government spending is found to be high for Core and Periphery. Fiscal policy in the Core is slightly countercyclical, whereas Periphery government spending is mostly acyclical.

Table 2: Calibration: Policy rules and technology processes

Monetary policy			
Smoothing	ρ_r	0.95	
Inflation	φ_π	1.40	
Output gap	φ_y	0.32	
Variance of innovations (10^{-6})		1.28	
Government spending		**Core**	**Periphery**
Smoothing	ρ_g	0.90	0.98
Output growth	ϕ_y	−0.17	0.01
Variance of innovations (10^{-4})		0.15	0.31
Technology			
AR(1) coefficient			
Tradables	ρ_T	0.89	0.91
Non-tradables	ρ_{NT}	0.91	0.93
Variance of innovations (10^{-4})			
Tradables		2.31	1.36
Non-tradables		0.21	0.14

Notes: See appendix A for description of the data.

Technology process: Technology in intermediate goods production follows an AR(1) process specific to each country and each sector, as specified in equation (12). We estimate sector- and country-specific Solow residuals, using industrial production data for the traded-goods sector and services data for the non-traded goods sector.[16] Results are reported in the bottom panel of Table 2. We find important differences across countries and sectors. In general, technology in Periphery is more persistent than in Core, while Core technology is more volatile. Moreover, technology in the traded-goods sector is slightly less persistent but more volatile than in the nontraded-goods sector.

[15]OLS estimation with linear trend. Note that our specification excludes a contemporaneous response of government spending to output. We thus employ an identification assumption which is frequently made in the VAR literature on fiscal policy transmission, see Blanchard and Perotti (2002).

[16]We use manufacturing data where industrial data is not available.

4.2 Model performance

Table 3 shows the ability of the model to replicate empirical facts. Specifically, we compare the predictions for standard deviations and correlations generated by the baseline model, which captures the EMU with country-specific unemployment benefit schemes, with characteristics of the data. The first three panels of the table show that the model is successful in predicting volatilities of key variables. In particular, the model does not suffer from a lack of volatility of unemployment (Shimer, 2005) because we introduce some degree of wage rigidity, see Hagedorn and Manovskii (2008) and Hall and Milgrom (2008) for details. Thus, the volatility of unemployment predicted by the model is close to the observed volatility.

Table 3: Model performance

		Data	**Model** Baseline
Core	$\text{Std}(Y) \cdot 100$	1.30	0.96
	$\text{Std}(C)/\text{Std}(Y)$	0.39	1.02
	$\text{Std}(I)/\text{Std}(Y)$	2.57	3.09
	$\text{Std}(G)/\text{Std}(Y)$	0.47	0.54
	$\text{Std}(U)/\text{Std}(Y)$	4.70	5.03
	$\text{Std}(\pi)/\text{Std}(Y)$	0.25	0.34
Periphery	$\text{Std}(Y^*) \cdot 100$	1.31	0.55
	$\text{Std}(C^*)/\text{Std}(Y^*)$	0.97	0.94
	$\text{Std}(I^*)/\text{Std}(Y^*)$	2.65	3.13
	$\text{Std}(G^*)/\text{Std}(Y^*)$	0.72	1.31
	$\text{Std}(U^*)/\text{Std}(Y^*)$	5.63	5.66
	$\text{Std}(\pi^*)/\text{Std}(Y^*)$	0.40	0.21
Trade	$\text{Std}(RX)/\text{Std}(Y)$	0.34	0.70
	$\text{Std}(NX)/\text{Std}(Y)$	0.06	0.06
Cross-country	$\text{Corr}(Y, Y^*)$	0.81	0.51
	$\text{Corr}(C, C^*)$	0.67	0.38
	$\text{Corr}(I, I^*)$	0.69	0.40
	$\text{Corr}(G, G^*)$	0.60	0.00
	$\text{Corr}(U, U^*)$	0.52	0.25
	$\text{Corr}(\pi, \pi^*)$	0.73	0.48

Notes: See appendix A for description of the data and the aggregation method. Model predictions are based on HP-filtered theoretical moments of the first-order approximation of the model.

The bottom panel of Table 3 summarizes the cross-country correlations in the data and the corresponding model predictions. The directions of the correlations are in line with the data, except for government expenditure, which is uncorrelated in the model. Specifically, the model is able to account for the empirical fact that output is more highly correlated across countries than consumption (Backus et al., 1992; Stockman and Tesar, 1995).

5 Effects of a European unemployment benefit scheme

In this section, we evaluate the effects of the introduction of a EUBS. Specifically, we identify the implications for volatilities and cross-country correlations, the transmission of shocks, and production efficiency and risk-sharing.

5.1 Volatilities and correlations

In the following, we document the effects of the introduction of a EUBS on unconditional volatilities of key variables and cross-country correlations. For this purpose, we implement two different EUBS regimes. The EMU scenario serves as the baseline case. The corresponding volatilities and correlations are displayed in the first column of table 4. In order to answer the question whether a EUBS can replace the stabilization via flexible exchange rates, we additionally introduce a PreEMU scenario. That is, we look at a scenario where Core and Periphery have independent monetary policy autorities. The calibration of the monetary and fiscal policy rules in each country, however, follows the EMU scenario. Hence, differences between this regime and the EMU scenario are merely due to the elimination of flexible exchange rates. Results are stated in the second column of Table 4.

We first implement a EUBS regime that is based on equal labor tax rates for all participating countries. The third column of Table 4 summarizes the resulting volatilities and correlations of key variables. This scheme would reduce volatilities of output and consumption in the Core. Not very surprisingly, however, the equal-tax-rate scheme turns out to lead to steady-state transfers between the region with a low unemployment rate (Core) to the one with a higher rate (Periphery). We consider this outcome as politically unfeasible, given the resistance towards a so-called 'transfer union' in several European countries. Moreover, the resulting unconditional and conditional statistics are similar to the second EUBS scenario. The below discussion is therefore to a large extent also valid for the equal-tax-rates case.

Second, we introduce a regime that leads to zero transfers in steady state. That is, the labor tax rate in the Periphery is set in a fixed proportion to the Core rate (i.e., $\tau^*_{L,t} = \iota\tau_{L,t}$), in a way that there are no transfers between the two regions in steady state. The results are summarized in the fourth column of Table 4. We find that the EUBS lowers the volatility of output and consumption in the Core, relative to the EMU case. Yet, foreign output and consumption become more volatile relative to the baseline EMU scenario. The same applies to the volatilities of labor and unemployment, respectively.

In the following, we will evaluate impulse-response functions and additional statistics to investigate the mechanisms that drive these observations. In short, the EUBS leads to stronger spillover effects of shocks across countries. In this sense, shocks in one country are 'exported' to the other country. Since the size of technology shocks in the Core exceeds that in the Periphery, the overall effect of the spillovers causes a reduction in unconditional Core volatilities.[17]

[17] See Table 2 in subsection 4.1 for the calibration of the shock processes.

Table 4: Effects on volatilites and correlations

	EMU	**PreEMU** EMU policy rules	**EUBS** Same tax rates	**EUBS** No st. st. transfers
Core				
Std(Y)	0.96	0.83	0.86	0.86
Std(C)	0.98	0.80	0.82	0.82
Std(L)	1.25	0.92	1.07	1.10
Std(U)	4.83	3.93	4.24	4.28
Std(π)	0.33	0.23	0.27	0.30
Periphery				
Std(Y^*)	0.55	0.81	0.60	0.61
Std(C^*)	0.52	0.78	0.54	0.54
Std(L^*)	0.77	1.05	1.01	0.97
Std(U^*)	3.13	4.32	3.27	3.28
Std(π^*)	0.12	0.15	0.16	0.15
Trade				
Std(RX)	0.67	0.83	0.54	0.57
Std(NX)	0.06	0.05	0.03	0.03
Cross-country				
Corr(Y, Y^*)	0.51	0.16	0.73	0.75
Corr(C, C^*)	0.38	0.03	0.84	0.85
Corr(L, L^*)	0.22	0.03	0.36	0.33
Corr(U, U^*)	0.25	0.19	0.52	0.55
Corr(π, π^*)	0.48	0.25	0.47	0.45

Notes: Statistics are based on HP-filtered theoretical moments. Standard deviations are multiplied with 100 for better readability.

The regime shift increases cross-country correlations even beyond the increase induced by the introduction of a common currency. Specifically, output and consumption are more synchronized with a EUBS. This suggests that the EUBS gives rise to an additional channel for consumption insurance. Moreover, the co-movement of labor and unemployment across countries is stronger when both countries pool unemployment insurance schemes at an international level. The cross-country correlation of inflation is not substantially affected by the regime shift, reflecting the common monetary policy at the level of the monetary union.

5.2 Shock transmission

We now investigate changes in shock transmission that are induced by an introduction of a EUBS. Figures 4, 5, 6, and 7 plot responses of important variables to negative shocks that originate in the Periphery. As for the supply side, we consider a negative technology shock in the non-tradables sector, NT (shown in the first column of the figures). A negative shock to government spending in the Periphery, displayed in the second column, represents a demand shock. The blue solid line shows the responses for the EMU case with national unemployment insurance schemes and a monetary union. The red dashed line plots our counterfactual scenario

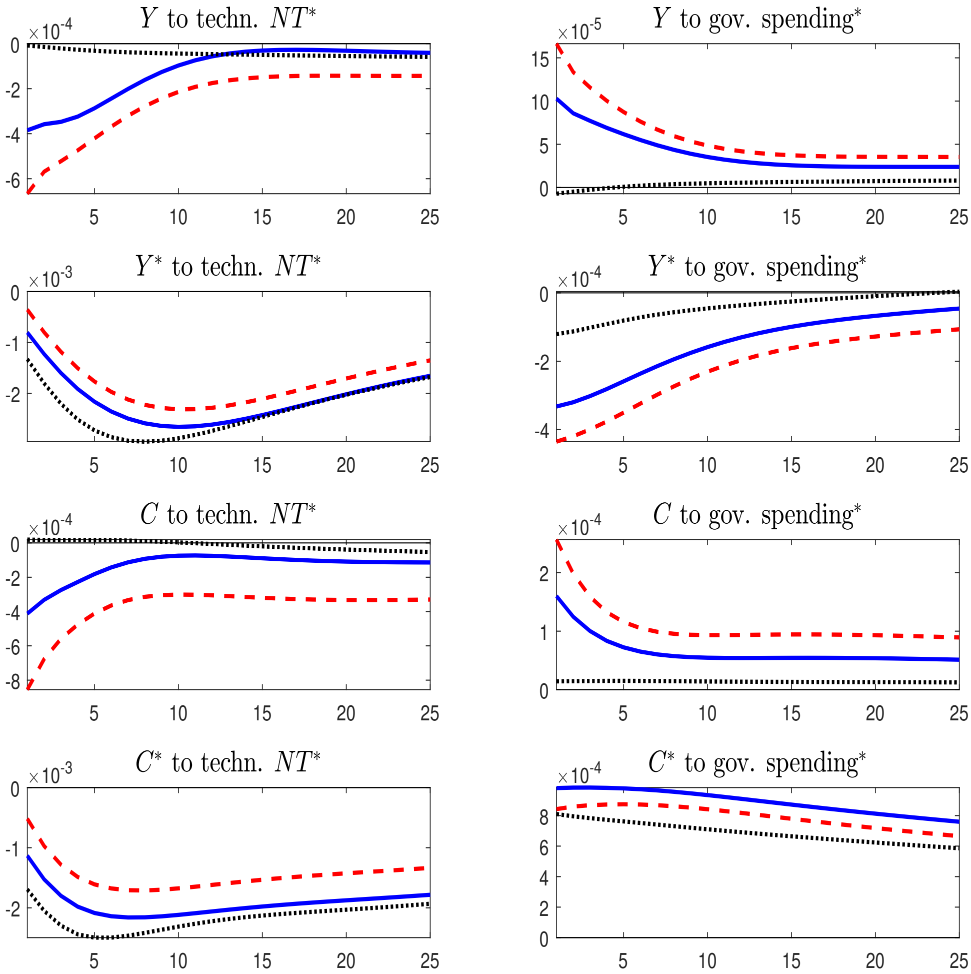

Figure 4: Shock transmission under EMU (blue solid), EUBS (red dashed), and PreEMU with EMU policy rules (black dotted) scenarios.

of a European unemployment benefit scheme within a monetary union. We focus on the scheme which is consistent with zero steady-state transfers, see the discussion in the previous subsection. Finally, the dotted black line represents the PreEMU scenario, featuring national unemployment insurance schemes and flexible exchange rates.

The impulse-response functions provide explanations for the more pronounced spillovers that are induced by a EUBS. Specifically, Figure 4 shows that output in the Core responds more to non-tradable-sector technology shocks in the Periphery, relative to the EMU scenario. Output in the Periphery, by contrast, decreases by less after a technology shock. This mirrors the results of the introduction of a common currency. As discussed in detail in Enders et al. (2013), abolishing the nominal exchange-rate already makes foreign technology shocks more and domestic technology shocks less important for domestic business cycles. The introduction of a EUBS amplifies this effect even more. The reason lies in the transfer: given that relative unemployment in the Periphery rises after contractionary shocks (in particular technology shocks), the common unemployment insurance scheme induces a positive transfer from Core taxpayers to the unemployed in the Periphery. As a result, Periphery consumption and output decrease by less, and Core consumption and output by more, compared to a situation without a EUBS.

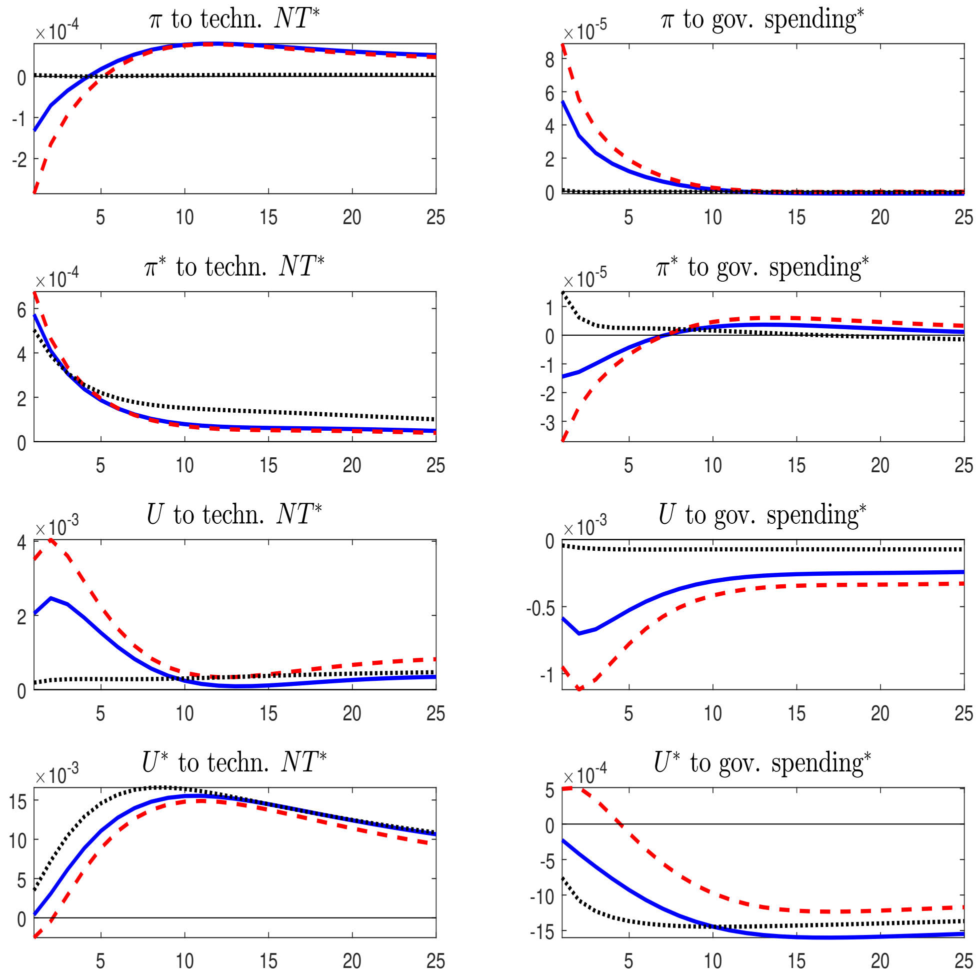

Figure 5: Shock transmission under EMU (blue solid), EUBS (red dashed), and PreEMU with EMU policy rules (black dotted) scenarios.

The effect of the transfer is also reflected in the path of unemployment in both countries, see Figure 5. The rise in Periphery unemployment is less pronounced with the transfer, whereas Core unemployment increases by more under a EUBS. The change in the shock transmission after the regime shift is in line with the increase in cross-country correlations documented in the previous subsection.

This, however, is only part of the story. Consider the responses to a negative technology shock originating in the Periphery's non-tradables sector depicted in Figure 6. The variable 'Transfer' refers to the cross-country transfer from Core to Periphery. As mentioned above, the negative shock induces a transfer from Core taxpayers to Periphery's unemployed in the EUBS scenario.[18] Due to the subdued relative price adjustments (because of sticky prices cum monetary union) and the home bias, Periphery households spend the received transfer relatively equally on domestically produced tradables, imports and, importantly, domestically produced non-tradables, denoted by NT^*. Hence, the reduction in demand for Periphery non-tradable goods induced by the rise in marginal costs (and prices) is mitigated in the EUBS scenario. As a result, labor in the Periphery non-traded goods sector increases relatively strongly, while Core

[18]Due to lower production efficiency and sticky prices, hours worked in Periphery's non-tradables sector initially increases, such that unemployment rises with a delay. The initial transfer flows therefore from Periphery to Core. This, however, reverses fairly quickly. The present discounted value of the transfer, and hence the wealth effect, is positive for Periphery.

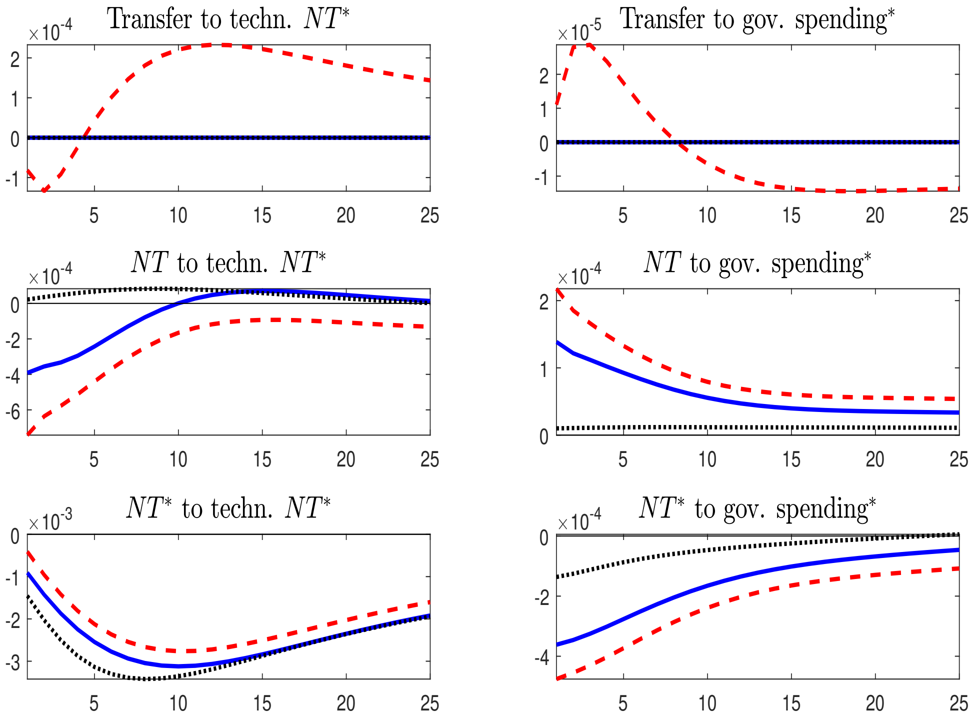

Figure 6: Shock transmission under EMU (blue solid), EUBS (red dashed), and PreEMU with EMU policy rules (black dotted) scenarios.

labor is reduced even further, see Figure 7. Additionally, capital in the Periphery decreases less than under EMU, and vice versa in the Core, see the responses of investment X_{NT} in the non-tradables sectors. Given that the contraction of this sector is less pronounced in the EUBS scenario, although production in the Periphery non-tradable goods sector has been hit by a negative shock, these factor allocations reduce efficiency in the economy.

We now turn to demand shocks. A negative shock to government spending in the Periphery leads to a positive wealth effect and falling output in this country. Again, spillover effects caused by the common unemployment insurance scheme increase Periphery consumption by less and Core consumption by more in the EUBS scenario (Figure 4). However, the transfer is much smaller than in response to technology shocks (by a factor of 10). The effects of the negative demand shock on most variables, especially on production and labor, are much smaller than for technology shocks in both countries. Intuitively, private capital markets are relatively efficient in providing risk-sharing possibilities after demand shocks. The effects of the wealth effect can be cushioned by adequate borrowing or lending. Additionally, unemployment in both country groups reacts fairly similar. Higher output in the Core pushes unemployment down, while sticky prices in combination with falling demand in the Periphery increase the effective markup and profits of firms. The resulting transfer is hence fairly small. The introduction of a EUBS does therefore not alter the responses significantly, relative to EMU.

Lastly, the responses to both shocks in the PreEMU scenario show that the EUBS cannot be considered a substitute for the flexible exchange rate regime. In the PreEMU case, cross-country spillovers are very limited because country-specific monetary policy accomodates country-specific shocks. The EUBS, however, amplifies spillovers across countries, see discussion above.

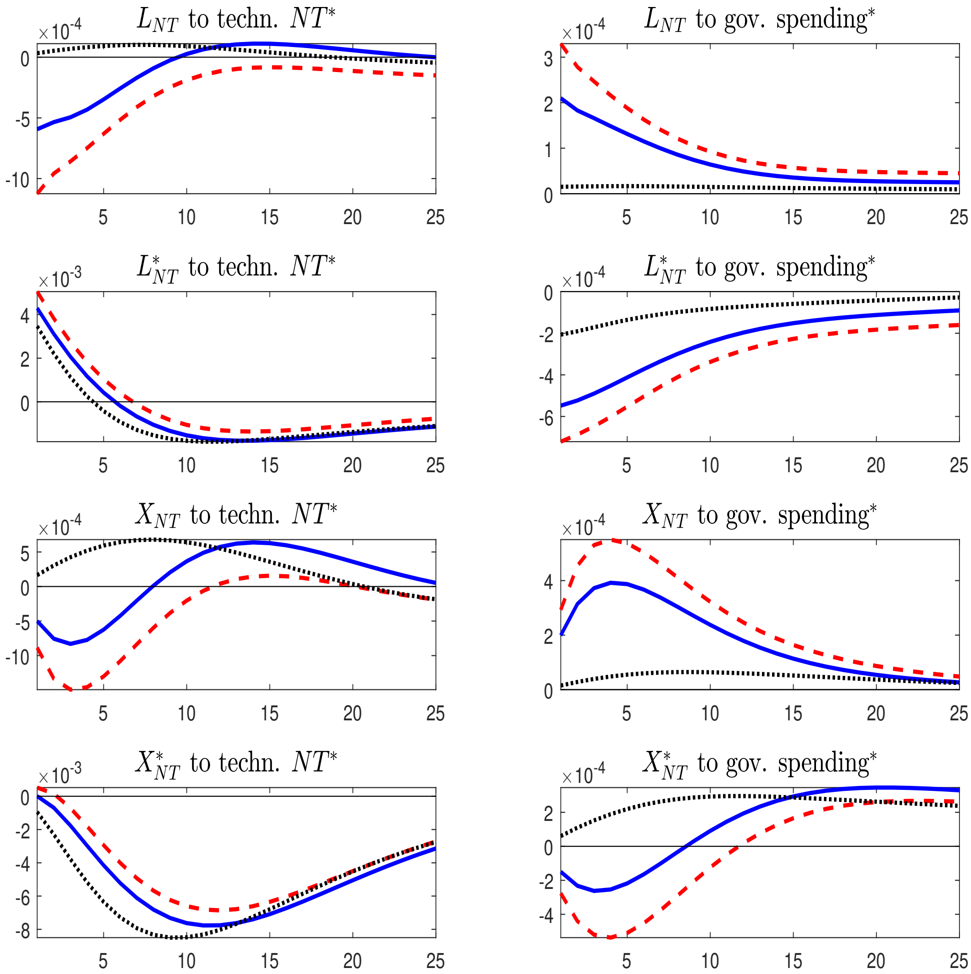

Figure 7: Shock transmission under EMU (blue solid), EUBS (red dashed), and PreEMU with EMU policy rules (black dotted) scenarios.

5.3 Efficiency and risk sharing

The introduction of an international unemployment insurance scheme increases co-movement of consumption and output across countries, but leads to misallocation of demand and factor inputs in response to technology shocks. Specifically, sticky prices give rise to a trade-off between consumption insurance and production efficiency, which becomes worse in the presence of a home bias, as discussed in Section 2. As shown in that section, a transfer that enhances efficiency flows away from the country hit by a negative technology shock, contrary to what an unemployment scheme generates. To study this aspect in more detail, we derive measures for efficiency for our large model. The social-planner solution of the quantitative model from Section 3 delivers the following labor wedges for the Core and the risk-sharing wedge

Core@Core tradable: $$\frac{-U_{L,t}}{MPL_{A,t}} - U_{C,t}C_{A,t}$$

Core@Core non-tradable: $$\frac{-U_{L,t}}{MPL_{N,t}} - U_{C,t}C_{N,t}$$

Core@Periphery: $$\frac{-U_{L,t}}{MPL_{A,t}} - U^*_{C,t}C^*_{A,t}$$

$$\text{Overall Core:} \qquad \frac{-U_{L,t}}{MPL_{A,t}} - \left[\frac{A_t}{Y_{A,t}} U^{\sigma}_{C,t} C^{\sigma}_{A,t} + \frac{A^*_t}{nY_{A,t}} U^{*\sigma}_{C,t} C^{*\sigma}_{A,t}\right]^{\frac{1}{\sigma}}$$

$$\text{Risk sharing:} \qquad \frac{C^*_t}{C_t} - \frac{P_t}{P^*_t},$$

where U_L denotes marginal disutility of labor, U_C marginal utility of consumption, C_k the derivative of the final goods bundle (5) with respect to good k, and MPL_k marginal product of labor in Sector k, determined by the production function (11). Corresponding labor wedges can be derived for the Periphery. Figure 8 depicts the responses of the labor wedges and the risk-sharing wedge to the negative supply shock originating in the Periphery's non-tradables sector discussed above.

The response of the Core labor wedge of the non-tradable goods sector at Core, Core@Core NT, is negative, implying that production is too low after the shock, relative to the first-best allocation. The response is more pronounced under a EUBS, which means that production is even lower than under EMU. This is in line with the finding that demand for the Core non-traded good is reduced further due to the cross-country transfer. The response of the overall Core labor wedge leads to the same conclusion. Now consider the Periphery labor wedge for the non-tradable goods sector at the Periphery, Periphery@Periphery NT. The wedge is positive on impact, reflecting that production is too high from an efficiency perspective. The EUBS even exacerbates the situation because the transfer mitigates the drop in demand for the Periphery non-traded goods, see Figure 6. At some point, the wedge turns negative because the higher investment rates in the non-tradable sector have increased labor's marginal product. Note, however, that the wedges reflect optimality, given the current state of the economy. Since the capital stock in this sector is inefficiently high, a negative wedge does not represent the first-best conditional on previous optimal decisions. The cross-country transfer under EUBS slightly improves efficiency in this segment, although production is still too low. Overall, the responses of the labor wedges to the negative supply shock suggest that the decline in production efficiency is more pronounced with an international unemployment insurance scheme.

Furthermore, the transfer also affects cross-country risk sharing. The response of the risk-sharing wedge shows that, under a EUBS, consumption in the Periphery is too high, relative to the first-best allocation. The risk-sharing condition of the social planner prescribes a shift to consumption in the Core, because the negative shock increases prices in the Periphery. However, the transfer embedded in the cross-country unemployment benefits is too large, such that Periphery households consume too much, relative to the price ratio, although relative price changes do not even fully reflect the increased marginal costs of production. The responses of the wedges in the PreEMU scenario are in line with the responses of the other variables. Movements in the flexible exchange rate reduce cross-country spillovers and hence production inefficiencies after a shock.

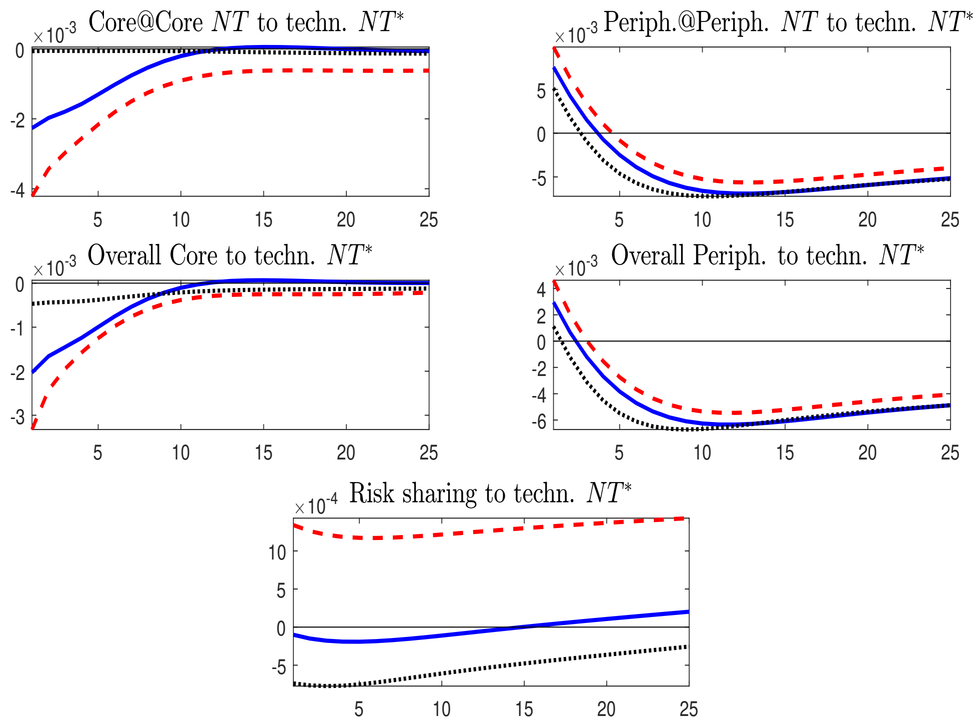

Figure 8: Shock transmission under EMU (blue solid), EUBS (red dashed), and PreEMU with EMU policy rules (black dotted) scenarios.

6 Conclusion

A well-known result from the theory of optimum currency areas states that one option to compensate the missing adjustment that is due to the loss of flexible exchange rates are state-contingent transfers. More recently, politicians in different countries of the euro area have taken up this argument and have pled for the introduction of a European unemployment benefit scheme. In this paper, we evaluate the macroeconomic effects of such a scheme in the specific context of the euro area and assess the impact on allocative efficiency.

We find that a EUBS has indeed the potential to stabilize consumption after a shock. This, however, comes at the cost of a misallocation of factor inputs. Following supply shocks, the less productive country receives a transfer via the EUBS. This boosts consumption, but a relatively large part of this additional demand is spent on inefficiently produced goods, that is domestic goods from the perspective of the receiving country. Capital and labor in this country are hence higher as under flexible exchange rates. This is in line with the negative effects of the transfer on allocative efficiency that we identify in a tractable version of the two-country model.

Following demand shocks, that is government spending shocks in our context, the existence of a EUBS has no large effects. Due to the unchanged technology levels and relatively similar consumption paths in both countries, induced by the common monetary policy stance, unemployment rates are too similar to trigger a large transfer. Reactions with and without a transfer in the monetary union are hence close to each other.

Appendix

A Data

A.1 Data series and sources

Our main data source is the OECD Economic Outlook, but we also take data from the OECD Main Economic Indicators, the OECD Quarterly National Accounts, the OECD STAN Database, and the AMECO Database of the European Commission. Table A-1 lists the exact names of the data series and the corresponding sources.

Table A-1: Data

OECD Economic Outlook 103, 1991Q1–2017Q4 (quarterly frequency)
GDP, volume, market prices
Private final consumption expenditure, volume
Government final consumption expenditure, volume
Government gross fixed capital formation, volume
Private non-residential gross fixed capital formation, volume
Gross fixed capital formation, housing, volume
Unemployment rate
Exchange rate, national currency per USD
GDP, volume, at 2010 PPP USD
GDP, value, market prices
Short-term interest rate
Long-term interest rate on government bonds
GDP, deflator, market prices
Price of commodity exports
Consumer price index, harmonised
Core inflation index, harmonised
Imports of goods and services, value, National Accounts basis, USD
Exports of goods and services, value, National Accounts basis, USD
Total employment, labour force survey basis
Hours worked per worker, total economy
OECD Main Economic Indicators 2018/7, 1991Q1–2017Q4 (quarterly frequency)
Production total manufacturing
Employment services
Employment industry including construction
Consumer price index, all items
OECD Quarterly National Accounts 2018/1, 1991Q1–2017Q4 (quarterly frequency)
Industry including energy
Services
OECD STAN (ISIC Rev. 4 , SNA08), 1991–2017 (annual frequency)
Manufacturing (D10T33)
Total Services (D45T99)
AMECO Edition May 2018, 1991–2017 (annual frequency)
Wage share (ALCD2)
Capital-output ratio (AKNDV)

A.2 Country aggregates and parameter values

We construct the parameter and target values for the aggregates *Core* (Austria, Belgium, Germany, Finland, France, Netherlands) and *Periphery* (Greece, Ireland, Italy, Portugal, Spain) using average PPP-adjusted GDP weights. If necessary, the weights are adjusted for missing data.

A.3 Filtering

We generally apply the HP-filter with a smoothing parameter of 1600 to the time series data, before computing statistics of interest. We apply the filter from the earliest available period (1991) until the end of the samples to remove the trend. We follow the same approach to compute the output gap. Note that data used in the estimation of the Taylor rule is not filtered.

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