

## ADEMU WORKING PAPER SERIES

### On the Design of a European Unemployment Insurance System

Árpád Ábrahám<sup>†</sup>  
Joaõ Brogueira de Sousa<sup>¥</sup>  
Ramon Marimon<sup>‡</sup>  
Lukas Mayr<sup>‡</sup>

April 2018

WP 2018/106

[www.ademu-project.eu/publications/working-papers](http://www.ademu-project.eu/publications/working-papers)

#### Abstract

We assess the benefits of a potential European Unemployment Insurance System (EUIS) using a multi-country dynamic general equilibrium model with labour market frictions. Our calibration provides a novel diagnosis of the European labour markets, revealing the key parameters – in particular, job-separation and job-finding rates – that explain their different performance in terms of unemployment (or employment) and its persistence. We show that there are only small welfare gains from insuring against country-specific cyclical fluctuations in unemployment expenditures. However, we find that there are substantial gains from reforming currently suboptimal unemployment benefit systems. In spite of country differences, it is possible to unanimously agree on an EUIS with unlimited duration of eligibility, which eliminates the risk of not finding a job before the receipt of benefits ends, and a low replacement rate of 15%, which stabilizes incentives to work and save. We argue that such reforms are more effectively designed at the European level than at the national level because national governments do not take into account general equilibrium effects of their reforms on citizens in other countries. Concerns regarding the political feasibility of such a system are addressed through country-specific contribution payments that eliminate cross-country transfers. The resulting tax differences across countries may be the best statistic of their structural labour market differences, in terms of job creation and destruction, providing clear incentives for reform.

**Jel codes:** J6, E2

**Keywords:** labour markets; unemployment insurance; job creation; job destruction; risk-sharing; economic monetary union

<sup>†</sup> European University Institute

<sup>¥</sup> European University Institute

<sup>‡</sup> European University Institute; UPF - BarcelonaGSE, CEPR and NBER

<sup>‡</sup> European University Institute

## Acknowledgments

This project is related to the research agenda of the ADEMU project, "A Dynamic Economic and Monetary Union". ADEMU is funded by the European Union's Horizon 2020 Program under grant agreement N° 649396 (ADEMU).

---

The ADEMU Working Paper Series is being supported by the European Commission Horizon 2020 European Union funding for Research & Innovation, grant agreement No 649396.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License Creative Commons Attribution 4.0 International, which permits unrestricted use, distribution and reproduction in any medium provided that the original work is properly attributed.



# 1 Introduction

The recent financial and sovereign debt crises have affected European labour markets asymmetrically both in terms of duration and severity of unemployment. In particular, stressed countries - such as Greece, Portugal and Spain - have experienced high levels of unemployment, making it very difficult, if not impossible, to provide adequate insurance for the unemployed and, at the same time, to satisfy the low-deficit (Fiscal Compact) commitments. This has raised interest in proposals for Europe-wide, or Euro-Area-wide, Unemployment Insurance schemes.<sup>1</sup>

Given the asymmetries and lack of perfect coordination of real business cycles across European countries,<sup>2</sup> a European Unemployment Insurance System (EUIS) can efficiently provide risk-sharing across national labour markets and, at the same time, reduce the countercyclical impact of unemployment expenditures on national budgets. Furthermore, it can provide three additional important benefits for the participant states. First, it can reduce the lasting recessionary effects which follow severe crisis, as it has happened in the euro crisis and recession; second, it can develop a much needed solidarity across national labour markets and, third, it can improve labour mobility and market integrations, since unemployment benefits, and the corresponding active policies of surveillance, do not need to be tied to a specific location.

However, the same asymmetries show that implementing a European Unemployment Insurance scheme may not be easy - or politically feasible - if it implies large and 'persistent transfers' across countries. In fact, these 'persistent transfers' are a good indicator of pending structural reforms; therefore, it is not just an issue of redistribution, it can also be a moral hazard problem: 'persistent transfers' may further delay costly, but needed, reforms.

Therefore, to assess the need, viability and possible design of an EUIS one needs to take into account its potential effects: on individual agents' employment and savings decisions; on the aggregate distribution of employment, unemployment and inactivity;

---

<sup>1</sup>In this paper we abstract from specific legal and institutional requirements; we will therefore refer to a European Unemployment Insurance System (EUIS) in reference to any possible transnational scheme that addresses the type of diversities which are present in the EU.

<sup>2</sup>For an overview on business cycles in the Euro Area see, for example, Böwer and Catherine (2006), Giannone et al. (2009) and Saiki and Kim (2014).

on national budgets, in particular taxes to finance unemployment benefits; on insurance transfers across countries; on aggregate savings and investment and, ultimately, on social welfare. In other words, one needs to address these interrelated effects in order to answer a basic question: which unemployment risks need and should – and, if so, how they should – be shared across European countries?

This is a conceptual question that requires a quantitative answer. Unfortunately, with the exception of the works of Dolls et al. (2015) and Beblavy and Maselli (2014), there is very little quantitative evaluation of European Unemployment Insurance schemes. In particular, there is no modelling framework to analyse the key trade-offs of such schemes. In this paper we develop and calibrate – to European countries – a dynamic model to study these effects and provide a set of policy experiments and an implementable proposal.

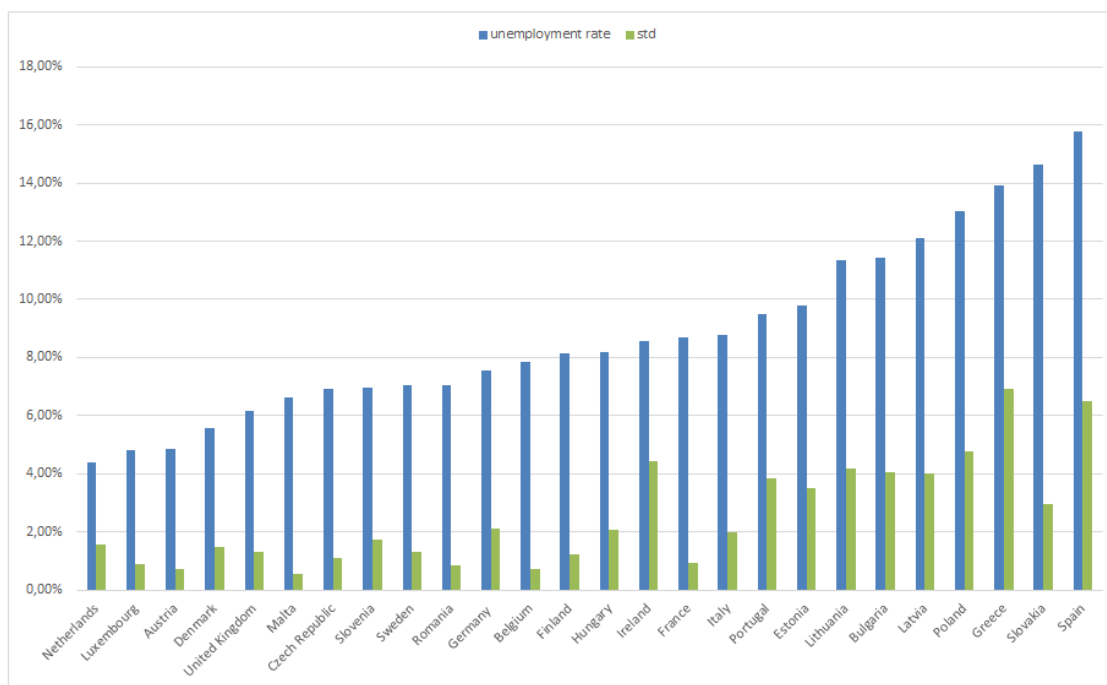


Figure 1: Average European Unemployment Rates: 2001-2014

Any model requires an adequate level of abstraction, in our case we need to effectively compare labour markets and unemployment policies of different countries. Regarding labour markets, Figure 1 ranks European countries using Eurostat data on average unemployment rates (and their variability) for different European countries (2001-

2014). This is informative of the ‘European labour market diversity’ but it is too partial and crude an approximation to build a model just based on these statistics. Alternatively, a very detailed description of countries’ labour markets and unemployment policies can be very informative but dilutes the main tradeoffs that should be at the core of a dynamic equilibrium model. Our approach is to study worker flows across the three states of employment, unemployment and inactivity. The corresponding transition matrices, and associated steady-state distributions, are the pictures that describe our different economies. For example, using Eurostat quarterly data on worker flows (2010Q2-2015Q4), Figure 2 shows similarities and differences in terms of ‘persistence flows’: Employment to Employment (“E to E”, denoted E-E) versus Unemployment to Unemployment (“U to U”, denoted U-U). With the exception of three countries (Spain, Portugal and Slovenia), these ‘persistence flows’ show a strong correlation among European labour markets, with more important differences on U-U. The corresponding ranking, across this E-E vs. U-U axis (of all but three countries), is not the same as the ranking of unemployment rates of Figure 1. In steady-state, the transition matrix of flows for a given country defines its stationary distribution of employment, and the corresponding Figures 1 and 2 are just two snapshots of European labour markets. Behind the scattered plots lie possible differences in preferences, technologies and market institutions, and labour policies. We will assume that across EU countries citizens share (almost) the same preferences and that labour mobility is relatively low across countries (we assume it is nil) but that EU countries still differ in the other aspects – mainly, market institutions and labour policies.

We build on the work of Krusell et al. (2011) and Krusell et al. (2015), who calibrate the U.S. three-states flows with a dynamic general equilibrium model with labour market frictions, to analyse the diverse European labour markets. As in their calibration analysis, we generate worker-flows transition matrices and distributions across the three states as the outcome of a dynamic general equilibrium. This requires us to set a few parameters on preferences and technology, and calibrate others to match flows and stocks, consistently with observed time series and the existing unemployment policies of a country. More specifically, our model economies are characterised by three sets of parameters: (i) generic parameters of preferences and technologies common to all

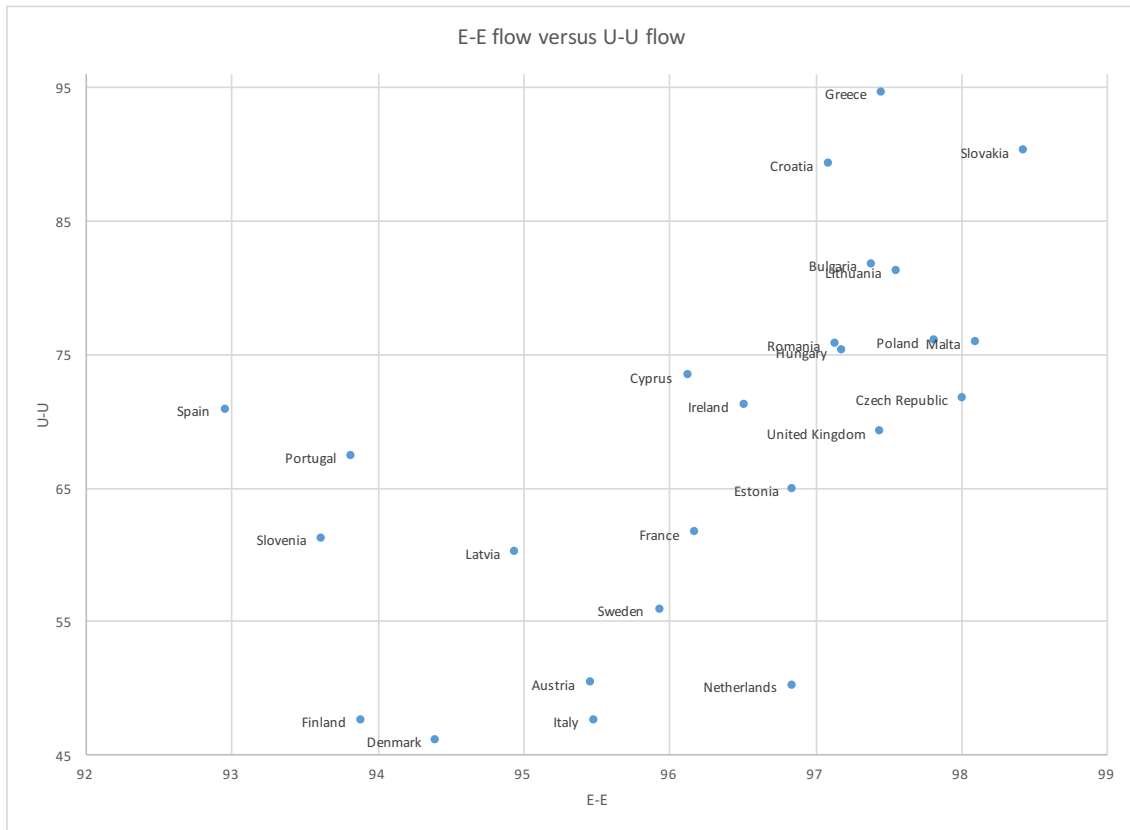


Figure 2: Persistence of Employment and Unemployment

economies – agents’ discount factors, idiosyncratic productivity shock, etc.; (ii) country-specific structural parameters of their economies - for example, the job-separation and job-finding rates, which in turn are a summary of different factors determining job creation, destruction and matching, and (iii) the country-specific unemployment insurance policies, summarized in two – plus one – parameters; the two are the replacement ratio (unemployment benefits to wages) and the duration of unemployment benefits; the third is the unemployment payroll tax rate needed to balance the budget within a period. Section 3 describes our model.

Our calibration is a contribution in itself: it provides a novel diagnosis of the European labour markets, since it reveals the key parameters that explain their different performance – in terms of unemployment (or employment) and its persistence. Country-specific structural parameters – in particular, job-separation and job-finding rates – and not UI policy parameters, are the key parameters. Not surprisingly, the job-finding rates for unemployed and for inactive are aligned, but their ranking, while very significant to

explain persistence, provides a partial picture of labour market performance: one needs to account for the job-separation rate – for example, the very high job-separation rate of Spain – to get a more accurate one. In contrast, the ‘technological’ dimension in which we allow countries to differ – the total factor productivity – is not a key parameter to account for labour market differences, it mostly accounts for average wage differences. The fact that differences in UI policy parameters do not correspond to differences in labour market performance does not mean they are not relevant: they are, for two related reasons. First, because they show interesting patterns: for example, countries with high unemployment rates –say, Spain, Portugal, Greece and Slovakia – have low replacement rates but, among them, only those with high job-separation rates have long average duration of unemployment benefits (Spain and Portugal), while long average duration of unemployment benefits and high job-separation rates are also characteristic of countries with low unemployment rates (Denmark and Finland). Second, they are relevant because different UI policies – and/or different distributions of employment – result in different payroll taxes, since in our calibration all national budgets balance. These tax differences also determine the desirability of UI policy changes, at the national or at the EU – or some other – level. It should be noted that our UI policy parameters are related, but not on a one-to-one basis, with reported replacement and duration rates. We account for the reported eligibility rates, but then we let the reported benefits and the existing unemployment rates and flows determine our calibrated UI parameters. Section 4 provides a more detailed description of our calibration procedures and results.

Our model and its calibration provide the framework for our policy experiments, the main goal and contribution of this paper. Perhaps the most frequently used argument in favor of an EUIS is that it may provide insurance against country specific large fluctuations in unemployment, which with limited fiscal capacity result in fluctuations in the tax burden associated with its financing. Our first experiment therefore targets a quantitative evaluation of the potential pure risk sharing benefits of an EUIS when one country suffers a severe negative shock. To this end, we compute the labour market and welfare consequences of a deep recession in two alternative scenarios: (i) the government is in financial autarky and needs to raise taxes on the employed in order to maintain a balanced UB budget; (ii) the country is insured against increased unem-

ployment and can go through the recession without raising taxes. Otherwise, we assume that the unemployment insurance system remains the same in all remaining countries in both cases. We find that the risk sharing benefits resulting from the welfare differences of the second scenario with respect to the first one are small, and marginally higher for the employed, whose taxes are smoother, than for the unemployed, whose benefits have not changed. This experiment implies that although insurance benefits exist, their small size, questions the rationale for a EUIS as a “rainy day fund”, unless it rains very often.

In light of this result, one may doubt the desirability of a European unemployment insurance system. Even more so as the observed heterogeneity in labour market institutions suggests that the optimal benefit systems could differ substantially across European countries, making it difficult for governments to reach a common ground. To evaluate this claim, we compute the optimal unilateral reform of the unemployment benefit system (financed at the national level), separately for each country. We perform this exercise in partial equilibrium assuming that a single country does not affect equilibrium prices. We find that the optimal mix of replacement rate, and duration of unemployment benefits, is surprisingly similar across the countries studied. In all countries it is optimal to provide an unlimited duration of eligibility and the optimal replacement rates vary between 20% and 45%.

Despite similar optimal national unemployment insurance policies one may still argue that the small difference suffice to let countries reform their systems by themselves rather than to force them into a common European benefit scheme. We show that this argument is flawed because individual national governments do not internalize general equilibrium effects of their reforms on citizens in other European countries. In particular, we show that if all European countries would reform their system simultaneously and the capital market is required to clear at the union level, i.e. in general equilibrium, the very same UI benefit systems that seem optimal in partial equilibrium, are in fact welfare reducing in most of the countries. If national governments are benevolent but only towards the citizens of their own country, they would reform the benefit system towards a more generous one than what is optimal from a collective European perspective. Increasing the generosity of the UI benefit system in some European countries, reduces private savings and hence the aggregate, European, capital stock. As a consequence the



marginal product of labour declines everywhere. This redistributes from poor agents, who derive most of their income from wages to rich agents with mainly capital income. Importantly, the common European capital market implies that this redistribution happens across all Europe.

The final contribution is to provide a better alternative: a common European Unemployment Insurance System (EUIS). We first show that a fully harmonized system which is jointly financed at the European level is unlikely to achieve unanimous support across member states as it would result in transfers from countries with structurally low unemployment to high unemployment countries. Interestingly, for some of the net payers, the welfare gains of such a reform are positive, suggesting that in these countries the current unemployment benefit systems are far from optimal. We then neutralize transfers through varying contribution payments across countries. We find that an EUIS with an unlimited duration and a replacement rate of 15% is welfare improving in *all* countries and almost unanimous. The unlimited duration insures agents against the risk of losing eligibility before the receipt of unemployment benefits ends. At the same time the low replacement rate stabilizes incentives to work and save, keeping the European capital stock and therefore wages high. A positive side effect of such a system with tax differences that eliminate cross-country transfers is that these differences may serve as an incentive device for individual countries to structurally reform weak labour market institutions.

## **Implementation**

Although it is not the focus of this paper, it is worth to briefly consider how this EUIS proposal could be implemented. The basic idea is that it can be implemented through the existing national Unemployment Insurance Systems, it is for this reason we have only considered the common form of unemployment benefits defined by their ‘replacement and duration’. If the national funds had enough borrowing capacity, to provide the unemployment benefits without increasing the taxes in times of crisis, and enough commitment, to properly accumulate funds in normal and good times, the EUIS would only require policy commitment and coordination. However, not all (if any) existing national systems satisfy these requirements, in which case a mixed solution between the

national UI funds and a central EU fund is in order.

The EUIS central fund can be hosted in the *European Stability Fund*<sup>3</sup> which would have contracts with participating countries stipulating (unemployment) countercyclical transfer between the national fund and the central fund as to guarantee the uniform unemployment benefits preserving smooth taxes within the limited borrowing capacity of the national fund. In other words, as with other *ESF* contracts, first there must be a country-risk assessment (an improved version of our calibration) to assess the country referential stable payroll tax rate and unemployment rate, as well as the thresholds unemployment rates determining country transfers to and from the central fund. The contract should be designed, as other *ESF* contracts, to guarantee that these transfers do not become permanent transfers. In fact, a stable system of payroll taxes and benefits results in fluctuating net revenues at the country level when, in addition to agents' idiosyncratic risk, there is also country risk (as in our first experiment in Section 5).

The mixed design of the EUIS means that the central fund absorbs these fluctuations beyond certain limits (given by unemployment rate thresholds), acting as a safe deposit when unemployment is relatively low and providing insurance when it is relatively high. Our reported structural differences across countries imply that constrained efficient contracts between participating countries and the fund should be country specific, but based on the same common principles. On a periodic basis – say, every seven years – the country risk assessment should be updated and the referential rates adapted accordingly, to make sure that transfers fulfil their stabilisation role without becoming persistent inflows or outflows, to or from the fund.

The remainder of this paper is organized as follows. The next section briefly discusses the current literature on the topic. In section 3 we present the model and in section 4 our calibration, which provides the basis for our policy experiments in section 5. Finally, section 6 concludes.

---

<sup>3</sup>See the *ESF ADEMU* proposal in Marimon and Cooley (2018, Chs. 2 and 12), based on Ábrahám *et al.* (2018) characterization of *ESF* constrained efficient contracts.

## 2 Literature Review

There are a few recent papers that also study different aspects of the design of a EUIS coming both from academic scholars and from policy institutions. In this section, we review briefly some of the most recent and relevant papers on this issue.

On the hand, Ignaszak et al. (2018) study the optimal provision of unemployment insurance in a federal state containing atomistic (and symmetric) regions. The focus of their paper is different from ours in three important dimensions. First, in their environment, the regions are *ex ante* identical, hence they cannot study the asymmetric effect of a EUIS on the different participating nations as we do. At the same time, their model allows for a rich interaction between federal and local policies as regional governments have a wide set of instruments, that they can use to respond to the introduction of new federal policies. Their main focus is indeed to study the crowding out of regional incentives due to generous federal insurance schemes (moral hazard). The third difference is that their model does not allow for an intertemporal saving technology for any agents (households, regions or the union altogether). Our results show that general equilibrium effects of different unemployment insurance policies through the savings channel can be quantitatively very important.

On the other hand, Claveres and Clemens (2017) and Moyen et al. (2016) study unemployment insurance and international risk sharing in a two-region DSGE model with frictional labour markets and calibrate their model to the core and the periphery of the Euro-zone. In both papers, a supranational agency runs an unemployment insurance scheme that triggers transfers to recessionary countries but has zero transfers in expectation. Such a scheme allows recessionary countries to maintain unemployment benefits and simultaneously reduce taxes, thus dampening recessionary effects. Our model differs in many dimensions from these papers. First, our model features a higher degree of heterogeneity both across and within countries. In particular, our policy experiments are performed with ten countries of the Euro area instead of two regions. As we show, labour market institutions and consequently flows across employment, unemployment and inactivity are as heterogeneous across countries within the core (and the periphery) as across the core and the periphery. For example, we found that certain implemen-

tations of an EUIS have significantly different effects on Belgium and Germany, two core countries. In addition, the combination of endogenous savings decisions and idiosyncratic productivity shocks result in a non-degenerate distribution of wealth in our model. We show that this within country wealth heterogeneity is a key determinant for both the welfare effects of UI policies and for determining the general equilibrium channel of policies through precautionary savings. Finally, our paper provides an extensive welfare evaluation (across countries, employment states and wealth levels) of different EUIS implementations both with business cycle fluctuations and by studying the transition to a new steady states after a policy reform.

In contrast with the previous papers, Dolls et al. (2015) and Beblavy and Lenaerts (2017) take into account the rich heterogeneity within the Euro area. They provide quantitative exercises that measure the possibilities for intertemporal and interregional smoothing of unemployment benefits and social security contributions under different versions of a EUIS. Both papers present a set of counterfactual scenarios where household income and the evolution of labour markets are kept fixed during the period of study, and different specifications of a EUIS are considered. As in our paper, both studies find considerable interregional and intertemporal smoothing possibilities. In contrast with our paper, the lack of individual responses does not allow them to evaluate the effects of different insurance systems on labour markets, household consumption, individual savings and welfare. In addition, this implies that there are no equilibrium adjustments either and no effect on aggregate savings and capital accumulation.

Finally, Dullien et al. () provide a concrete proposal to be discussed at the European Parliament following a similar approach as the two papers above. In contrast with our work, they only focus on the fund-contract aspect, applying the self-insurance and the reinsurance principles to the design of a EUIS which operates national funds and a joint ‘stormy day fund’ that is operational only when the country is hit by a severe crisis. Similarly to ours, their scheme is intended to be implemented on a voluntary basis and it has interesting countercyclical features, which can improve upon the current situation. However, the national contracts are not based on a country-specific risk-assessment, the final destination of the funds is not guaranteed and similarly the above papers the methodology does not allow to evaluate the impact on individual decisions and on equi-

librium outcomes.

### 3 Model

Our model economy consists of a union of  $I \in \mathbb{N}$  countries. We assume that the population in each country  $i \in \{1, \dots, I\}$  is fixed and that there is no migration across countries. This implies that labor markets clear country by country. Capital, on the other hand, is perfectly mobile across countries. We assume that the union as a whole is a closed economy such that the (weighted) sum of the capital stocks in all countries equals the savings of all citizens in the union.

Each country is modeled along the lines of Krusell et al. (2011) and Krusell et al. (2015). Their model captures key economic decisions of agents regarding their labour market behaviour and is therefore suited to think about unemployment policy. In particular, in the model, given labour income taxes and unemployment benefits, agents with an opportunity to work are able to choose whether or not they work and agents currently not employed are able to choose whether or not to actively search for a job.

**Timing and Preferences.** Time  $t \in \{0, 1, 2, \dots\}$  is discrete. Each country is populated by a continuum of agents of measure  $n^i$ , where  $\sum_{i=1}^N n^i = 1$ . Preferences over consumption, labour supply and job search are given by

$$\mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left[ \log(c_t) - \alpha w_t - \gamma^i s_t \right]. \quad (1)$$

Agents derive utility from consumption  $c_t$  and disutility from employment  $w_t$  and job search  $s_t$ . The parameter  $\alpha$  captures the disutility of work and is assumed to be the same in each country. The parameter  $\gamma^i$  denotes the disutility of active job search and is varying across countries. In this way we capture that the governments' assistance in the search for a job differs across countries. The time discount factor  $\beta \in (0, 1)$  is the same for all citizens in the union. Workers can only choose to supply labor on the extensive margin, i.e.  $w_t \in \{0, 1\}$ . Additionally, the search decision is also discrete:  $s_t \in \{0, 1\}$ .

**Markets and Technology.** The production sector is competitive. Firms, who produce according to a constant returns to scale technology, hire labour from the domestic labour market and pay a wage per efficiency unit of labour that equals the marginal product of labour. They rent capital from the international capital market at a price  $r_t$  and pay for the depreciation of capital; the total rental price equals the marginal product of capital, which is the same across countries. Workers supply labour in the domestic market. This market is characterized by frictions that affect workers' separations from jobs, and workers' access to a job opportunity. In what follows, these frictions are described in detail.

In the beginning of every period, agents who were employed in the previous period can lose their job with probability  $\sigma^i$ . The probability of finding a job while not employed depends on the search effort. An agent who is actively searching during period  $t$  finds an employment opportunity for period  $t + 1$  with probability  $\lambda_u^i$ ; an agent who is not actively searching, with probability  $\lambda_n^i < \lambda_u^i$ . After losing a job, agents who search may be eligible for unemployment benefits. The process that determines eligibility for unemployment benefits is described below. Note that the job arrival rates and the job separation rate are country specific. In this way we capture the heterogeneity in labour market institutions across Europe.

Agents are heterogeneous with respect to their labour productivity, denoted by  $z_t \in Z = \{\bar{z}_1, \bar{z}_2, \dots, \bar{z}_{n_z}\}$ . Idiosyncratic productivity follows a first order Markov chain with transition probabilities  $p(z'|z)$ . This process is assumed to be the same in each country.

Agents cannot directly insure themselves against the idiosyncratic productivity risk, however they can save using a risk-free bond. The risk-free return is given by the international real interest rate  $r_t$ .

Production is given by the Cobb-Douglas technology:

$$F^i(K_t^i, L_t^i) = A_t^i (K_t^i)^\theta (L_t^i)^{1-\theta}, \quad (2)$$

where  $A_t^i$  denotes total factor productivity in country  $i$ ,  $K_t^i$  the aggregate capital stock in country  $i$  and  $\theta$  the capital share of output.  $L_t^i$  is aggregate labour in country  $i$ , measured in efficiency units. In what follows, we generally assume no aggregate (country-specific)

shocks, i.e.  $A_t^i = A^i$ .<sup>4</sup>

**Individual Labour Market States.** An agent can be employed, unemployed or inactive. The difference between unemployed and inactive agents is that the former exert search effort while the latter do not. Further, if an agent is unemployed he can either be eligible for unemployment benefits, in which case he receives a certain fraction of his potential income as a wage worker or he can be non-eligible, in which case he does not receive benefits and hence solely lives from his savings. This gives a total of four possible individual labor market states that an agent can attain,  $x_t \in \{e, u^e, u^n, n\}$ : employed, unemployed eligible, unemployed non-eligible, non-participating;

**Unemployment Benefits.** Eligibility for unemployment benefits is partially determined by agent's endogenous decisions, partially by exogenous shocks. Only agents who are exogenously separated from their job are eligible for unemployment benefits, while agents who quit their job themselves are not eligible. Further, in order to maintain eligibility agents have to continuously exert search effort. Once an agent stops searching, she is non-eligible even if at some later time she starts searching again. Finally, in every period with some probability  $\mu^i$  agents lose eligibility even if they search for a job. This is a parsimonious way to capture limited (and country-specific) duration of unemployment benefit receipt.<sup>5</sup> Non-eligibility is an absorbing state. The only way to regain eligibility is to find a job, be employed for some time and then be exogenously separated again.

An eligible unemployed agent in country  $i$  receives unemployment benefits  $b_t^i(z_t)$  according to

$$b_t^i(z_t) = \bar{b}_t^i \omega_t^i z_t \quad (3)$$

where  $\bar{b}_t^i$  is the replacement rate in country  $i$ ,  $\omega_t^i$  is the wage per efficiency unit of labour and  $z_t$  is the agent's current productivity level. The formula in (3) implies that an agent receives unemployment benefits according to his current labor market productivity. A

---

<sup>4</sup>We deviate from this assumption only in subsection 5.1.

<sup>5</sup>In reality this duration is not stochastic but fixed. However, implementing a fixed duration is computationally expensive as it requires to keep track of the periods that each unemployed agent already receives benefits. To economize on the state space we hence use this stochastic process as in Krusell et al. (2011) and Krusell et al. (2015).

more realistic assumption would be to have unemployment benefits depend on past labour earnings. We choose (3) to economize in the dimension of the state space of the model (avoiding the need to keep track of past productivity of currently unemployed agents), and because the process  $z_t$  is persistent, implying that current productivity is a good proxy for previous labor earnings.

**Budget Sets.** In every period  $t$ , each agent in country  $i$  chooses a pair of consumption and savings from a budget set  $B_t^i(a, z, x)$  that depends on his current assets, productivity and employment state as well as on current prices  $r_t$  and  $\omega_t^i$ . The budget set of an agent who is employed in period  $t$  ( $x_t = e$ ) is given by

$$B_t^i(a, z, e) = \left\{ (c, a') \in \mathbb{R}_+^2 : c + a' \geq (1 + r_t)a + (1 - \tau_t^i)\omega_t^i z \right\}. \quad (4)$$

An employed agent finances consumption  $c$  and savings  $a'$  with current period's asset  $a$  inclusive of interest income  $r_t a$  and income from work, net of the tax rate  $\tau_t^i$ . An unemployed agent who is eligible for unemployment benefits faces the budget set

$$B_t^i(a, z, u^e) = \left\{ (c, a') \in \mathbb{R}_+^2 : c + a' \geq (1 + r_t)a + b_t^i(z) \right\}. \quad (5)$$

He does not have wage income but receives some fraction of his potential income as unemployment benefits.

Finally, both unemployed non-eligible and non-active agents finance consumption and next period's assets exclusively from savings:

$$B_t^i(a, z, u^n) = B_t^i(a, z, n) = \left\{ (c, a') \in \mathbb{R}_+^2 : c + a' \geq (1 + r_t)a \right\}. \quad (6)$$

**Labor Market Decisions and Value Functions.** The individual optimization problem has a recursive representation. Denote the value of an individual in country  $i$ , period  $t$ , and state  $(a, z, x)$ , by  $V_t^i(a, z, x)$ . The time index of the value function captures in a simple way that the current value depends on current and future prices and government policies, which both vary over time. Then the value of an agent in employment is given



by

$$V_t^i(a, z, e) = \max_{(c, a') \in B_t^i(a, z, e)} \left\{ \log(c) - \alpha + \beta \sum_{z' \in Z} p(z'|z) \left[ (1 - \sigma^i) \max_{x' \in \{e, u^n, n\}} V_{t+1}^i(a', z', x') \right. \right. \\ \left. \left. + \sigma^i \left( \lambda_u^i \max_{x' \in \{e, u^e, n\}} V_{t+1}^i(a', z', x') + (1 - \lambda_u^i) \max_{x' \in \{u^e, n\}} V_{t+1}^i(a', z', x') \right) \right] \right\}. \quad (7)$$

The Bellman equation reflects the dynamics of the labour market. In the present period the worker derives utility from consumption but disutility of work. The continuation value takes into account that with probability  $1 - \sigma^i$  the agent will not be separated from the job. In this case he can choose between staying employed or to quit the job. In the latter case he can choose to stay inactive or to search for a new job. He will, however, not be eligible for benefits as he decided to leave the firm himself. Hence, if the worker does not get separated from his job he has three choices,  $x' \in \{e, u^n, n\}$ . With probability  $\sigma^i$  the worker is separated from his job. Then with probability  $\lambda_u^i$  he immediately gets matched with a new firm, in which case he again can choose between employment, unemployment and inactivity. If he chooses unemployment he is eligible for benefits since he was exogenously separated from the job. With probability  $1 - \lambda_u^i$  he does not immediately find a new job. In this case he can only choose between eligible unemployment and inactivity, i.e.  $x' \in \{u^e, n\}$ . Note that a worker who was separated from his job will get unemployment benefits for one period with certainty as long as he searches for a new job during this period.

Similarly, the value of an eligible unemployed agent in country  $i$  satisfies:

$$V_t^i(a, z, u^e) = \max_{(c, a') \in B_t^i(a, z, u^e)} \left\{ \log(c) - \gamma^i + \right. \\ \left. \beta \sum_{z' \in Z} p(z'|z) \left[ \lambda_u^i \left( (1 - \mu^i) \max_{x' \in \{e, u^e, n\}} V_{t+1}^i(a', z', x') + \mu^i \max_{x' \in \{e, u^n, n\}} V_{t+1}^i(a', z', x') \right) \right. \right. \\ \left. \left. + (1 - \lambda_u^i) \left( (1 - \mu^i) \max_{x' \in \{u^e, n\}} V_{t+1}^i(a', z', x') + \mu^i \max_{x' \in \{u^n, n\}} V_{t+1}^i(a', z', x') \right) \right] \right\}. \quad (8)$$

In the present period an unemployed agent incurs the utility cost of searching  $\gamma^i$ . While

searching, a job offer for next period arrives with probability  $\lambda_u^i$ , in which case the agent can choose between employment, unemployment and inactivity. With the remaining probability  $1 - \lambda_u^i$  the agent does not receive a new offer and thus can only choose between unemployment and inactivity. Further the unemployed loses eligibility for benefits with probability  $\mu^i$  and keeps eligibility with the remaining probability  $1 - \mu^i$ .

The value of the non-eligible unemployed is very similar. The only exception is that he will not be eligible for benefits next period with certainty,

$$V_t^i(a, z, u^n) = \max_{(c, a') \in B_t^i(a, z, u^n)} \left\{ \log(c) - \gamma^i + \beta \sum_{z' \in Z} p(z'|z) \left[ \lambda_u^i \max_{x' \in \{e, u^n, n\}} V_{t+1}^i(a', z', x') + (1 - \lambda_u^i) \max_{x' \in \{u^n, n\}} V_{t+1}^i(a', z', x') \right] \right\}. \quad (9)$$

Finally, the value for non-active (i.e. not actively searching) agents in country  $i$  is given by

$$V_t^i(a, z, n) = \max_{(c, a') \in B_t^i(a, z, n)} \left\{ \log(c) + \beta \sum_{z' \in Z} p(z'|z) \left[ \lambda_n^i \max_{x' \in \{e, u^n, n\}} V_{t+1}^i(a', z', x') + (1 - \lambda_n^i) \max_{x' \in \{u^n, n\}} V_{t+1}^i(a', z', x') \right] \right\}. \quad (10)$$

The value of the non-active is similar to the non-eligible unemployed. The difference is that a non-active does not suffer the disutility of search and has a lower probability of a receiving a job offer next period, i.e.  $\lambda_n^i < \lambda_u^i$ .

**Definition of Partial and General Equilibrium.** We will now define two equilibria: (i) the partial equilibrium for a specific country  $i$ , which takes the union interest rate  $r_t$  as given; (ii) the general equilibrium for the union, for which the interest rate  $r_t$  is required to adjust such that aggregate savings equal aggregate capital in the union.

Individual state variables are assets  $a \in \mathbb{R}_+$ , idiosyncratic productivity  $z \in Z$ , and employment status  $x \in \{e, u^e, u^n, n\}$ . The aggregate state in country  $i$  is described by the joint measure  $\zeta_t^i$  over assets, labor productivity status and employment status. Let  $\mathcal{B}(\mathbb{R}_+)$  be the Borel  $\sigma$ -algebra of  $\mathbb{R}_+$ ,  $\mathcal{P}(Z)$  the power set over  $Z = \{\bar{z}_1, \bar{z}_2, \dots, \bar{z}_{n_z}\}$  and

$\mathcal{P}(X)$  the power set over  $X = \{e, u^e, u^n, n\}$ . Further, let  $\mathcal{M}$  be the set of all finite measures over the measurable space  $\{(\mathbb{R}_+ \times Z \times X), \mathcal{B}(\mathbb{R}_+) \times \mathcal{P}(Z) \times \mathcal{P}(X)\}$ .

**Definition 1** *Partial equilibrium in country  $i$ : Given sequences of interest rates  $\{r_t\}_{t=0}^\infty$  and unemployment benefit policies  $\{(\bar{b}_t^i, \mu_t^i)\}_{t=0}^\infty$  and given an initial distribution  $\zeta_0^i$ , a partial equilibrium in country  $i$  is defined by a sequence of value functions  $\{V_t^i\}_{t=0}^\infty$ , consumption and savings decisions  $\{c_t^i, a_{t+1}^i\}_{t=0}^\infty$ , firm production plans  $\{K_t^i, L_t^i\}_{t=0}^\infty$ , payroll taxes  $\{\tau_t^i\}_{t=0}^\infty$ , wages  $\{\omega_t^i\}_{t=0}^\infty$  and measures  $\{\zeta_t^i\}_{t=1}^\infty$ , with  $\zeta_t^i \in \mathcal{M} \forall t$ , such that:*

- (i) *Agents optimize: Given prices, unemployment benefit policies and tax rates, the value function  $V_t^i$  and the policy functions for consumption  $c_t^i$  and savings  $a_{t+1}^i$  satisfy the Bellman equations (7), (8), (9) and (10) with equality for each  $t \geq 0$ .*
- (ii) *Firms optimize: Prices satisfy  $r_t = F_K^i(K_t^i, L_t^i) - \delta$  and  $\omega_t^i = F_L^i(K_t^i, L_t^i)$  for each  $t \geq 0$ .*
- (iii) *The labour market clears:*

$$L_t^i = \sum_{z \in Z} z \int_0^\infty \zeta_t^i(a, z, e) da \quad \forall t \geq 0 \quad (11)$$

- (iv) *The government budget clears:*

$$\tau_t^i \omega_t^i L_t^i = \sum_{z \in Z} b_t^i(z) \int_0^\infty \zeta_t^i(a, z, u^e) da \quad \forall t \geq 0 \quad (12)$$

- (v) *The law of motion  $\zeta_{t+1}^i = H_t^i(\zeta_t^i)$  holds for each  $t \geq 0$ : Thereby the function  $H_t^i : \mathcal{M} \rightarrow \mathcal{M}$  can be explicitly written as follows:*

$$\zeta_{t+1}^i(\mathcal{A} \times \mathcal{Z} \times \mathcal{X}) = \sum_{x \in X} \sum_{z \in Z} \int_0^\infty T_t^i((a, z, x); \mathcal{A} \times \mathcal{Z} \times \mathcal{X}) \zeta_t^i(a, z, x) da,$$

where  $T_t^i((a, z, x); \mathcal{A} \times \mathcal{Z} \times \mathcal{X})$  describes the transition probability of moving from state  $(a, z, x)$  in period  $t$  to any state  $(a', z', x')$  such that  $a' \in \mathcal{A} \subset \mathbb{R}_+$ ,  $z' \in \mathcal{Z} \subset Z$ ,  $x' \in \mathcal{X} \subset X$  in period  $t + 1$ .<sup>6</sup>

---

<sup>6</sup>The description of the transition function  $T_t^i$  is quite involved and therefore deferred to the appendix.

**Definition 2** *General equilibrium in the union of countries:* Given a collection of sequences of unemployment benefit policies  $\{(\bar{b}_t^i, \mu_t^i)\}_{t=0}^\infty\}_{i=1}^I$  and given a collection of initial distributions  $\{\zeta_0^i\}_{i=1}^I$ , a general equilibrium in the union of countries is defined by sequences of value functions  $\{V_t^i\}_{t=0}^\infty\}_{i=1}^I$ , policy functions  $\{c_t^i, a_{t+1}^i\}_{t=0}^\infty\}_{i=1}^I$ , firm production plans  $\{L_t^i, K_t^i\}_{t=0}^\infty\}_{i=1}^I$ , payroll taxes  $\{\tau_t^i\}_{t=0}^\infty\}_{i=1}^I$ , wages  $\{\omega_t^i\}_{t=0}^\infty\}_{i=1}^I$ , measures  $\{\zeta_t^i\}_{t=1}^\infty\}_{i=1}^I$ , with  $\zeta_t^i \in \mathcal{M}$ , and by a sequence of interest rates  $\{r_t\}_{t=0}^\infty$  such that all conditions of definition 1 are satisfied for each country  $i \in \{1, 2, \dots, I\}$  and in addition the capital market clears at the union level, i.e.

$$\sum_{i=1}^I n^i K_{t+1}^i = \sum_{i=1}^I n^i \sum_{x \in X} \sum_{z \in Z} \int_0^\infty a_{t+1}^i(a, z, x) \zeta_t^i(a, z, x) da \quad (13)$$

holds.

**Definition 3** *Stationary general equilibrium:* A stationary general equilibrium is a general equilibrium in which all government policies, decision rules, value functions, aggregate variables and prices are constant in all countries of the union.

## 4 Calibration

We calibrate the model assuming that in  $t = 0$  the union of  $I$  countries is in a stationary general equilibrium (see Definition 3 above). Hence, we assume that the Euro-Zone as a whole is a closed economy with no net capital in- or outflows. However, we want to note here that the structural calibrated parameters are not sensitive to this choice. In particular, if we do not require capital market clearing at the union level and consider any world interest rate within a reasonable range it does not affect the overall calibration much. Currently the countries we consider are the eleven countries that formed the original Euro-Zone in 1999 plus Estonia, Greece, Latvia, Slovenia and Slovakia.

The model presented in the previous section has three sets of parameters, which correspond to the three panels of Table 1. The upper panel describes technological and preference parameters that are common to all countries. In particular, we assume that in all countries the capital share of production  $\theta$ , the depreciation of capital  $\delta$ , the time discount factor  $\beta$  and the utility cost of work  $\alpha$  is the same. Further, we assume that

Parameter	Definition
$\theta$	Capital share of output
$\delta$	Capital depreciation rate
$\beta$	Discount factor
$\rho_z$	Persistence of productivity
$\sigma_z^2$	Variance of prod. shock
$\alpha$	Utility cost of labor
$A^i$	Total factor productivity
$\gamma^i$	Utility cost of search
$\sigma^i$	Job separation rate
$\lambda_u^i$	Job finding rate for unemployed
$\lambda_n^i$	Job finding rate for inactive
$\mu^i$	Prob. of loosing UB eligibility
$\bar{b}^i$	UB replacement rate

Table 1: Model parameters.

idiosyncratic productivity follows the same Markov process, for which we use a discretized version of an AR(1) process with persistence  $\rho_z$  and variance  $\sigma_z^2$ .

The middle and lower panels display parameters that are specific to each country. The middle panel includes parameters that capture - in a reduced form - different labour market institutions: total factor productivity  $A^i$  (which affects wage differences across countries), the cost of job search  $\gamma^i$ , the exogenous job separation rate  $\sigma^i$ , as well as the job arrival rates  $\lambda_u^i$  and  $\lambda_n^i$ . The lower panel contains parameters that define country specific unemployment benefit policies ( $\mu^i, \bar{b}^i$ ).

In total our model has  $6 + I \times 7$  parameters. The three sets of parameters constitute a hierarchical structure in the degree to which policy can influence them. The unemployment benefit policy parameters ( $\mu^i, \bar{b}^i$ ) can be changed relatively easy by governments, while it takes more complex labour market reforms to change the institutional parameters ( $A^i, \gamma^i, \sigma^i, \lambda_u^i, \lambda_n^i$ ) and it is very hard, if not impossible, to change the parameters of the first panel. Given the scope of this paper, in the policy experiments below we only vary unemployment benefit policies (and how these are financed), though we want to explicitly mention here that the institutional parameters are not set in stone and can be changed through structural labour market reforms.

A central aspect of our analysis are the transitions between employment, unemployment and inactivity. Flow statistics are a useful measure since they quantify the aggregate transitions between labour market states in the data. In order to calibrate

the model, we therefore use estimated quarterly transition probabilities, and the corresponding three average labour market stocks, generously provided by Etienne Lalé. Lalé and Tarasonis (2017) estimate these transition probabilities using quarterly data on prime-age workers (25-54) in the EU countries, from 2004 until 2013.<sup>7</sup> Data on unemployment benefits in EU Member States is taken from Esser et al. (2013), and data on population and average labour earnings from Eurostat.

## 4.1 Calibration strategy

We now describe in detail how the model is calibrated. First, we set the technological parameters  $\theta$ ,  $\delta$ ,  $\rho_z$  and  $\sigma_z$  to the quarterly counterparts of Krusell et al. (2015), who use monthly data for the US economy to estimate them. We discretize the AR(1) process for individual productivity process by 5 different productivity states using the Tauchen method. We set the discount factor  $\beta$  to 0.99, implying a subjective discount rate close to one percent per quarter.

The policy related parameters are chosen as follows. The parameter  $\mu^i$ , which is the conditional probability of remaining eligible for UB next period, is also the inverse of the average duration of unemployment benefits in the model. We therefore set  $1/\mu^i$  to the maximum duration of eligibility according to the law in country  $i$ . As described above, we model the eligibility process in this way because it allows for a simpler representation and a reduction in the dimensionality of the state space. For the unemployment benefit replacement rates, we set  $\bar{b}^i$  to the data equivalents in Esser et al. (2013).

The remaining five country specific parameters  $A^i$ ,  $\gamma^i$ ,  $\sigma^i$ ,  $\lambda_u^i$  and  $\lambda_n^i$  are calibrated in order to match the following five data moments: the differentials of average wages across countries,<sup>8</sup> the share of unemployed individuals in the population, the employment-to-employment, the unemployment-to-employment, and the non-active to employment flows. Finally, we set the common utility cost of work parameter  $\alpha$  such that the population-weighted average of the fraction of employed agents in the Union matches the data.

Table 2 lists the common parameters, and table 3 contains the country specific pa-

---

<sup>7</sup>The underlying data is from the EU-SILC dataset, except Germany which comes from the GSOEP.

<sup>8</sup>We picked Germany, the largest country in the European Union, as our reference country. So TFP in Germany is equal to one and for the other countries it is calibrated in order to match wages relative to German wages.

Parameter	Definition	Value
$\theta$	Cobb-Douglas capital weight	0.3
$\delta$	Capital depreciation rate	0.01
$\rho_z$	Persistence of individual productivity	0.89
$\sigma_z^2$	Variance of individual productivity	0.08
$\alpha$	Utility cost of work	0.89
$\beta$	Discount factor	0.99

Table 2: Common Parameters. Time period is 1 quarter;  $r$  clears the EU capital market.

Parameters for the calibrated European countries. We also report the tax rates  $\tau^i$  that clear the government budget in each country.

	$A^i$	$\gamma^i$	$\sigma^i$	$\lambda_u^i$	$\lambda_n^i$	$b^i$	$1/\mu^i$	$\tau^i(\%)$
Austria	0.92	0.63	0.04	0.25	0.08	0.28	2.27	0.92
Belgium	1.01	0.60	0.02	0.10	0.06	0.37	19.70	2.13
Germany	1.00	0.01	0.01	0.10	0.10	0.23	3.94	0.45
Estonia	0.57	0.35	0.03	0.17	0.10	0.46	3.86	2.94
Spain	0.81	0.68	0.06	0.17	0.04	0.33	7.80	4.43
Finland	0.97	0.40	0.05	0.21	0.18	0.36	7.58	3.75
France	0.93	0.30	0.02	0.16	0.06	0.35	7.88	1.90
Greece	0.82	0.90	0.04	0.17	0.03	0.65	3.94	5.60
Ireland	1.05	0.55	0.03	0.13	0.05	0.36	3.94	1.97
Italy	0.92	0.48	0.03	0.13	0.04	0.09	2.58	0.25
Luxembourg	1.15	0.95	0.02	0.17	0.04	0.27	3.94	0.53
Latvia	0.45	0.30	0.04	0.16	0.07	0.57	2.95	1.60
Netherlands	0.87	0.03	0.01	0.14	0.13	0.35	3.50	1.00
Portugal	0.69	0.49	0.06	0.15	0.09	0.36	5.91	4.98
Slovenia	0.77	0.14	0.01	0.14	0.05	0.65	1.97	0.98
Slovakia	0.54	0.25	0.03	0.13	0.07	0.08	1.97	0.16

Table 3: Country specific parameters.

## 4.2 Quality of the Fit

In this section we investigate how well the model fits the European labour markets. In the calibration described above, several labour market moments were targeted. These are shown in Figures 3 to 6. In Figure 3 we observe that the average unemployment rate in Spain, Greece, Latvia and Portugal is much higher than the European average, while in Austria, Germany, Luxembourg and the Netherlands it is lower. The persistence of employment (Figure 4) is high in almost all countries. The exceptions are Spain, Finland and Portugal who have substantial flows out of employment in each quarter. The flows

from unemployment to employment (Figure 5) are quite heterogeneous across European countries. Interestingly, it is lowest in Germany, a country with rather low structural unemployment. By contrast, Austria, which has similar average unemployment rates as Germany, has the highest flow from unemployment to employment. We observe substantial heterogeneity also in the flows from inactivity to employment (Figure 6). For example, in Finland this flow is much higher than in the other countries.

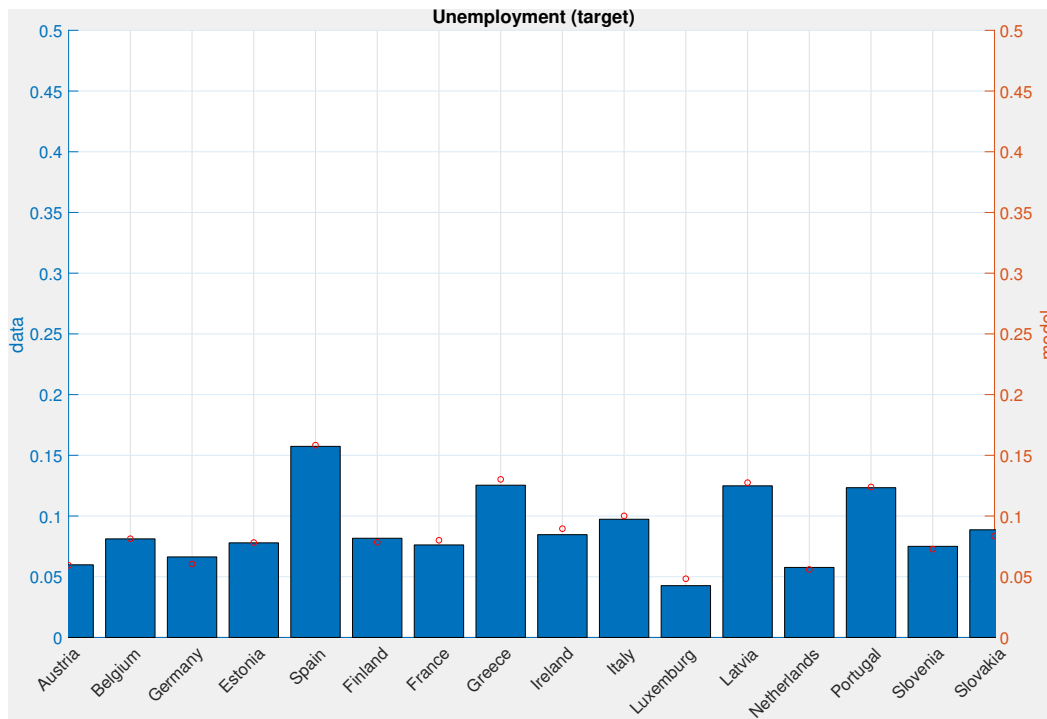


Figure 3: Unemployment.



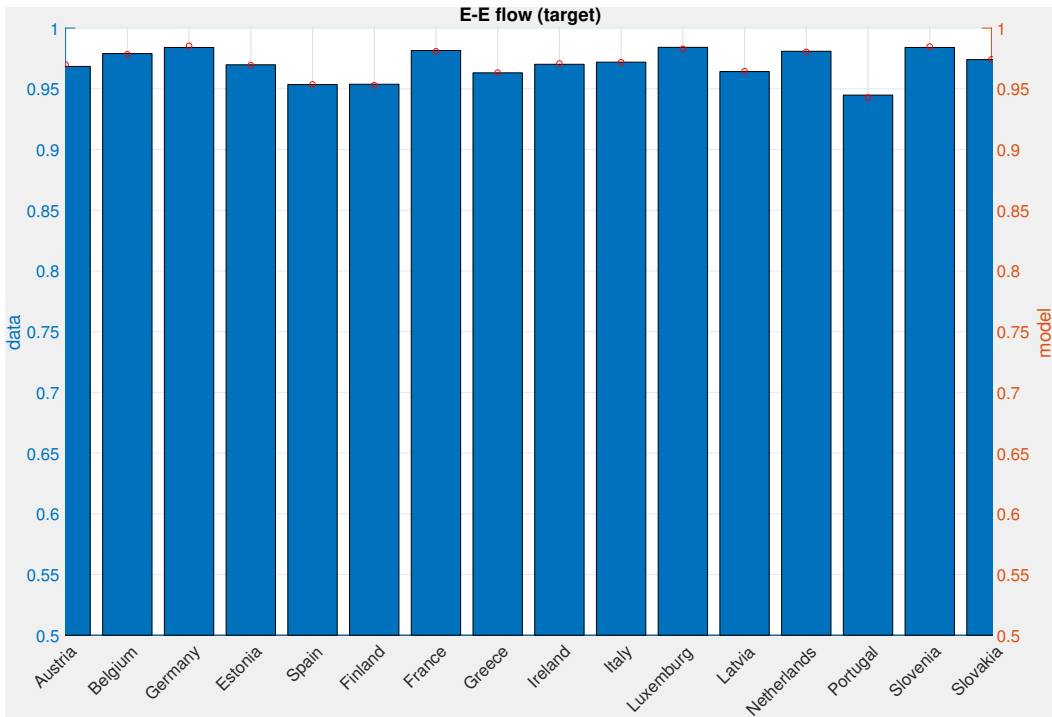


Figure 4: Employment-Employment Flows.

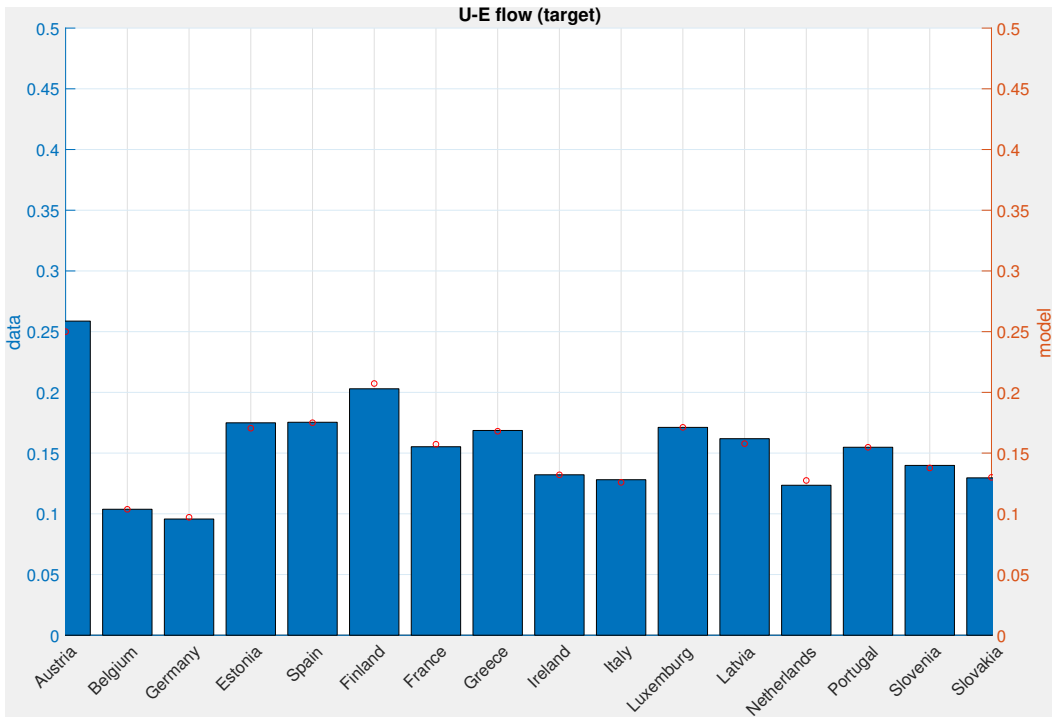


Figure 5: Unemployment-Employment Flows.

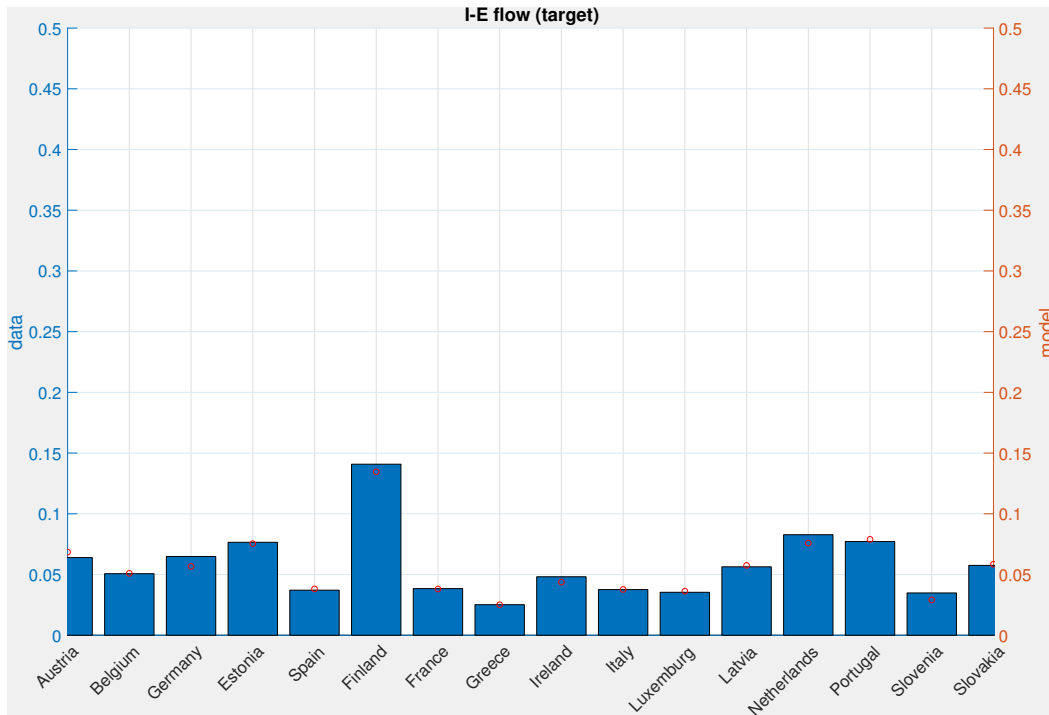


Figure 6: Inactivity-Employment Flows.

The employment ratios were not targeted country by country, but the union average was. At the country level, the comparison with the data is shown in Figure 7. The model does very well in replicating the heterogeneity in stocks of employment that we observe in the data.

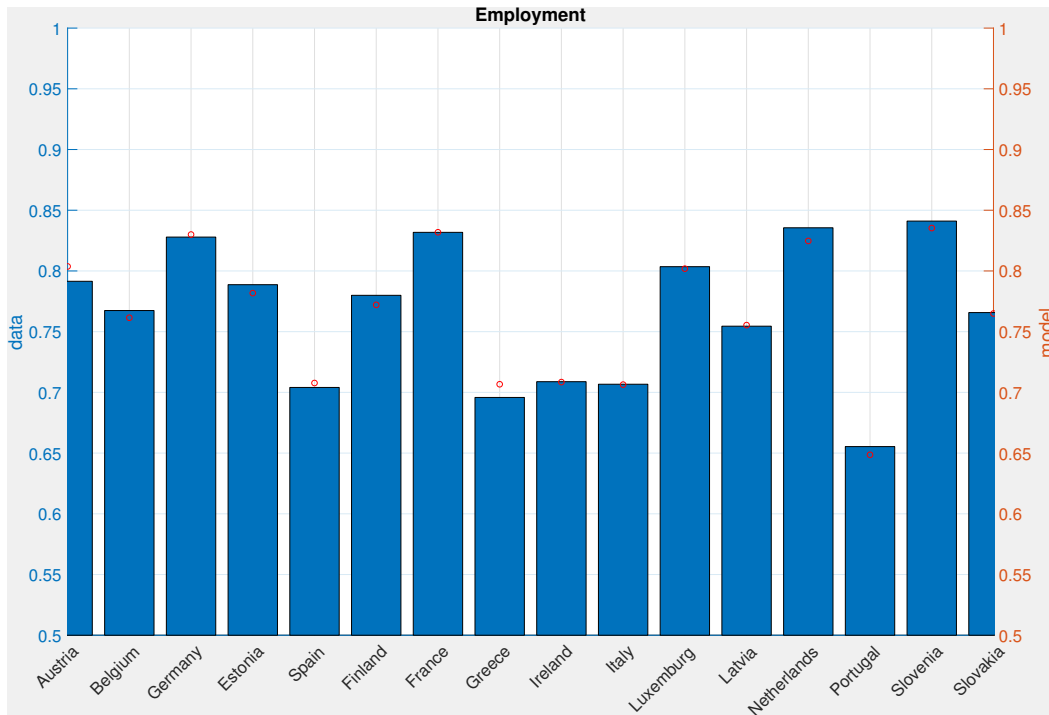


Figure 7: Employment.

Given that the model shares of employed and unemployed agents is in line with the data counterparts, the model unemployment rate is also as in the data (Figure 8). Another important moment in the model is the average persistence of an unemployment spell in each country, which is not targeted directly by the calibration. The model predictions is shown in Figure 9. By and large the model performs well also along this dimension, though there are some cases where it underpredicts (Estonia, Greece, Portugal), and one where it overpredicts (Slovenia) the average duration of an unemployment spell by more than one quarter.

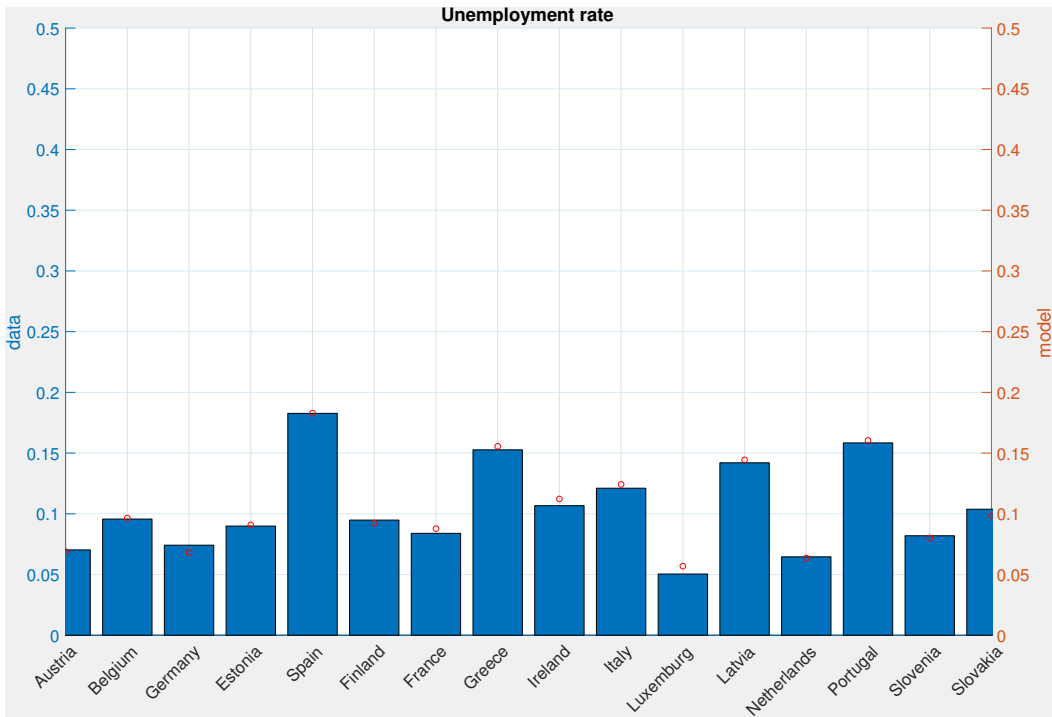


Figure 8: Unemployment Rate.

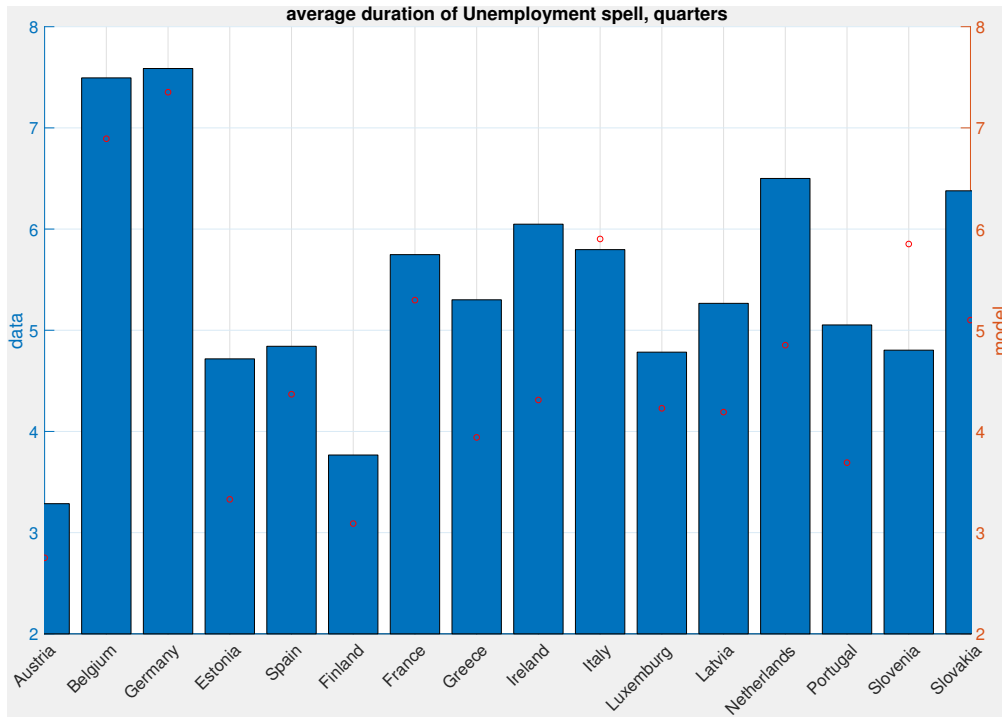


Figure 9: Average Unemployment Duration.

For completeness, the persistence of inactivity is shown in Figure 10 below. Again, the model does a good job in replicating the data with only minor deviations.

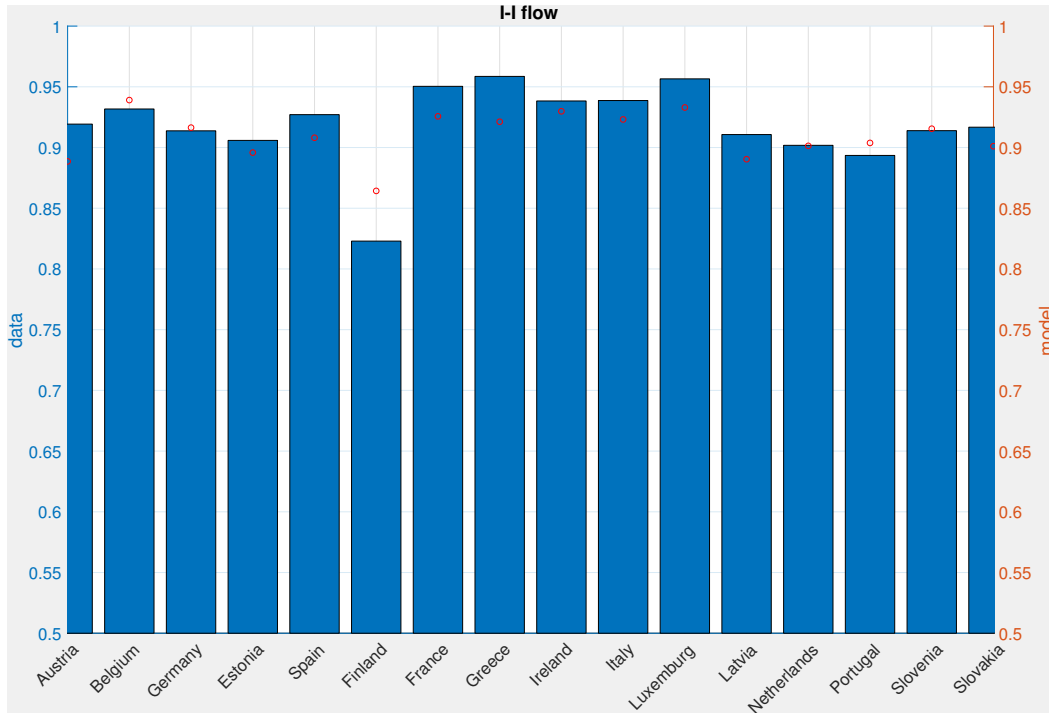


Figure 10: Inactivity to Inactivity Flows.

### 4.3 Diversity of Labour Market Institutions

Our calibration makes apparent that labour market institutions vary substantially across countries. We visualize this in the Figures 11 to 13. Figure 11 shows the job arrival rate for non-searchers ( $\lambda_n^i$ , horizontal axis) and searchers ( $\lambda_u^i$ , vertical axis) for each of the calibrated economies. We observe that these two rates are correlated but their values differ substantially across countries. For example, in Finland, the Netherlands and Estonia the job finding rate for not actively searching individuals is higher than 10%, while in Greece, Italy, Spain and Luxembourg it is lower than 5%.

Figure 12 plots average the job finding rate for non-employed on the x-axis, but this time against the job separation rate  $\sigma^i$  on the y-axis. It hence gives an idea of the rigidity of the respective labour markets. Countries in the southeast have the high job finding and low separation rates. Countries in the northwest corner have high job destruction risk and low chances of finding a job while not working. Note for instance that while Germany and Spain have similar job finding rates for the non-employed, job destruction in Spain is roughly 5 times higher, contributing to higher unemployment in Spain.

Finally, Figure 13 shows that the countries also differ substantially with respect to

their unemployment benefit system. It plots the replacement rate vs. the average duration for which unemployed are eligible to receive benefits.

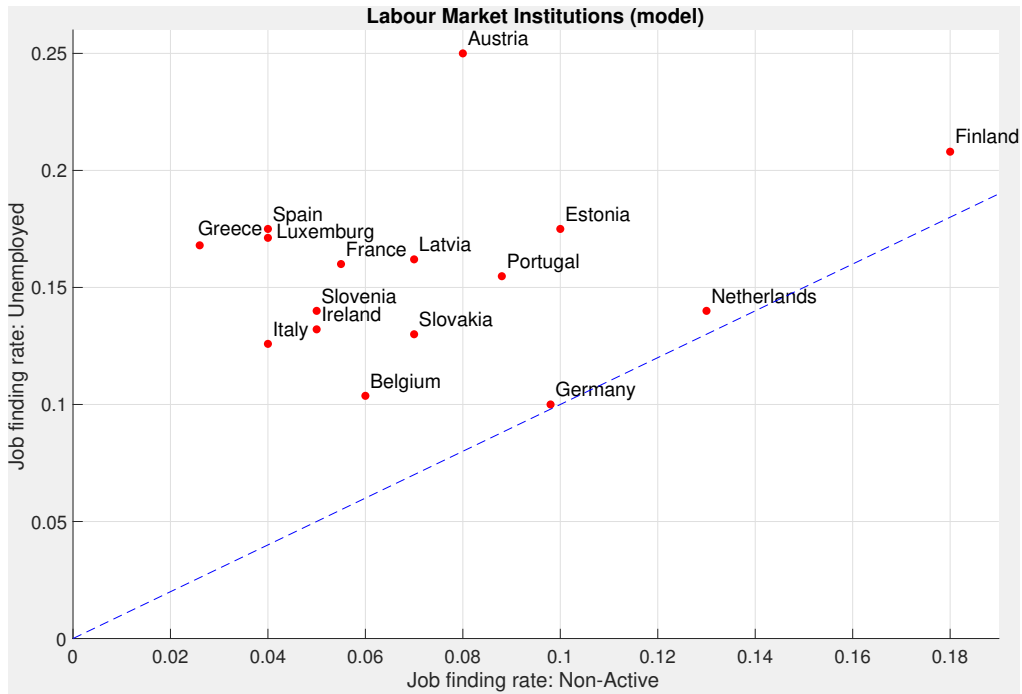


Figure 11: Job Arrival Rates

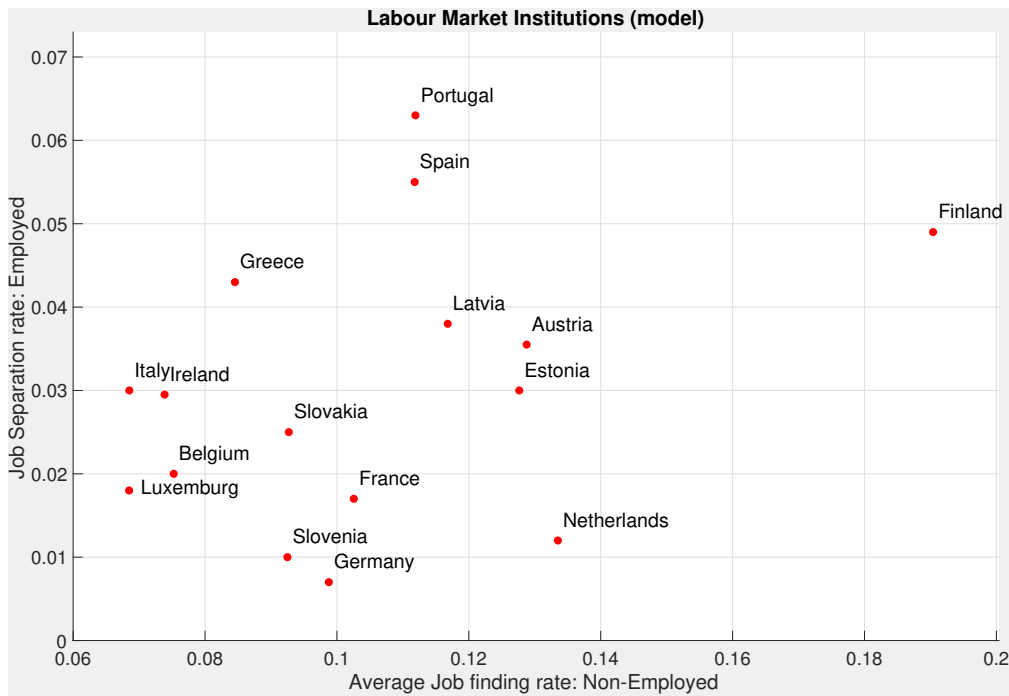


Figure 12: Labour Market Rigidity

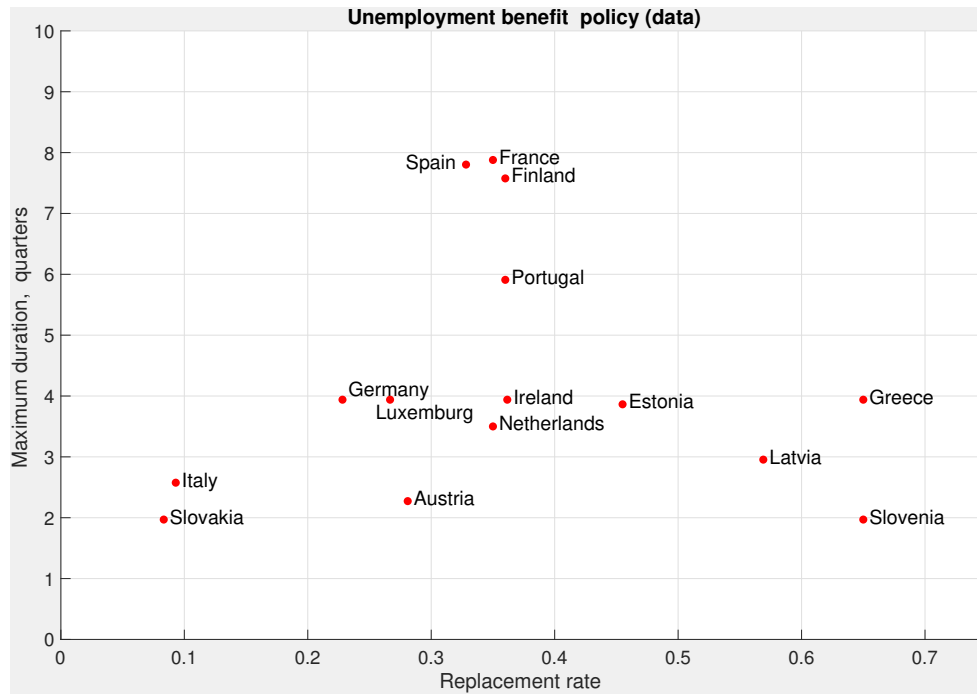


Figure 13: National Unemployment Benefit Systems.

## 5 Policy Experiments

Based on our calibration, which initializes the economy in  $t = 0$ , we are now able to perform several experiments and analyze the evolution of countries' labour markets and other macroeconomic variables under different configurations of unemployment policy for  $t \geq 1$ . In this part of the analysis we restrict the set of countries to a number of ten: Austria, Belgium, Germany, Spain, Finland, France, Ireland, Italy Luxembourg and Netherlands. These countries account for more than 90% of the Euro-Zone's total GDP.

As we pointed out earlier, a key motivation for an EUIS would be that it may provide insurance against country specific fluctuations in unemployment and, in particular, against fluctuations in the tax burden associated with its financing. In Subsection 5.1, we directly study the pure insurance effects of such policy from the viewpoint of individual European countries. In this experiment, the EUIM only insures countries against country-specific fluctuations in unemployment, while keeping the benefit systems at the status quo. We will see that the welfare benefits of such an insurance system are very small.

As we have seen above, the ten countries are quite heterogeneous in their labour

market institutions, suggesting that the individually optimal benefit systems could vary substantially across countries. If this was the case and in light of the result that the benefits of insuring against country specific shocks are small, one may doubt the desirability of a common European unemployment insurance system. In Subsection 5.2, we ask what the countries' individually optimal benefit systems are and whether an agreement to a common harmonized European benefit system could actually be achieved. For this means we compute the optimal unilateral reform separately for each country (in partial equilibrium). We find that the optimal unemployment benefit systems are surprisingly similar. In all countries it is optimal to provide an unlimited duration of eligibility and the optimal replacement rates vary between 20% and 45%.

Abstracting from other political constraints, one may argue that these slight differences are sufficient to implement reforms at the country level rather than at the union level. We show that such an argumentation is only true if one assumes that the Euro-Zone as a whole is a small open economy. If, on the other hand, prices are affected by unemployment policy, it neglects spill over effects across countries. In particular, we show that if all European countries would reform their system simultaneously and the capital market is required to clear at the union level, i.e. in general equilibrium, the very same UI benefit systems that are optimal in partial equilibrium turn out to be actually welfare worsening in most of the countries. The reason for this result is that increasing the generosity of the UI benefit system in almost all countries, reduces private savings and hence the aggregate, European, capital stock. As a consequence the marginal product of labour declines everywhere. This is bad for poor agents, who, irrespective whether they are currently employed or not, derive most of their lifetime income from wages.

In reality, the responsiveness of prices to policy changes is likely in between the two extreme cases we consider - the Euro-Zone as small open vs. a closed economy. The point we want to make is that if prices are at least to some degree affected by unemployment policy, lack of coordination across European member states may result in detrimental reforms, thus providing a rationale for centralizing unemployment policy at the European level. In the last subsection 5.3, we therefore search for a common harmonized European benefit system that is welfare improving in all countries of the union in general equilibrium. We consider two versions of this experiment that differ in the way the



governments' budgets clear. First, we consider a fully harmonized system, where the tax rate in each country is the same and the ten individual government budget constraints (12) are replaced by a single European one. Such a system, by construction, results in transfers from countries with structurally low unemployment rates to countries with high unemployment and thus does not achieve unanimous agreement among member states. Interestingly, for some of the net payers, the welfare gains of such a reform are positive, suggesting that in these countries the current unemployment benefit system is far from optimal. In the second version of this experiment the tax rates which finance the harmonized system vary across countries such that each government's budget constraint (12) is satisfied. Such a system eliminates cross-country transfers and we show that with a replacement rate of 15% all countries are better off than in the status quo.

## 5.1 Insuring Country Level Fluctuations Only

As we mentioned above, the main argument for an EUIM can be that it may provide insurance against country level fluctuations in unemployment. This insurance might be very valuable as European countries (especially recently after the crisis) have a hard time to finance the increasing fiscal burden of unemployment using debt because of tighter deficit requirements. In the following experiment we provide the "best chance" for these insurance benefits to realise as we assume that individual countries have no access to any debt or savings to smooth out unemployment fluctuations.

The experiment is constructed as follows. At time  $t = 0$  the country is in its steady state. At the end of this period, when all decisions are already made, it becomes aware that at  $t = 1$  it is hit by a completely unanticipated negative shock. After the shock hits the country returns back to its steady state in a deterministic and gradual way.

Similarly to Krusell et al. (2015), we model shocks as hitting simultaneously TFP ( $A$ ) and exogenous labor market flows ( $\sigma$ ,  $\lambda_u$  and  $\lambda_n$ ).<sup>9</sup> In particular, a deep recession will be modelled as a drop in TFP and job arrival rates and a rise in the separation rate. We model economic fluctuations in this way, because it is well-known that fluctuations of TFP alone are not able to generate large enough fluctuations of unemployment if output

---

<sup>9</sup>Note that in order to economize on notation we suppressed the time subscript in these parameters in the description of our model. In most of our analysis these parameters are indeed treated as constant. Only in the present subsection we deviate from this assumption.

fluctuations are reasonable. This issue is amplified in our framework by the fact that job creation and job destruction are not modelled endogenously.

Given all these assumptions, note that after the shock is realised the economy is following a deterministic pattern and eventually converges back to its steady state. Hence, after the realisation of the shock agents have perfect foresight when solving their dynamic optimisation problems. We consider two cases: financial autarky and insurance through the EUIS. In financial autarky, along the transition the tax rate needs to adjust to balance the government budget constraint every period. In the case of the EUIS, we assume that countries can get full insurance against the rise in unemployment expenditure and thus can leave the tax rate at its steady state value. We assume that the shock is a zero probability event and therefore comes at a complete surprise to agents. This assumption also implies that leaving the tax rate with the EUIS at the steady state value is actuarially (from an ex-ante perspective) fair.

We want to note here that the zero probability assumption serves one purpose: To calculate an *upper bound* for the actual welfare gains that a EUIS would achieve when its sole purpose was to insurance against country level fluctuations in unemployment expenditures. If we relax this assumption and assume that the shock happens with some positive probability, an actuarially fair EUIS would imply a higher tax rate than the steady state tax rate, i.e. countries would have to pay an insurance premium. This reduces consumption and thus welfare. It also would imply that agents would prepare themselves for the possibility of such a shock through higher savings, in which case the smoothing of taxes is less valuable than in case of the fully unanticipated shock.

We calculate the welfare effect of the introduction of this EUIS by comparing the welfare of autarky and the EUIS of each individual at the end of period  $t = 0$ , i.e. after learning that shocks will occur next period. That we calculate the welfare gains conditional on the negative shock happening again provides an upper bound for the actual insurance gains.

The argument that we want to make with this exercise is that even in a highly stylized scenario which in several dimensions is constructed in a way to increase welfare gains of an EUIS relative to what we would expect in reality, the gains of insuring country level fluctuations are small.

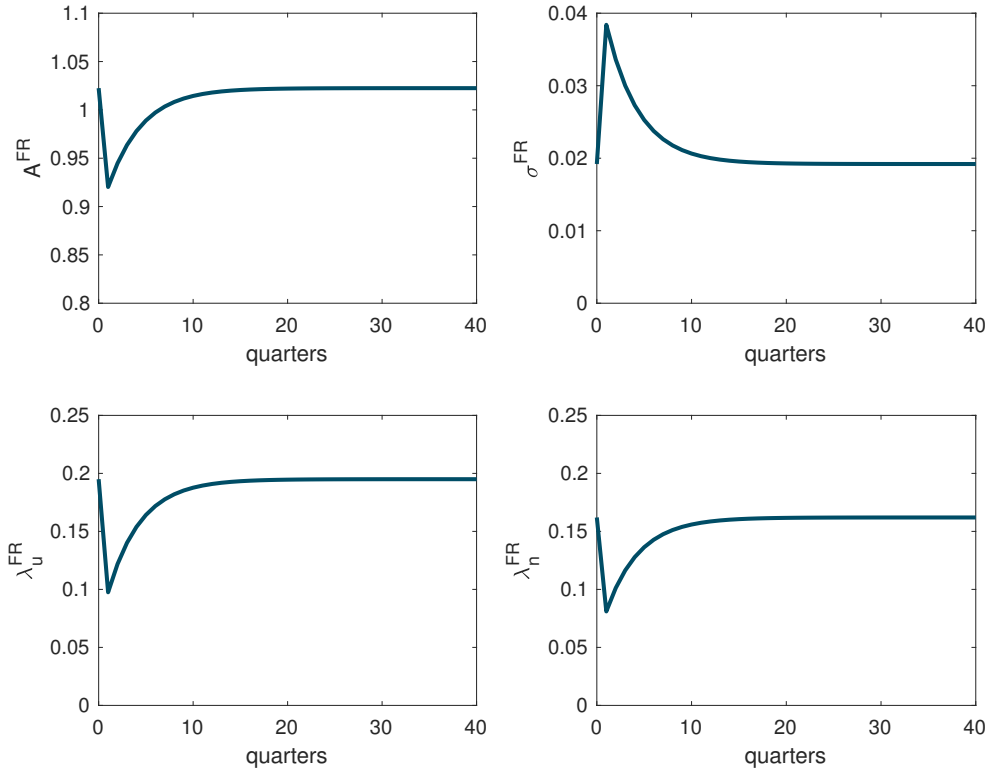


Figure 14: Shock process in France

**The Shocks.** The combination of shocks has the following structure. Consider first total factor productivity in country  $i$ . At  $t = 0$  the country is in steady state, i.e.  $A_0^i = A^i$ . At  $t = 1$  a negative shock of size  $\epsilon_A$  hits,

$$\log(A_1^i) = (1 - \epsilon_A) \log(A^i).$$

The shock has persistence  $\rho_A$  and moves back to the steady state in a gradual and deterministic way,

$$\log(A_t^i) = \rho_A \log(A_{t-1}^i) + (1 - \rho_A) \log(A^i) \quad \text{for } t \geq 1.$$

Similarly, the job separation rate and the job arrival rates are hit in  $t = 1$ ,

$$\begin{aligned}\sigma_1^i &= (1 + \epsilon_\sigma)\sigma^i \\ \lambda_{u,1}^i &= (1 - \epsilon_{\lambda_u})\lambda_u^i \\ \lambda_{n,1}^i &= (1 - \epsilon_{\lambda_n})\lambda_n^i.\end{aligned}$$

After that they gradually return back to their steady state values, i.e. for  $t \geq 1$

$$\begin{aligned}\sigma_t^i &= \rho_\sigma \sigma_{t-1}^i + (1 - \rho_\sigma)\sigma^i \\ \lambda_{u,t}^i &= \rho_{\lambda_u} \lambda_{u,t-1}^i + (1 - \rho_{\lambda_u})\lambda_u^i \\ \lambda_{n,t}^i &= \rho_{\lambda_n} \lambda_{n,t-1}^i + (1 - \rho_{\lambda_n})\lambda_n^i\end{aligned}$$

holds.

We consider a deep recession with TFP dropping by 10% ( $\epsilon_A = 0.1$ ), the job separation rate doubling ( $\epsilon_\sigma = 1$ ), and the job finding rates being reduced by half ( $\epsilon_{\lambda_u} = \epsilon_{\lambda_n} = 0.5$ ). We further assume that  $\rho_A = \rho_\sigma = \rho_{\lambda_u} = \rho_{\lambda_n} = 0.75$ . Figure 14 depicts the evolution of the shock for the case of France.

The shock induces changes in labour markets, which are depicted in Figure 15. To some extent these responses are driven directly by the exogenous shock. For example a higher separation rate reduces employment by construction. But to a substantial degree they result from endogenous decisions of agents. For example, we observe that unemployment decreases at impact and only later rises above its steady state value (middle panel) and that at the same time inactivity increases at impact and gradually decreases later (lower panel). The reason is that because of lower wages and a lower likelihood to find a job even when searching, many agents are not willing to incur the utility loss of searching and instead decide not to participate. Only later, when economic conditions improved, they start searching for a job again. Further, many not separated agents decide to quit working because of the reduction in wages. In the upper panel we see that already during the first period (before the shock hits but after agents learned about the coming recession) employment declines.

If the country is in financial autarky, this mechanism is amplified through a rise in

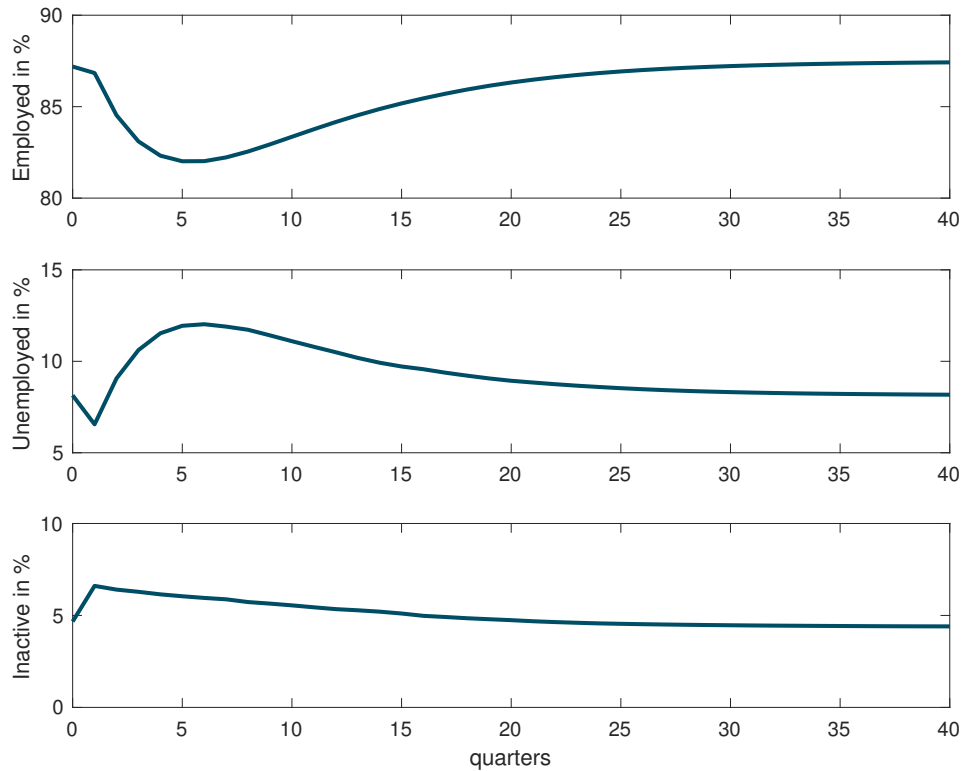


Figure 15: Labor Market in France

taxes, distorting incentives to (try to) work further. Figure 16 shows how taxes in France would evolve under autarky (solid line) as opposed to the case in which the country is fully insured against fluctuations in benefit expenditures (dashed line). In France such a shock would result in a gradual increase in the payroll tax that is from 1.9% to about 3.3% at the peak of the recession.

We performed this very same exercise for all our ten countries. The tax rates in autarky for all countries are shown in Figure 17. We saw before that the steady state taxes which finance the country specific unemployment benefit systems differ substantially across country. This is a consequence of both different unemployment benefit policies and different labour market institutions that determine job creation and destruction. As we can see in Figure 17 these difference not only affect the steady state level of taxes but also their responses to shocks.

Table 4 shows the welfare gains of insuring against country level fluctuations in

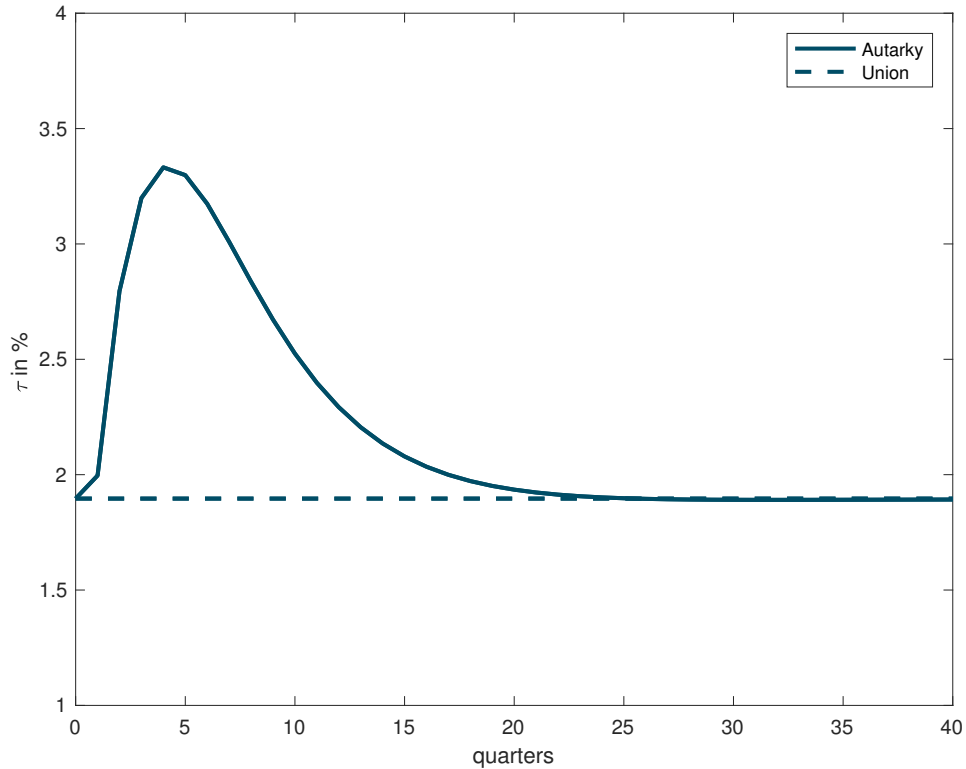


Figure 16: Taxes in France

taxes. Remember that they are computed conditional on the shock happening. One obvious feature of these results is the very small magnitude of the average welfare gains. This is due to the fact that most welfare gains come from the small improvement of consumption smoothing for the employed. In fact, the only reason why also unemployed and non-active have positive welfare gains is because they may be employed, and thus paying taxes, in the future.

This exercise shows that risk-sharing by itself does not provide a strong rationale for the introduction of an EUIS. In light of this result one may doubt the desirability of a common European unemployment benefit scheme. Especially, since the observed heterogeneity in labour market institutions (see section 4) suggests that the optimal benefit system could differ substantially across countries, making it difficult to reach a consensus across Europe. In the next section we want to evaluate this claim and analyze how different optimal benefit systems are across countries.

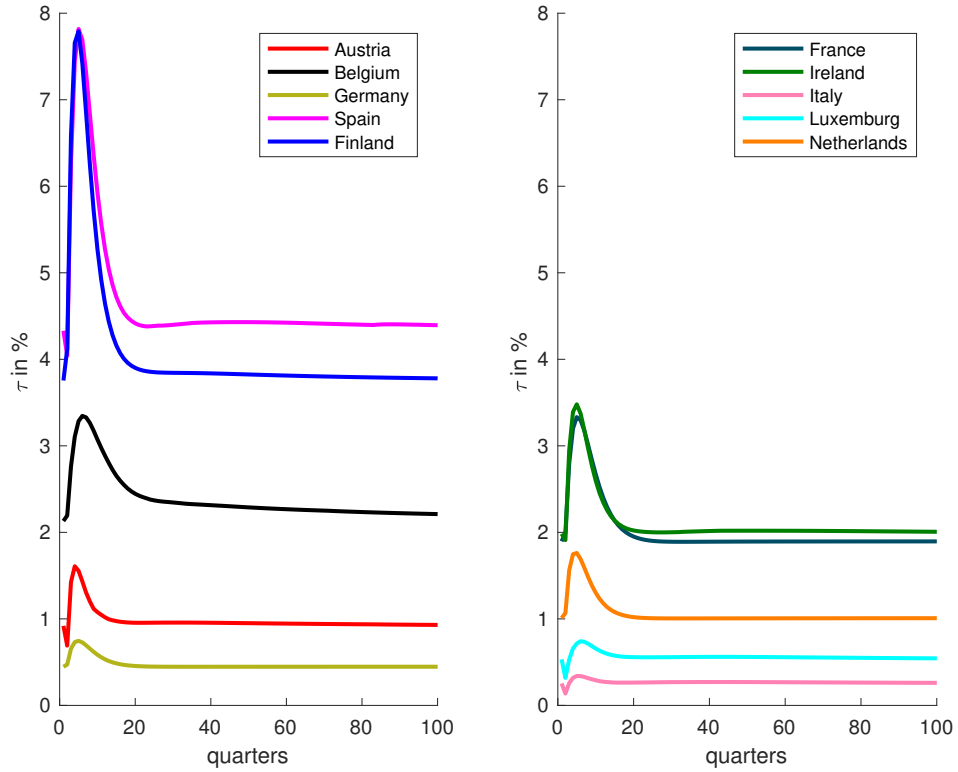


Figure 17: Taxes in Autarky

	Employed	Un. Eligible.	Un. Non-Elig.	Non-Active	Total
Austria	0.05	0.04	0.04	0.03	0.04
Belgium	0.18	0.14	0.17	0.10	0.15
Germany	0.02	0.01	0.01	0.00	0.02
Spain	0.26	0.18	0.20	0.09	0.21
Finland	0.27	0.20	0.27	0.16	0.24
France	0.10	0.06	0.06	0.02	0.09
Ireland	0.11	0.06	0.08	0.04	0.09
Italy	0.01	0.01	0.01	0.01	0.01
Luxembourg	0.02	0.02	0.02	0.01	0.02
Netherlands	0.04	0.02	0.02	0.01	0.04

Table 4: Welfare gains (in % CEV) of insuring country level fluctuations

## 5.2 National Reforms of the Unemployment Benefit System

Before trying to harmonize European unemployment insurance systems, it is worthwhile to compute the optimal unemployment insurance system individually for each

country. This gives us an idea whether the substantial heterogeneity in labour market institutions across Europe actually allow for such a harmonization or whether they make it impossible to reach a consensus across Europe. In the following subsection 5.2.1 we therefore compute the optimal national unemployment benefit reforms separately for each country, in partial equilibrium. It turns out that optimal national benefit systems are similar but not identical. To be specific, all countries find an unlimited duration of benefit receipt optimal while optimal replacement rates vary between 20% and 45%.

One might think that even if optimal policies are similar, countries are still better off by reforming the system to their individual optimum rather than to join a common European scheme. In subsection 5.2.2 we show that in such a scenario it is important to take into account that the European Union has a common capital market. In particular, we show that sticking to the partial equilibrium analysis would result in large imbalances between capital and savings across Europe, unlikely to be sustained in reality. The reason is that the optimal partial equilibrium reforms are rather generous, resulting in a large decline in precautionary savings. In section 5.2.3 we show that in general equilibrium this would result in a substantial decline in the capital stock. The induced changes in equilibrium prices, in particular a substantial decrease in Europe-wide wages would render seven out of the ten reforms that seem optimal in partial equilibrium, actually welfare worsening. This suggests that optimal unemployment insurance should be designed at the broader European level.

### 5.2.1 Optimal Unilateral Reform

In this section we compute the optimal reform for each country separately. For each country  $i$  we ask the question: What is the optimal unilateral once-and-for-all change in  $(\bar{b}^i, \mu^i)$  if only country  $i$  was to change its benefit system and the other countries would stick to the status quo? This analysis is done in partial equilibrium, i.e. we assume that a single country does not affect the equilibrium interest rate when changing its unemployment benefit policy even though the savings decisions of its citizens change. This implies that the marginal product of capital and hence the capital-labour ratio is pinned down by the interest rate and as a consequence also wages are unaffected by the change in policy.



We assume that the government maximizes the utilitarian welfare of its citizens. Formally, the government in country  $i$  chooses a pair of policy parameters  $(\bar{b}_1^i, \mu_1^i)$  with  $\bar{b}_t^i = \bar{b}_1^i$  and  $\mu_t^i = \mu_1^i$  for all  $t \geq 1$  such that social welfare is maximized,<sup>10</sup>

$$\max_{(\bar{b}_1^i, \mu_1^i)} SW(\bar{b}_1^i, \mu_1^i) = \max_{(\bar{b}_1^i, \mu_1^i)} \sum_{x \in X} \sum_{z \in Z} \int_0^\infty V_0^i(a, z, x; \bar{b}_1^i, \mu_1^i) \zeta_0^i(a, z, x) da.$$

Thereby, individually optimal policies, firm production plans and taxes adjust such that all equilibrium conditions in Definition 1 are satisfied. Note that for each individual we compute the value in the initial period and therefore take into account the whole transitional dynamics to the new steady state.

In order to be able to interpret the welfare gains associated with the policy reform, we translate them into consumption equivalent variation. In particular,  $\Delta^i(a, z, x)$  defines the per period percentage increase in consumption that you would need to give an individual with initial state  $(a, z, x)$  when the benefit system is kept at the status quo such that he is indifferent between this status quo and the optimal reform. The aggregate welfare gain is then defined as

$$\Delta^i = \sum_{x \in X} \sum_{z \in Z} \int_0^\infty \Delta^i(a, z, x) \zeta^i(a, z, x) da.$$

Similarly, we define the aggregate welfare gain of the employed, unemployed eligible, unemployed non-eligible and inactive as

$$\Delta_x^i = \frac{\sum_{z \in Z} \int_0^\infty \Delta^i(a, z, x) \zeta^i(a, z, x) da}{\sum_{z \in Z} \int_0^\infty \zeta^i(a, z, x) da} \quad \text{for } x \in \{e, u^e, u^n, n\}.$$

Table 5 shows the current benefit policy and the optimal reform in each country along with the taxes that finance this policy. For the optimal reform we report the new steady state taxes  $\tau_\infty^i$ . Note, however, that along the transition taxes vary in order to clear the government budget period by period.

We see that despite the substantial heterogeneity in labour market institutions, optimal unemployment benefit policies are surprisingly similar. In particular, in all countries

---

<sup>10</sup>Here we add the policy parameters as arguments in the value function to make it explicit that the values depend on policy parameters.

an unlimited duration of eligibility is optimal. This policy eliminates the risk of not finding a job before losing eligibility. There is some variation in optimal replacement rates but all are in the range of 20 to 45 percent.<sup>11</sup> The main difference are the tax rates that finance the rather similar benefit policies.

Country	Status Quo			Optimal Reform			$\Delta$
	$1/\mu_0^i$	$b_0^i$	$\tau_0^i(\%)$	$1/\mu_1^i$	$b_1^i$	$\tau_\infty^i(\%)$	
Austria	2	0.28	0.92	$\infty$	0.45	4.61	1.51
Belgium	20	0.37	2.13	$\infty$	0.25	1.36	0.16
Germany	4	0.23	0.45	$\infty$	0.25	3.15	1.40
Spain	8	0.33	4.43	$\infty$	0.45	11.26	2.27
Finland	8	0.36	3.75	$\infty$	0.20	0.90	0.33
France	8	0.35	1.90	$\infty$	0.35	3.75	1.18
Ireland	4	0.36	1.97	$\infty$	0.45	8.37	1.72
Italy	3	0.09	0.25	$\infty$	0.45	9.22	3.23
Luxembourg	4	0.27	0.53	$\infty$	0.45	3.52	1.07
Netherlands	4	0.35	1.00	$\infty$	0.25	4.53	0.89

Table 5: Optimal National Reforms of the Benefit System

For example, there are five countries for which a replacement rate of 45% is optimal. In Ireland, Italy and Spain the more generous benefit scheme comes along with large increases in the tax rate, which eventually reach 8.4%, 9.2%, and 11.3%, respectively. In Austria and in Luxembourg, on the other hand, the same benefit system is optimal but the tax rates only reach values of 4.6% and 3.5%, respectively. The reason for these are the structurally different labour market institutions. In particular, in section 4 we saw that in Spain the job separation rate is much higher, while in Ireland and Italy the job finding rates are much lower than in the other countries.

The last column shows the aggregate welfare gains. In Belgium this gain is less than 0.2% of consumption equivalent variation as the current benefit system is not too far from the optimal one. In particular the duration of eligibility is much higher than in all the other countries. Still there are some gains from extending the duration to infinity and slightly reducing the replacement rate. On the other extreme the welfare gains for Italy are large, about 3.2% CEV. According to our model the current benefit system in Italy with an average duration of eligibility of 3 quarters and a replacement rate of less than 10% is way too restrictive.

<sup>11</sup>Our optimization routine optimized over increments of 0.05 in the replacement rate dimension.

Of course, not every individual in a country benefits from the reform in the same way. Table 6 shows the welfare gains at a more dis-aggregated level. We see that in countries where the unemployment system becomes more generous (Austria, Spain, France, Ireland, Italy, Luxembourg) the main beneficiaries are the eligible unemployed as they are the ones who are most directly affected. However, even if the gains are smaller, also the other agents benefit from the reform as they might be eligible unemployed in the future.

	Employed	Un. Eligible.	Un. Non-Elig.	Non-Active	Total
Austria	1.40	3.06	2.62	1.57	1.51
Belgium	0.13	0.28	0.70	0.18	0.16
Germany	1.35	5.20	1.42	1.11	1.40
Spain	2.07	4.16	3.87	1.74	2.27
Finland	0.34	0.14	0.51	0.37	0.33
France	1.11	2.63	1.44	0.84	1.18
Ireland	1.54	4.52	4.37	1.40	1.72
Italy	3.06	9.42	6.15	2.50	3.23
Luxembourg	0.94	4.05	2.56	1.12	1.07
Netherlands	0.85	2.98	0.79	0.71	0.89

Table 6: Welfare gains (in % CEV) of individually optimal reforms

Finland has the most restrictive reform. Even if the duration of eligibility is extended, the replacement rate is substantially reduced to 20%. As a consequence the eligible unemployed benefit the least from the reform. The other agents benefit more through the reduction in taxes. This is directly true for the employed. But also the non-eligible unemployed and the inactive like the reform more than the eligible unemployed. The reason is that these agents will sooner earn wage income and pay taxes than they will receive unemployment benefits. Remember that the only way to gain eligibility for benefits for these agents is by going through employment and being exogenously separated from the job.

### 5.2.2 Simultaneous Reforms - The Euro-Zone as a Small Open Economy

Remember that we computed the optimal reform above sequentially, each time from the perspective of an individual country, which takes interest rates and wages as given. We treated this single country as a small open economy and assumed that eventual capital in- or outflows resulting from the reform are absorbed from outside the country.

We now ask the question: What happens if all countries would simultaneously reform their system to the individually optimal reforms computed above?

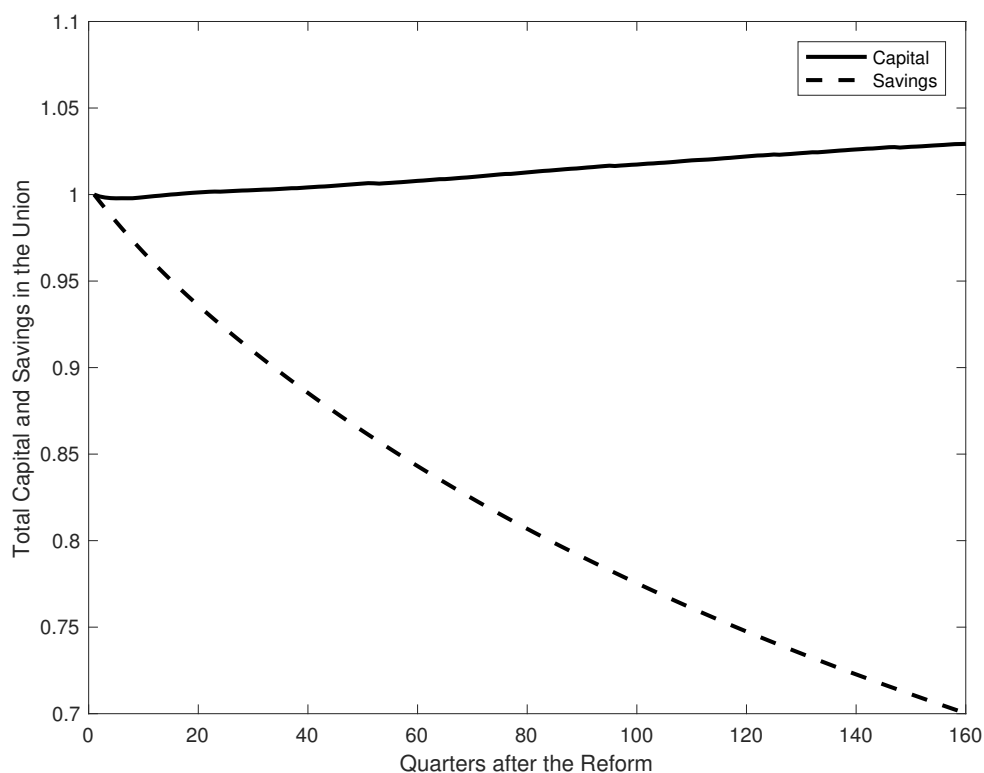


Figure 18: Capital and Savings in the Union under Open Economy Assumption

To answer this question an assumption on how the capital market clears is necessary. An extreme assumption would be that the Euro-Zone as a whole is a small open economy and therefore prices would not change even if all countries would change their unemployment benefit systems at the same time.<sup>12</sup> In such a case the answer is simple: The same set of reforms as the one computed above (Table 5) is optimal and it will result in the same welfare gains (Table 6). However, the reforms would imply large imbalances between total European savings and total European capital. Figure 18 shows that in this scenario private savings decline substantially while the capital stock actually rises as a result of the reforms. Forty years after the reform about one third of the total European

<sup>12</sup>Note that in such a case, also at  $t = 0$  the capital market need not clear and one could instead pick another world interest rate. We experimented with interest rates in a reasonable range and this did not affect optimal policies much.

capital stock is financed from outside the union. The unlimited duration of eligibility reduces the risk of individuals substantially and therefore leads to a reduction in precautionary savings. On the other hand, Figure 19 shows that the new policies, on aggregate, induce many inactive agents to start searching. As some of them eventually find jobs also employment and thus aggregate effective labour increases. As a consequence the marginal product of capital increases and firms demand more capital.

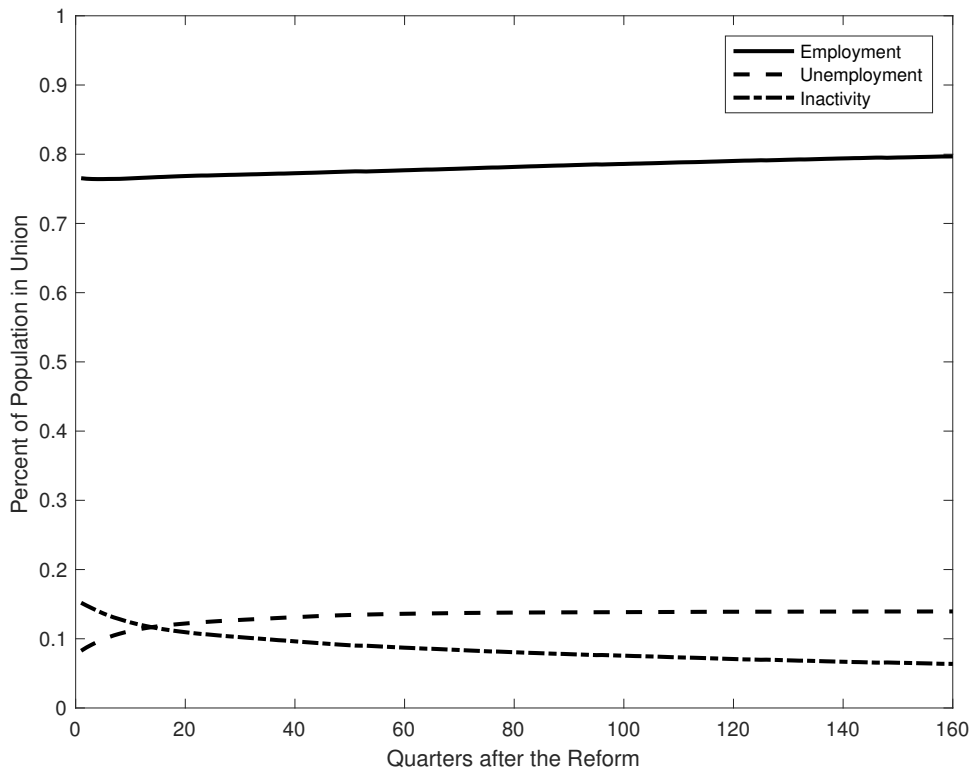


Figure 19: Aggregate Labour Market States under Open Economy Assumption

### 5.2.3 Simultaneous Reforms - The Euro-Zone as a Closed Economy

While one can challenge the view that the Euro-Zone as a whole is a closed economy, one can certainly reject the hypothesis that it is too small to have any impact on the interest rate. In particular, the imbalances in savings and capital which we see in Figure 18 are way beyond what we observe in the data.

Therefore, we now assume that there cannot be imbalances in capital and savings for

the union as a whole. In particular, we solve for the path of interest rates  $\{r_t\}_{t=1}^{\infty}$  that clears the capital market at the union level (condition (13)). This change in the interest rates will change optimal firm production plans and optimal individual behaviour and it will change the equilibrium path of wages in all countries.

The resulting welfare effects are strikingly different. In Table 7 we observe that general equilibrium effects not only have negative effects in eight countries, in seven out of the ten countries they even reverse the sign of the welfare gains. Only in Belgium and in Finland agents benefit from general equilibrium effects. In Luxembourg the gains are still positive but substantially lower than under the open economy assumption.

	Employed	Un. Eligible.	Un. Non-Elig.	Non-Active	Total
Austria	-0.39	1.12	0.43	-0.21	-0.30
Belgium	1.16	0.96	1.19	1.03	1.12
Germany	-0.82	2.72	-1.20	-0.82	-0.77
Spain	-0.39	1.43	0.72	-0.36	-0.17
Finland	1.83	1.53	1.96	1.69	1.78
France	-0.44	0.98	-0.33	-0.51	-0.37
Ireland	-0.31	2.32	1.55	-0.21	-0.12
Italy	-0.32	5.05	1.56	-0.32	-0.10
Luxembourg	-0.01	2.76	1.08	0.24	0.10
Netherlands	-3.09	-1.48	-3.95	-3.15	-3.09

Table 7: Welfare gains (in % CEV) of Reforms under Closed Economy Assumption

How can these results be explained? First, note that the aggregate capital stock is now substantially lower than in the open economy case. Capital is now solely financed by the saving of Euro-Zone citizens and as mentioned above the reforms on average reduce savings. Figure 20 depicts the evolution of capital (savings) when the capital market clears at the union level.

This reduction in the capital stock causes an increase in the marginal product of capital but reduces the marginal product of labour. As a consequence, interest rates rise but wages decline after the reform (see Figure 21). Note that wages vary across countries but their relative proportions are unaffected. To be specific, for any pair  $i, j \in \{1, 2, \dots, I\}$  and any  $t \geq 0$  it holds that  $w_t^i/w_t^j = A^i/A^j$ . This implies that wages decline in all countries of the union.

The movements in prices are good for agents who derive most of their net present

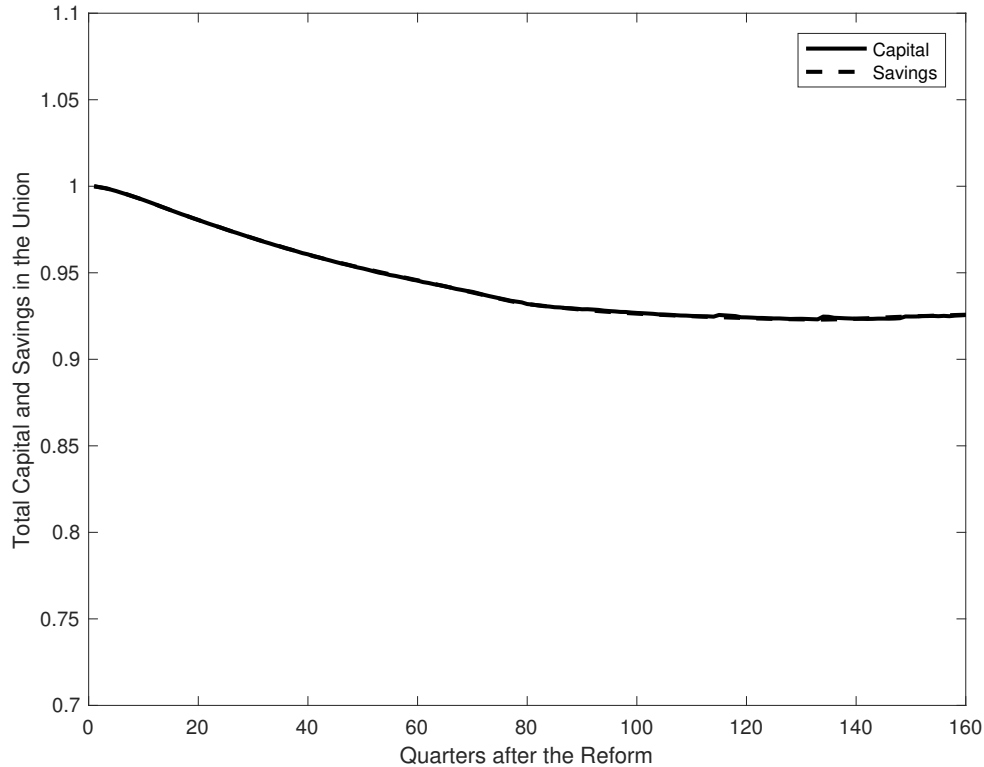


Figure 20: Capital and Savings in the Union under Closed Economy Assumption

live time income from capital but bad for those whose main income source are wages. Welfare gains are computed in percent of initial consumption implying that if an initially poor and an initially rich agent experience the same consumption increase in absolute value, the welfare gain for the poor agent will be higher. Hence, what matters mostly for the aggregate welfare effects are the changes in the income composition of poor agents. Agents with little assets do not gain much from the higher interest rate but they lose substantially from lower wages. In the right panel of Figure 21 we see that in the long run wages decrease by about 1.5%, the same order of magnitude as the average decline in welfare through GE effects. It is important to note that by and large all groups in a country lose or benefit from general equilibrium effects in a similar way (compare Tables 6 and 7). At first glance this seems surprising since non-eligible unemployed and non-active agents currently do not have wage income while the other two groups do, the employed directly and the eligible unemployed indirectly as their unemployment

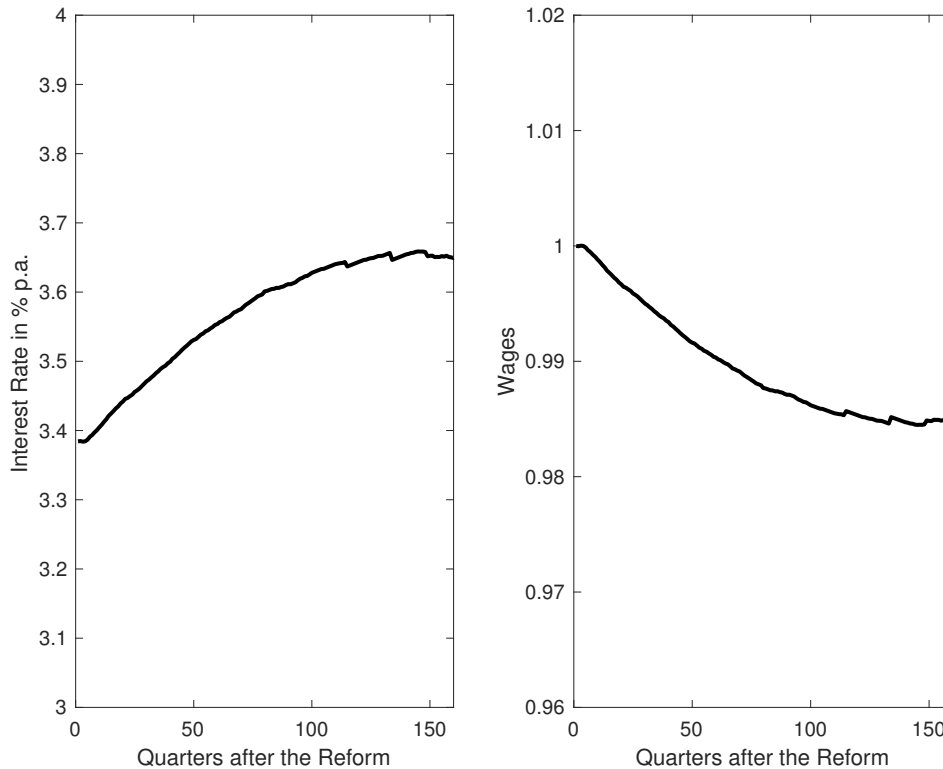


Figure 21: Equilibrium Prices under Closed Economy Assumption

benefits are proportional to wages. The reason for this result is that mobility across labour market states is higher than across wealth. For example, a currently poor non-eligible unemployed will sooner be employed and get wage income than he will be rich enough to derive most of his lifetime income from capital returns.

Now why are there two countries, Belgium and Finland, who benefit from the general equilibrium effects? Because these two countries are relatively rich on average and have a relatively equal distribution of wealth. This means that the wealth owned by consumption poor agents is higher than in the other countries and therefore their consumption losses are not big enough to offset the overall consumption gains.

The general equilibrium feedback effects from prices in turn change the behaviour of agents. For example, in Figure 22 we observe that the decline in inactivity is muted compared to the open economy case and that employment declines, while before it was increasing. Higher interest income allows inactive agents to run down their assets at a



lower pace and at the same time lower wages make employment less attractive.

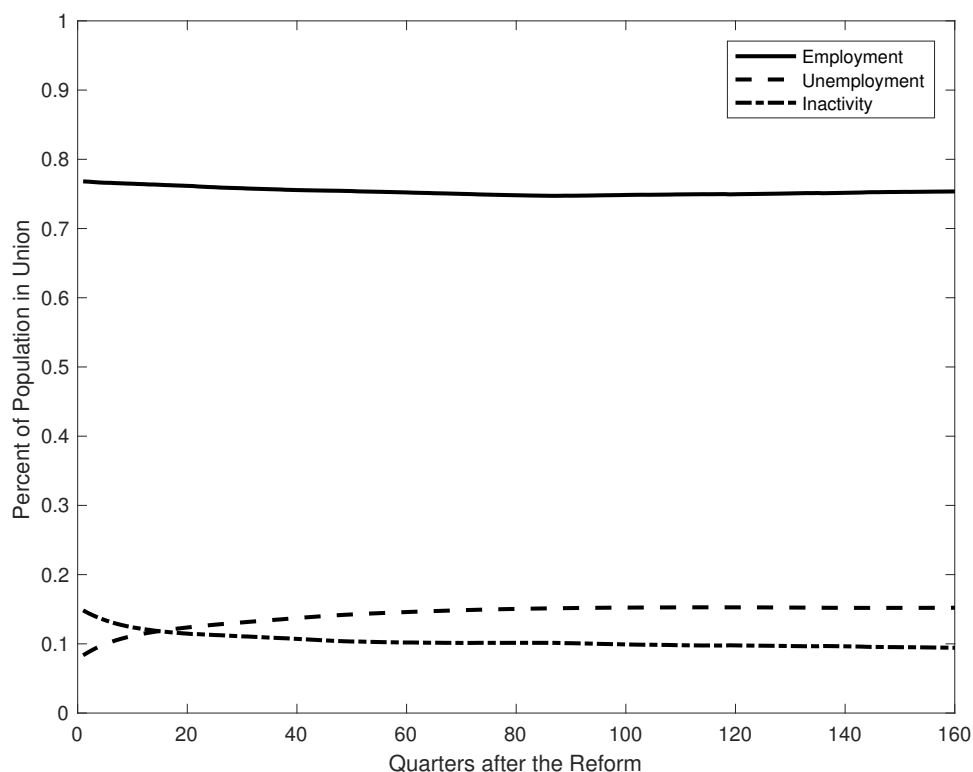


Figure 22: Aggregate Labour Market States under Closed Economy Assumption

In sum, the results of this section are twofold: (i) According to our model current national unemployment benefit systems are not optimal and for some countries there is a large potential for welfare improvement through policy reform; (ii) An integrated European capital market causes unemployment policies in some European countries to affect the citizens of other European countries even under the assumption that labor is not mobile. The latter implies that lack of coordination across member states may result in detrimental reforms and thus provide a rationale to centralize unemployment policy at the European level. This is the direction we explore next.

### 5.3 Harmonized European Unemployment Insurance Scheme

Can we find a harmonized European unemployment benefit system that is welfare improving in all countries of the union? We find that the answer to this question depends

on how such a system is financed. If contribution payments vary such that cross-country transfers are eliminated, we find that a harmonized benefit system with an unlimited duration and a replacement rate of 15% is welfare improving in all countries. On the other hand, we could not find such a system, when it is financed jointly at the union level.

### 5.3.1 Joint Financing on the Union Level

Let us first consider jointly financed benefit systems. In this experiment, we replace individual countries' budget constraints with a common European one. Instead of  $I$  government budget constraints (equation (12)) which solve for  $I$  different tax rates, there is only one tax rate that clears the union budget constraint

$$\tau_t \sum_{i=1}^I \omega_t^i L_t^i = \bar{b} \sum_{i=1}^I \omega_t^i \sum_{z \in Z} z_t \int_0^\infty \zeta_t^i(a, z, u^e) da \quad \forall t \geq 0. \quad (14)$$

Note that both the tax rate and the replacement rate are independent of  $i$ . As we mentioned above not every country would agree to this form of financing no matter what the benefit system is.

In Table 8 we show the results for the benefit system with an unlimited duration of eligibility and a common replacement rate of 15%. We see that while most countries gain from the reform, there are three exceptions, all of whom are net payers: Austria, France and the Netherlands. Interestingly, not all countries which are net payers lose from the reform. In particular the welfare gains in Belgium, Germany, Finland and Ireland are positive even though these countries pay substantial transfers, between 0.14% and 0.87% of their respective GDP. This result is another indicator that current unemployment benefit policies are far from optimal in some of the countries.

Country	Status Quo			Optimal Reform			$\Delta$	Transfer/GDP
	$1/\mu_0^i$	$\bar{b}_0^i$	$\tau_0^i(\%)$	$1/\mu_1^i$	$\bar{b}_1^i$	$\tau_\infty^i(\%)$		
Austria	2	0.28	0.92	$\infty$	0.15	1.47	-0.29	-0.51
Belgium	20	0.37	2.13	$\infty$	0.15	1.47	0.25	-0.71
Germany	4	0.23	0.45	$\infty$	0.15	1.47	0.20	-0.14
Spain	8	0.33	4.43	$\infty$	0.15	1.47	1.45	0.74
Finland	8	0.36	3.75	$\infty$	0.15	1.47	1.04	-0.87
France	8	0.35	1.90	$\infty$	0.15	1.47	-0.06	-0.16
Ireland	4	0.36	1.97	$\infty$	0.15	1.47	0.68	-0.09
Italy	3	0.09	0.25	$\infty$	0.15	1.47	0.87	0.29
Luxembourg	4	0.27	0.53	$\infty$	0.15	1.47	-0.40	-0.64
Netherlands	4	0.35	1.00	$\infty$	0.15	1.47	0.17	0.07

Table 8: Harmonized Benefit System Financed Jointly

### 5.3.2 Country-Specific Contribution Payments

Let us next consider the case of varying contribution payments across countries, which clear each country's government budget constraint separately. To be specific, in this experiment we require that condition (12) holds for each  $i \in \{1, 2, \dots, I\}$ . Table 9 shows that in this case the very same benefit system (unlimited duration, replacement rate of 15%) that we considered above is welfare improving in all countries of the union.

To understand why this mix of taxes and benefits is welfare improving in all countries it is worthwhile to remember three findings of our analysis so far: (i) European countries have structurally different labour market institutions which as a consequence lead to very different long term averages in employment, unemployment and inactivity (section 4); (ii) Despite these differences, the optimal unilateral reforms are surprisingly similar with an unlimited duration of unemployment benefits and replacement rates between 20% and 45% (section 5.2.1). (iii) If all countries were to reform their benefit systems by themselves to their respective individual optima this would result in a substantial decline in the capital stock. As a consequence wages across Europe would be lower and especially poor agents, who derive most of their lifetime income from labour, would experience large welfare losses (section 5.2.3).

Country	Status Quo			Optimal Reform			$\Delta$
	$1/\mu_0^i$	$\bar{b}_0^i$	$\tau_0^i(\%)$	$1/\mu_1^i$	$\bar{b}_1^i$	$\tau_\infty^i(\%)$	
Austria	2	0.28	0.92	$\infty$	0.15	0.73	0.23
Belgium	20	0.37	2.13	$\infty$	0.15	0.45	0.92
Germany	4	0.23	0.45	$\infty$	0.15	1.27	0.38
Spain	8	0.33	4.43	$\infty$	0.15	2.53	0.62
Finland	8	0.36	3.75	$\infty$	0.15	0.22	2.03
France	8	0.35	1.90	$\infty$	0.15	1.23	0.11
Ireland	4	0.36	1.97	$\infty$	0.15	1.34	0.79
Italy	3	0.09	0.25	$\infty$	0.15	1.90	0.60
Luxembourg	4	0.27	0.53	$\infty$	0.15	0.55	0.32
Netherlands	4	0.35	1.00	$\infty$	0.15	1.57	0.08

Table 9: Optimal Harmonized Benefit System Financed at the Country Level

These three findings help in the design of a collectively optimal unemployment benefit system. The first finding says that for a system to be politically sustainable we need varying contribution payments across countries. As we have seen, a common, jointly financed, system would result in transfers from countries with structurally low unemployment to countries with structurally high unemployment. The former, at least some of them, would not participate in such a scheme. We therefore demand from the system that it eliminates cross-country transfers. This is achieved through varying tax rates that clear government budgets at the national level, i.e. that satisfy condition (12). We again observe that in countries with structurally weak labour market institutions such as Spain or Italy these tax rates are substantially higher than in other countries with more efficient institutions such as Belgium or Finland.

The second finding suggests that it makes sense to harmonize the benefit system and we indeed find that an unlimited duration of eligibility and a replacement rate of 15% is welfare improving in all countries. As before the unlimited duration eliminates the risk of losing eligibility before finding a job. However, the replacement rate is lower than in any of the unilaterally optimal reforms computed above, where the minimal replacement rate was the Finnish one with 20%. The third finding explains why this is the case. We have seen that a too generous benefit system discourages savings, which in general equilibrium reduces wages, the main income source of poor agents. In Figure 23 we see that in the long-run the capital stock is reduced by only about 2% and 3%, while before it was between 7% and 8%. As a consequence the effects on prices are muted as

can be seen in Figure 24. In particular, the wage decline is only about half to what we observed in Figure 21.

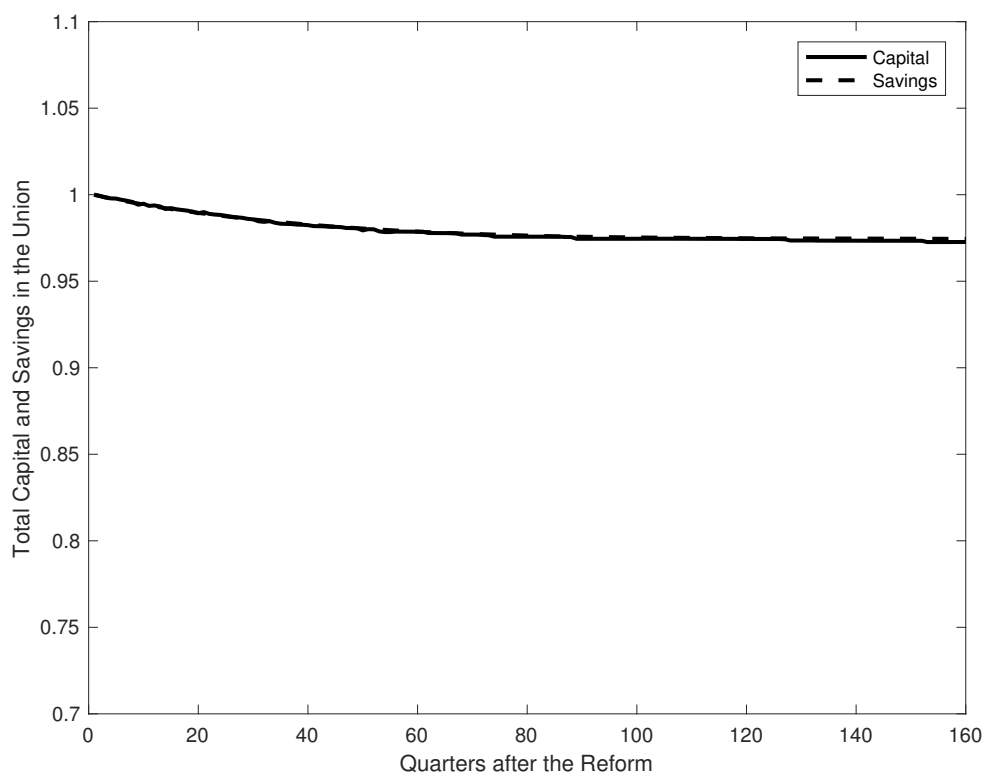


Figure 23: Capital and Savings with Harmonized UI Benefit System

Both, less generous unemployment benefits and higher wages, make employment more and inactivity less attractive and as a consequence aggregate employment is stabilized (Figure 25).

As before, the welfare effects are not only heterogeneous across countries but also across different groups within each country. This is shown in Table 10. We see that while the size varies, the sign is positive almost everywhere. In fact, only one single group does not benefit from the reform, the eligible unemployed in Belgium. The reason is that the current benefit system in Belgium has already a rather high duration of eligibility (20 quarters) and its current replacement rate is much higher than after the reform (37% vs. 15%). What stands out are the high welfare gains in Finland. In Table 10 we see that the tax rate after the reform is much lower than before. Together with strong labour market

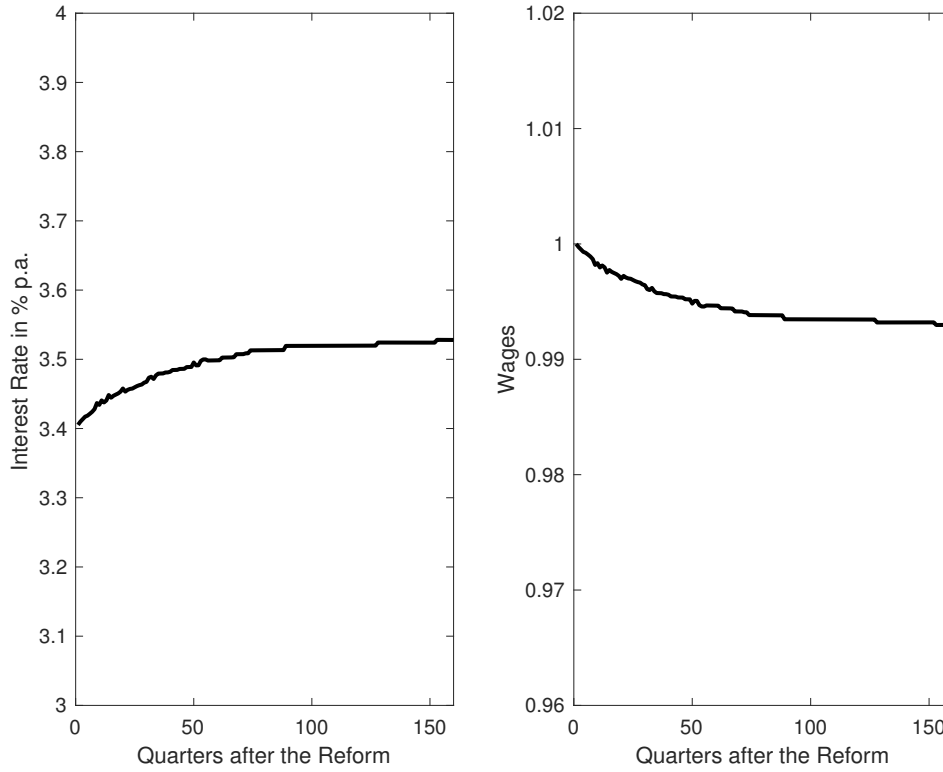


Figure 24: Equilibrium Prices with Harmonized UI Benefit System

institutions that make the duration of non-employment very short, at least for people who are willing to work, these tax reductions lead to substantial welfare gains for all groups.

	Employed	Un. Eligible.	Un. Non-Elig.	Non-Active	Total
Austria	0.21	0.56	0.47	0.24	0.23
Belgium	1.05	-0.35	0.15	0.81	0.92
Germany	0.34	2.34	0.44	0.28	0.38
Spain	0.65	0.44	0.65	0.58	0.62
Finland	2.09	1.64	1.83	1.90	2.03
France	0.11	0.15	0.18	0.09	0.11
Ireland	0.77	1.07	1.31	0.73	0.79
Italy	0.48	2.73	1.58	0.51	0.60
Luxembourg	0.30	0.85	0.51	0.33	0.32
Netherlands	0.06	0.91	0.13	0.03	0.08

Table 10: Welfare gains in (in % CEV) with Harmonized UI Benefit System

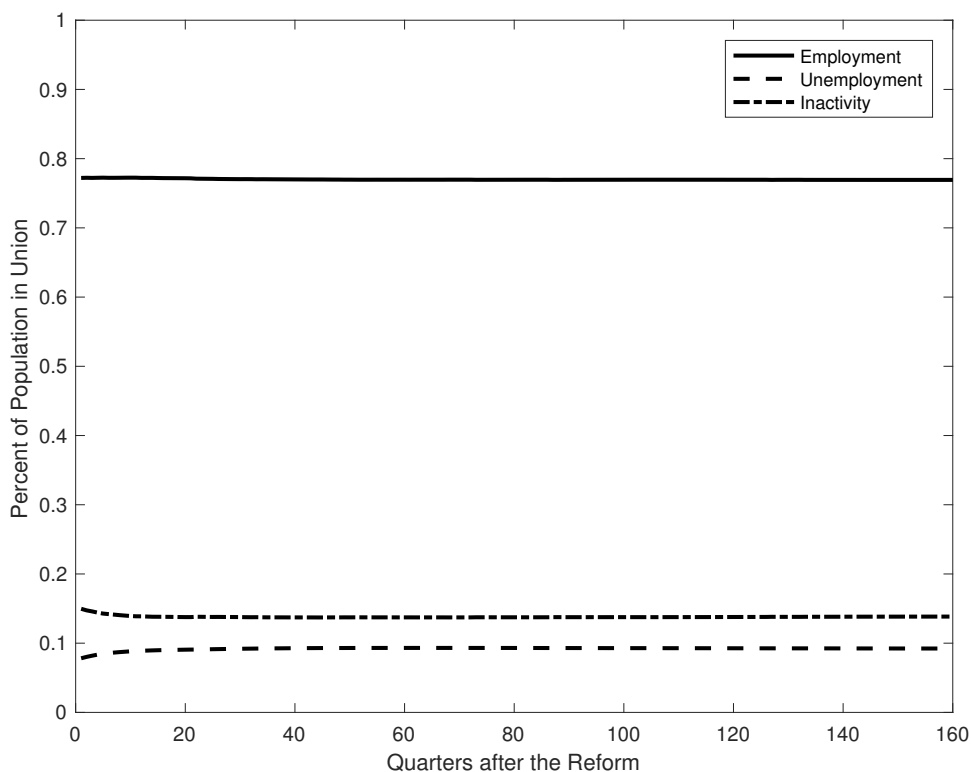


Figure 25: Aggregate Labour Market States with Harmonized UI Benefit System

## 6 Conclusion

This paper is aimed at assessing the value of a European Unemployment Insurance System (EUIS) and, in particular, how it should be designed as a constrained efficient mechanism. We take as a constraint the current labour market institutions which determine differences in job destruction and the likelihood to receive offers by the unemployed (searching for a job) and the inactive (not actively searching), we also limit the scope of unemployment insurance contracts to contracts defined by their coverage duration and their replacement rate. Our work provides a quantitative proof of the potential gains that market reforms – not just labour market reforms – can achieve in many European countries. In fact, the first contribution of this paper is to provide a novel diagnosis of European labour markets. The second, which is almost a corollary of the first, is to show quantitatively that country-specific structural parameters play a determinant role in explaining the different performance of labour markets across the EU.

Based on this calibration we perform a set of policy experiments. We show that the gains from pure risk-sharing (i.e. absent UI reforms) are very limited but that substantial welfare gains can be achieved by reforming the existing UI systems within European countries. Even if, as we document, labour markets are very different, almost surprisingly the (parameterised) UI systems that maximise welfare are very similar: unemployment benefits duration should be unlimited and replacement rates more similar across countries than what they are now. We show that unemployment benefit reforms in some European countries affect the citizens of other countries through general equilibrium effects which result from a common capital market. In particular, the decline in precautionary savings associated with more generous unemployment benefit systems causes a reduction in the aggregate, European, capital stock. This in turn causes a decline in wages all over Europe. This means that reforms which may seem optimal at the national level can be detrimental at the European level once general equilibrium effects are taken into account.

Finally, we show that a common, less generous, European benefit system can tackle this problem. We find that a harmonized benefit system with an unlimited duration and a replacement rate of 15% is welfare improving in all countries, when it is financed by country specific contribution payments. The welfare gains are relatively large for all countries, and almost unanimous within countries, even without accounting for the risk-sharing gains that countries would have if, in addition to agents' idiosyncratic risk we also had aggregate country risks. That is, we required that each country runs a balanced budget, thereby eliminating permanent cross-country transfers. With country risks and no aggregate European risk, at the steady-state constant – but differential – taxes would also provide risk-sharing, with short-run cross-country transfers across the EUIS, possibly with the support of a centralized fund as we discussed in the Introduction. Even with European aggregate risk the EUIS would play a major stabilising role: taxes would not be constant, unless the fund has borrowing capacity (which it should), but still provide risk-sharing across countries and agents. In any case, the resulting tax differences across countries reflect their structural labour market differences, in terms of job creation and destruction. These tax differences also provide clear incentives for labour market reforms.



In sum, by increasing welfare across European citizens the proposed EUIS can also be an important cohesive EU institution. There is no need to wait for European labour markets to converge to implement the EUIS. In fact, it can promote national labour market reforms and European labour market integration.

## References

- Beblavy, M. and K. Lenaerts (2017): Feasibility and Added Value of a European Unemployment Benefits Scheme, CEPS Special Report.
- Beblavy, M. and I. Maselli (2014): An Unemployment Insurance Scheme or the Euro Area: A Simulation Exercise of Two Options, CEPS Special Report.
- Böwer, U. and G. Catherine (2006): Determinants of Business Cycle Synchronization across Euro Area Countries, ECB Working Paper No. 587.
- Claveres, G. and M. Clemens (2017): Unemployment Insurance Union.
- Dolls, M., C. Fuest, D. Neumann and A. Peichl (2015): An Unemployment Insurance Scheme for the Euro Area? A Comparison of Different Alternatives Using Micro Data, CESifo Working Paper No. 5581.
- Dullien, S., J. Fernandez, M. Lopez, d. P. D. Maass, Gero and J. von Weizsacker: Fit for Purpose: German-Spanish proposal for a robust European Unemployment Insurance.
- Esser, I., T. Ferrarini, K. Nelson, J. Palme and O. Sjöberg (2013): Unemployment Benefits in EU Member States, Technical report, Directorate-General for Employment, Social Affairs and Inclusion, EC.
- Giannone, D., M. Lenza and L. Reichlin (2009): Business Cycles in the Euro Area, ECB Working Paper No. 1010.
- Ignaszak, M., P. Jung and K. Kuester (2018): Federal Unemployment Insurance: Theory, and an Application to Europe.
- Krusell, P., T. Mukoyama, R. Rogerson and A. Şahin (2011): A Three State Model of Worker Flows in General Equilibrium, *Journal of Economic Theory* 146, 1107–1133.

- Krusell, P., T. Mukoyama, R. Rogerson and A. Şahin (2015): Gross Worker Flows over the Business Cycle, Working Paper.
- Lalé, E. and L. Tarasonis (2017): The Life-cycle Profile of Worker Flows in Europe, Working Paper.
- Moyen, S., N. Stahler and F. Winkler (2016): Optimal Unemployment Insurance and International Risk Sharing.
- Saiki, A. and S. H. Kim (2014): Business Cycle Synchronization and Vertical Trade Integration: A Case Study of the Eurozone and East Asia, DNB Working Paper No. 407.

# A Appendix

## A.1 Transition Function

The transition function  $T_t^i((a, z, x); \mathcal{A} \times \mathcal{Z} \times \mathcal{X})$  describes the probability that an agent, who is in state  $(a, z, x)$  in period  $t$ , is in any state  $\{(a', z', x') : a' \in \mathcal{A}, z' \in \mathcal{Z}, x' \in \mathcal{X}\}$  in period  $t + 1$ . This function is quite involved as it captures exogenous shocks and endogenous decisions of the agent. Next period's assets  $a'(a, z, x)$  are purely endogenous as they are chosen from the agent in period  $t$  and not subject to any shock. Next period's productivity level  $z'$  is purely exogenous and depends on the Markov transition probabilities. Next period's employment state  $x' \in \{e, u^e, u^n, n\}$  depends on a combination of exogenous shocks (job separation, job finding) and endogenous decisions (work, search), which in turn depend on assets and individual productivity.

We can write the transition function as

$$T_t^i((a, z, x); \mathcal{A} \times \mathcal{Z} \times \mathcal{X}) = \mathbb{1}_{a_{t+1}^i(a, z, x) \in \mathcal{A}} \cdot \sum_{z' \in \mathcal{Z}} p(z'|z) \left\{ \mathbb{1}_{e \in \mathcal{X}} \cdot xe(a_{t+1}^i(a, z, x), z') + \mathbb{1}_{u^e \in \mathcal{X}} \cdot xu^e(a_{t+1}^i(a, z, x), z') + \mathbb{1}_{u^n \in \mathcal{X}} \cdot xu^n(a_{t+1}^i(a, z, x), z') + \mathbb{1}_{n \in \mathcal{X}} \cdot xn(a_{t+1}^i(a, z, x), z') \right\},$$

where  $xe(a_{t+1}^i(a, z, x), z')$  describes the probability of moving from labor market state  $x \in \{e, u^e, u^n, n\}$  into employment, conditional on saving  $a_{t+1}^i(a, z, x)$  and on drawing productivity shock  $z'$ . Similarly,  $xu^e(\cdot)$  is the conditional probability of moving into unemployment and being eligible for benefits, and so on.

It is useful to define the decision to search for a job next period, conditional on being not eligible for unemployment benefits by

$$s_{t+1}(a', z', 0) = \left\{ \begin{array}{ll} 1 & \text{if } \arg \max_{x' \in \{u^n, n\}} V_{t+1}^i(a', z', x') = u^n \\ 0 & \text{else} \end{array} \right\}$$

and the decision to search for a job conditional on being eligible for unemployment

benefits by

$$s_{t+1}(a', z', 1) = \left\{ \begin{array}{ll} 1 & \text{if } \arg \max_{x' \in \{u^e, n\}} V_{t+1}^i(a', z', x') = u^e \\ 0 & \text{else} \end{array} \right\}$$

Similarly, define the decision to work next period, conditional on being not eligible for unemployment benefits by

$$w_{t+1}(a', z', 0) = \left\{ \begin{array}{ll} 1 & \text{if } \arg \max_{x' \in \{e, u^n, n\}} V_{t+1}^i(a', z', x') = e \\ 0 & \text{else} \end{array} \right\}$$

and the decision to work conditional on being eligible for unemployment benefits by

$$w_{t+1}(a', z', 1) = \left\{ \begin{array}{ll} 1 & \text{if } \arg \max_{x' \in \{e, u^e, n\}} V_{t+1}^i(a', z', x') = e \\ 0 & \text{else} \end{array} \right\}$$

The conditional transition probability from employment into employment is then given by

$$ee(a_{t+1}^i(a, z, x), z') = (1 - \sigma^i)w_{t+1}^i(a_{t+1}^i(a, z, e), z', 0) + \sigma^i\lambda_u^i w_{t+1}^i(a_{t+1}^i(a, z, e), z', 1).$$

There are two possibilities how an agent, who is employed in period  $t$ , is also employed in  $t+1$ : (i) the agent does not get separated, which happens with probability  $1 - \sigma^i$  and does not quit his job, which is the case if the work decision  $w_{t+1}^i(a_{t+1}^i(a, z, e), z', 0) = 1$ . Since job quitters are not eligible for benefits the last entry of the work decision is zero; (ii) the agent gets separated from his job (with probability  $\sigma^i$ ) but immediately finds a new job (with probability  $\lambda_u^i$ ) and decides to work. In case of exogenous separation the agent would be eligible for unemployment benefits, therefore the last entry in the work decision is equal to one. One can observe that this conditional probability is a mixture of exogenous probabilities and endogenous decisions.

Similarly, we can define the other conditional probabilities: The probability of mov-

ing from employment to unemployment and being eligible for benefits is

$$eu^e(a_{t+1}^i(a, z, x), z') = \sigma^i s_{t+1}^i(a_{t+1}^i(a, z, e), z', 1) \left[ (1 - \lambda_u^i) + \lambda_u^i (1 - w_{t+1}^i(a_{t+1}^i(a, z, e), z', 1)) \right].$$

Eligibility next period requires that the worker is exogenously separated, which happens with probability  $\sigma^i$  and that the agent is actively searching for a job, i.e.  $s_{t+1}^i(\cdot) = 1$ . There are again two possibilities to be unemployed next period: (i) With probability  $1 - \lambda_u^i$  the agent does not immediately find a new job (ii) with probability  $\lambda_u^i$  the agent immediately finds a new job but he decides not to accept the offer ( $w_t^i(\cdot) = 0$ ).

The conditional probability of moving from employment into unemployment and being eligible for benefits is equal to the probability of not being separated (once you are separated you are automatically eligible for benefits), given that the agent decides to quit  $w(\cdot) = 0$  and to search for a new job  $s(\cdot) = 1$ :

$$eu^n(a_{t+1}^i(a, z, x), z') = (1 - \sigma^i)(1 - w_{t+1}^i(a_{t+1}^i(a, z, e), z', 0)) s_{t+1}^i(a'(a, z, e), z', 0).$$

Finally, the conditional probability of moving from employment into inactivity is given by

$$eu^n(a_{t+1}^i(a, z, x), z') = (1 - \sigma^i)(1 - w_{t+1}^i(a_{t+1}^i(a, z, e), z', 0))(1 - s_{t+1}^i(a_{t+1}^i(a, z, e), z', 0)) + \sigma^i \left( 1 - \lambda_u^i + \lambda_u^i (1 - w_{t+1}^i(a_{t+1}^i(a, z, e), z', 1)) \right) (1 - s_{t+1}^i(a_{t+1}^i(a, z, e), z', 1)).$$

The agent can become inactive either if he does not get exogenously separated but decides to quit working and searching (first line) or if he gets separated and does not search for a new job (second line).

We now described all possibly cases for an agent who is employed in period  $t$ , i.e.  $x_t = e$ . In an analogous way this can be done for all other initial labor market states, i.e. for  $x_t \in \{u^e, u^n, n\}$ .