European Economic Review 156 (2023) 104469

Contents lists available at ScienceDirect

European Economic Review

journal homepage: www.elsevier.com/locate/eer

On the design of a European Unemployment Insurance System ☆

Árpád Ábrahám [a], João Brogueira de Sousa [b], Ramon Marimon [c,*], Lukas Mayr [d]

[a] University of Bristol, United Kingdom
[b] Nova School of Business and Economics, Universidade NOVA de Lisboa, Portugal
[c] Universitat Pompeu Fabra, Barcelona School of Economics, European University Institute, CEPR and NBER, Spain
[d] University of Essex and IZA, United Kingdom

ARTICLE INFO

JEL classification:
J6
E2

Keywords:
Labour markets
Unemployment insurance
Job creation
Job destruction
Risk-sharing

ABSTRACT

We study the welfare effects of both existing and counter-factual European unemployment insurance (UI) policies using a rich multi-country dynamic general equilibrium model with labour market frictions. The model successfully replicates several salient features of European labour markets, in particular the cross-country differences in the flows between employment, unemployment and inactivity, as a result of labour market and UI policy differences across euro area countries. We find that mechanisms like the recently introduced instrument for temporary support to mitigate unemployment risks in an emergency (SURE), which allows national governments to borrow at low interest rates to cover expenditures on unemployment risk, yield sizeable welfare gains. Furthermore, we find that, in spite of the calibrated heterogeneity across euro area countries, there is a common direction in which they can improve their UI policies; in particular, a harmonized benefit system that features a one-time payment of around three quarters of income upon separation is welfare improving in all euro area countries relative to the status quo.

1. Introduction

Since the onset of the 21st century European labour markets have been repeatedly hit by severe economic crises. In the 2008–2012 financial and sovereign debt crisis stressed countries – such as Greece, Portugal and Spain – experienced very high levels of unemployment, making it very difficult, if not impossible, for their governments to provide adequate insurance to the unemployed without violating the low-deficit (Fiscal Compact) commitments. This raised interest in proposals for a Europe-wide or Euro-Area-wide unemployment insurance scheme. However, only during the COVID-19 pandemic was a first version of a European unemployment insurance mechanism launched. In 2020 the European Commission introduced the "Temporary Support to Mitigate Unemployment Risks in an Emergency" (SURE) mechanism, in order to mitigate the negative economic consequences of the coronavirus outbreak. This fund provides financial assistance of up to €100 billion in the form of loans from the EU to affected Member States to address the recessionary increases in expenditures on the unemployed and in job retention programs. Compared to

☆ We would like to thank for their comments: Two anonymous referees, the editor, Juan Dolado, Mike Elsby, Juan F. Jimeno, Etienne Lalé, Rody Manuelli, Richard Rogerson and Pedro Teles, and the participants in conferences and workshops where versions of this paper have been presented. Most of the research leading to this paper has been conducted within the Horizon 2020 ADEMU project, "A Dynamic Economic and Monetary Union", funded by the European Union's Horizon 2020 Program under grant agreement No 649396. BSE is supported by the Severo Ochoa Programme for Centres of Excellence in R&D (CEX2019-000915-S). João Brogueira de Sousa gratefully acknowledges funding from Fundação para a Ciência e a Tecnologia, Portugal (UIDB/00124/2020, UIDP/00124/2020 and Social Sciences DataLab - PINFRA/22209/2016), POR Lisboa and POR Norte (Social Sciences DataLab, PINFRA/22209/2016).

* Corresponding author.
E-mail address: ramon.marimon@upf.edu (R. Marimon).

https://doi.org/10.1016/j.euroecorev.2023.104469
Received 29 April 2022; Received in revised form 22 March 2023; Accepted 14 April 2023
Available online 16 May 2023

Next Generation EU (NGEU) programs, SURE has been very successful in terms its subscription.[1] This seems a 'revealed preference' argument in favour of having a similar permanent EU instrument to support countries suffering severe shocks. However, a permanent facility or program should be based on a rigorous analysis of its welfare benefits and potential redistribution effects.

We contribute to this analysis in three ways. First, we provide a novel picture of labour market differences across euro area countries, by developing and calibrating a multi-country model with incomplete markets and country specific search costs, job arrival and destruction rates, and UI and social policies. This framework allow us to model and match the marked cross-country differences both in labour market flows and unemployment insurance (UI) policies. These differences – which we show to be substantial, – in turn shape agents' decisions along the dimensions that we would expect to be the most relevant in reality: the decision to accept job offers, to quit jobs, to search for new jobs, and to save (and thereby to self-insure against job-loss). Our calibrated model of 16 euro area countries provides a good fit not only in terms of unemployment rate differences, but also in terms of transitions between employment, unemployment, and inactivity, as well as wealth distributions.

Second, we consider a simple European Unemployment Insurance System (EUIS) as a risk-sharing mechanism, akin to a permanent version of SURE. One key difference compared to SURE is that instead of providing the same lending terms to all participating countries, which may or may not satisfy all their financing needs, the EUIS provides all the necessary funding to cover unemployment insurance costs following a sever shock. At the same time, the costs of these funds are based on countries' risk-assessment, guaranteeing that the non-permanent transfers principle is maintained, while countries' financing costs are smoothed, as in insurance contracts. As with SURE, the EUIS is targeted at workers' unemployment benefits.[2] In our model UI benefits are always covered and financed with a designated payroll tax per period or in the long run. In contrast, with SURE they become part of sovereign debt, financed through the general government budget. EUIS insurance against large aggregate shocks provides significant consumption smoothing benefits (through tax smoothing) for all member countries at a relatively low cost. In particular, we show that when submitting the countries to severe shocks, of similar magnitude of the financial-euro crises or the pandemic crisis, the EUIS yields sizeable welfare gains.[3]

Our third contribution is to explore thoroughly whether, despite of the heterogeneity across European labour markets, there can be welfare gains in further harmonizing UI policies. Our calibrated model is suitable for this exploration and we show that, with a frontloaded payment scheme, the 16 euro area countries can improve their UI policies. In particular, a harmonized benefit system that features a one-time payment of around three quarters of income upon separation is welfare improving in all euro area countries relative to the status quo. While such reform of the UI systems does not require, or imply, a EUIS, it helps to define a more coherent EUIS than the simple risk-sharing mechanism we first analyse: different financing needs for a common shock would not reflect different UI policies, but labour market differentials, making more explicit the costs of higher unemployment risk, resulting on higher costs for covering common EU benefits. Furthermore, such a EUIS can provide other benefits, not accounted for in our analysis, as it can facilitate mobility (as UI benefit entitlements could transparently and easily be transferable across countries without the need of cross-country transfers), or increase 'European identity' and cohesion.

In Section 2 we present the model used to arrive at these conclusions, which is a multi-country version of the model in Krusell et al. (2011) and Krusell et al. (2017). In this model agents can be employed, unemployed or inactive and they face idiosyncratic labour productivity shocks in all states. They transit between these three labour market states partially through their endogenous decisions (job acceptance, quitting, search effort) and partially through exogenous forces (job arrival and separation shocks). They can self-insure against these and against productivity shocks by saving in a risk-free asset. The government provides unemployment benefits for a limited duration and means-tested social assistance to ensure a consumption floor to all individuals. The latter is critical to generate a realistic wealth distribution, in particular at the bottom. Both unemployment benefits and means tested transfers are financed by a tax on labour.

In Section 3 we calibrate our model such that the equilibrium stocks of employed, unemployed and inactive, as well as the flows between these states are in line with their empirical counterparts in each Eurozone country. More specifically, our model consists of three sets of parameters: (i) generic parameters of preferences and technologies, common to all economies; (ii) country-specific structural or institutional parameters mainly responsible for labour market flows; (iii) the (current) country-specific UI and social insurance policies. By allowing structural parameters to vary across European countries our model accounts for the rich heterogeneity in European labour market institutions. At the same time it is parsimonious enough to allow for a meaningful comparison between countries, revealing how different European labour market institutions are. In addition, the model generates wealth distributions in European countries with a large fraction of individuals owning basically zero wealth. This feature is key to get a reliable welfare assessment of our EUIS proposals.

As said, we see our multi-country model and its flexible parameterization as a contribution itself, because it can be adopted to study many other relevant research questions where asymmetries across European labour markets and reasonable wealth distributions are important. Moreover, it allows one to consider general equilibrium effects of these institutional reforms.

Our model and its calibration provide the framework for our policy experiments, the ultimate goal and contribution of this paper. First of all, in Section 4, we hit our economies with a large unanticipated shock that creates a significant rise in unemployment and a drop in wages. This event represents not regular business cycle fluctuations but rather a deep crisis such as the COVID pandemic.

[1] As of March 29, 2022 the EU has provided €91.8 billion out of the €100bn available, with 19 out of the 27 EU (13 out of the 19 EA) countries benefiting from it.

[2] Note that a EUIS does not cover employment retention policies, as SURE has done in the COVID-19 crisis, although it can be easily extended to cover these and other costs of unemployment risk protection.

[3] See Section 4 for a more detailed discussion on welfare gains across countries and workers.

Then we compare the aggregate path of the economies both under balanced budget and with the help of the EUIS, modelled as a fund with country specific actuarially fair accounts. We use the balanced budget transition as a benchmark, since large crises often make borrowing very costly (due to rising spreads) especially for Southern and Eastern members of the Eurozone. As opposed to no-borrowing, the EUIS allows to smooth the taxes that finance the rising unemployment benefit claims. The experience-rated contribution rates make the EUIS dynamically budget neutral. These contribution rates clearly reflect the labour market conditions in these countries. In economies where the labour market is less resilient to aggregate shocks these contributions need to be higher. In those economies, for the same reason, welfare gains are also higher, as less flexible labour markets imply a higher increase in the tax burden of unemployment insurance when aggregate shocks hit. The welfare gains are significant, ranging between 0.2 and 0.4 percent of consumption equivalent variation in the vast majority of the countries. Moreover, joining the fund would enjoy large political support in all countries (no less than 72 percent in any country).

In Section 5 we assess whether European governments, with heterogeneous labour markets, can reach a common ground in designing a harmonized EUIS that is a benefit system which features the same duration of eligibility and the same replacement rate across all member states. Crucially, we leave the means tested social assistance of individual countries at their current levels. We find that the optimal *national* scheme is most often described by a generous one-time payment of two to four quarters of lost income upon separation, with no payments thereafter. This system provides the best combination of insurance and incentives for job search effort and acceptance, in the presence of a consumption floor guaranteed by means tested social transfer.

Importantly for the question at hand, we find that a harmonized system that provides a lump sum payment of three quarters of income upon separation is welfare improving, relative to status quo national policies, in each and every county of the Eurozone. As before, the country specific contributions rates to finance the EUIS are heterogeneous and reflect the differences in labour market institutions. The welfare gains across countries are sizeable, up to one percent in consumption equivalent variation, and they depend on the generosity of the current system, on the level of social assistance and how important the moral hazard concerns are. While this more generous system creates additional costs and hence higher tax rates, part of these costs are recovered through higher employment rates and a more productive workforce. We also show that our two institutional-policy experiments are mutually consistent. In Appendix A.1 we perform the risk-sharing exercise of Section 4 for the 16 countries with the harmonized EUIS and, for most countries, welfare gains are even higher. Even though we report all the results in the main text assuming that the Eurozone (and each individual country) is a small open economy, our results are largely robust to considering the Eurozone as a closed economy.

EUIS literature review

Our research on European Unemployment Insurance Systems is related to the literature that studies risk-sharing mechanisms for the European Union or the Eurozone. The need for some form of stabilization, shock-absorbing or risk-sharing fund was already recognized by the Four and Five Presidents' Reports (2012 and 2015)[4] and more recently by the European Fiscal Board (2018). Most of the theoretical-quantitative and applied research on this topic focuses on country-risks, with the general theoretical and empirical result that there are potential welfare gains from having a well-designed European Fiscal Fund or Central Fiscal Capacity at the EU or Eurozone level. In particular, the empirical literature for the Eurozone emphasizes the role of public intervention in providing insurance against very severe shocks that may have lasting consequences (Furceri and Zdienicka, 2015), even if public risk-sharing may have improved after the euro crisis (Cimadono et al., 2020).[5] This is consistent with the fact that in established federations cross-regional transfer multipliers are not large at business cycle frequencies (Pennings, 2021 on US), while there are large gains from properly insuring households' large economic shocks, such as layoffs and illness (Stepner, 2019 on Canada). The theoretical literature also emphasizes that, in a union of sovereign states, risk-sharing transfers should not become permanent and should minimize inherent moral-hazard problems. It also emphasizes the complementarity between risk-sharing in normal times, as well as crisis prevention and resolution.[6] Complementing this literature, we show the potential risk-sharing gains that can be achieved in the Eurozone by insuring severe shocks.

Closer to our work are studies within this literature that focus on different versions of European unemployment insurance. Ignaszak et al. (2018) study the optimal provision of unemployment insurance in a federal state containing atomistic (and symmetric) regions, with transfers implemented through regional budgets. Their main focus is indeed to study the crowding out of regional incentives due to generous federal insurance schemes. In their model, as in most of the literature on cross-country risks, transfers are implemented through the regional budgets. A main moral hazard problem arises from the ability of regional governments to use federal transfers for arbitrary purposes. This problem does not arise in our economies since there is a specific payroll tax to cover unemployment benefits.

Claveres and Clemens (2017) and Moyen et al. (2019) study unemployment insurance and international risk-sharing in a two-regions model with frictional labour markets and calibrate their model to the core and the periphery of the Eurozone.[7] In both papers, a supranational agency runs an unemployment insurance scheme that triggers transfers to recessionary countries but has zero

[4] Rompuy et al. (2012) and Juncker et al. (2015), respectively.

[5] Qualifying this last claim, (Ferrari and Rogantini, 2021), strengthening the methodology used by these papers, find a reduction of risk-sharing with the adoption of the euro, which they associate with the euro crisis. The recent work of Beetsma et al. (2021) shows how a Central Fiscal Capacity can stabilize risks in the Eurozone.

[6] See Müller et al. (2019) and Ábrahám et al. (2021) for more complete characterizations, which also account for union-exit and moral hazard.

[7] With the same two-regions framework, Enders and Vespermann (2021) shows that risk-sharing can result in misallocation in economies with nominal frictions. Focusing on severe shocks, we abstract from nominal frictions.

transfers in expectation. Such a scheme allows recessionary countries to maintain unemployment benefits and simultaneously reduce taxes, thus dampening recessionary effects as in our experiment assessing the potential insurance gains of a EUIS. Going beyond the two-regions analysis, our model features a high degree of heterogeneity both across and within countries. In particular, our policy experiments are performed with 16 countries of the Euro area instead of two regions. As we show, labour market institutions and consequently flows across employment, unemployment and inactivity are heterogeneous across countries within the core (and the periphery) but also across the core and the periphery. Nevertheless, subject to similar severe shocks, there are both periphery and core countries achieving high welfare gains from participating in a EUIS.

In contrast to the previous papers, Dolls et al. (2018) and Beblavy and Lenaerts (2017) take into account the rich heterogeneity within the Eurozone. 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 as a rainy day fund. 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 to 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.

Our work on the design of (constrained) optimal national and EUIS also relates and contributes to the literature on optimal unemployment insurance. In particular, our findings are consistent with the theoretical and empirical literature that, accounting for the moral hazard cost, endorses a declining profile of unemployment benefits; from the pioneer theoretical work of Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997), to the recent theoretical and empirical work based on the evidence from Sweden (Kolsrud et al., 2018) and Hungary (Lindner and Reizer, 2020). We show that in economies where search effort is not contractable and there is a minimum income coverage, very heterogeneous Eurozone countries can reach consensus on fully front-loading their unemployment benefits with a common replacement ratio.

2. Model

Our model economy consists of a union of I 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 labour markets clear country by country. Capital, on the other hand, is perfectly mobile across countries. Regarding capital market clearing, we consider two canonical cases: in the first case, we assume that the union as a whole is a closed economy such that the (population weighted) sum of the capital stocks in all countries equals the savings of all citizens in the union; in the second case, each country (and therefore the union, as the sum of all countries) is treated as a small open economy and takes the world interest rate as given. Each country is modelled along the lines of Krusell et al. (2011) and Krusell et al. (2017). Their model captures key economic decisions of agents regarding their labour market behaviour and is therefore suited to think about unemployment policy. In particular, given labour income taxes and unemployment benefits, agents with a job opportunity 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 new job.

Timing and Preferences. Time $t \in \{0, 1, 2, \dots\}$ is discrete. Each member state is populated by a continuum of agents of measure m^i, where $\sum_{i=1}^{I} m^i = 1$. Individual preferences over consumption, labour supply and job search are given by:

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

Agents derive utility from consumption c_t and disutility from employment l_t and job search s_t. The parameter α^i captures the disutility of work and the parameter γ^i denotes the disutility of active job search. The time discount factor $\beta \in (0, 1)$ is the same for all citizens in the union. Workers choose to supply labour on the extensive margin, i.e. $l_t \in \{0, 1\}$. Additionally, the search decision is also discrete: $s_t \in \{0, 1\}$.

Labour Productivity. Agents are heterogeneous with respect to their labour productivity, denoted by $z_t \in Z = \{\bar{z}_1, \bar{z}_2, \dots, \bar{z}_{n_z}\}$. This process is assumed to be the same in each country, but depends on whether the worker is employed or not. Specifically, employed agents' productivities follows

$$\log(z_{t+1}) = \rho \log(z_t) + \epsilon_{e,t+1}, \qquad \text{where } \epsilon_{e,t+1} \sim N(0, \sigma_z^2)$$

while during non-employment

$$\log(z_{t+1}) = \rho \log(z_t) + \epsilon_{n,t+1}, \qquad \text{where } \epsilon_{n,t+1} \sim N(\mu_z^n, \sigma_z^2),$$

where $\mu_z^n < 0$ captures the depreciation of human capital during non-employment spells.

Individual Labour Market States. An agent can be employed or non-employed. All non-employed agents can decide whether or not to actively search for job opportunities. In line with official unemployment statistics, we define as *unemployed* only those who are actively searching for a job. Otherwise they are considered as *out of the labour force* or *inactive*.

However, search is not observable by the government, which implies that despite their name 'unemployment benefits' (and other transfers) cannot depend on unemployment but only on non-employment status.[8] Consequently, there is no complete overlap

[8] Note that while the government cannot distinguish the inactive from the unemployed, official unemployment statistics are generally obtained from labour force surveys, in which individuals are typically considered unemployed if they report to have actively searched within the last month. The stocks of unemployed in these surveys are the data counterpart to the model stock of unemployed, which depends on search effort.

between searchers and those who are eligible for unemployment benefits. In particular, we will have both individuals who are searching but not eligible for unemployment benefits, and those who are receiving unemployment benefits, yet not actively searching.

At the beginning of every period, agents who were employed in the previous period can lose their job with probability σ^i. The probability of finding a job while not employed depends on search effort. An agent who is actively searching during period t finds an employment opportunity for period $t+1$ with probability λ_u^i, while if not actively searching agents face a lower job arrival rate $\lambda_n^i < \lambda_u^i$. Note that the job arrival rates and the job separation rate are country specific. We capture the heterogeneity in labour market institutions across the Eurozone in this way.

Non-employed agents may or may not be eligible for unemployment benefits. Agents who are exogenously separated from their job are eligible for unemployment benefits, while agents who quit their job are not eligible. All exogenously separated agents, that is all agents who do not quit their job voluntarily, are eligible during the first period after a job loss. From the second period of the non-employment spell onwards, they lose eligibility with probability μ^i each period. This is a parsimonious way to capture limited (and country-specific) duration of unemployment benefit receipt.[9] Non-eligibility is an absorbing state. The only way to regain eligibility is to go through an employment spell and loose the job again.

In sum, agents can be in one of three labour market states $x \in \{e, n^e, n^n\}$: employment (e), non-employment, and eligibility for benefits (n^e); or non-employment and non-eligibility (n^n). Whether agents are unemployed or inactive is determined by the endogenous search decision of the non-employed (and therefore not a state variable).

Financing Consumption. Agents have four potential sources to finance their consumption. First, all agent may finance consumption out of savings (assets) a, which pay a risk-free interest rate r_t. Second, employed agents receive net labour income $(1-\tau^i)\omega_t^i z_t$, where τ^i is a linear labour income tax and ω^i the country wage rate. Third, non-employed agents with wealth $a \leq \bar{a}$ receive means tested social income (transfers) equal to t_r^i. We observe such minimum income policies in all Eurozone countries. The transfers are important to capture a substantial share of the population with almost zero or no liquid wealth. Finally, eligible non-employed agents receive unemployment benefits:

$$b_t^i(z_t) = \max\{\bar{b}^i \omega_t^i z_t, \mathbb{I}_{\{a<\underline{a}\}} t_r\}, \tag{1}$$

where $\bar{b}^i$ is the benefit replacement rate in country i and $\omega_t^i z_t$ is the worker's gross (potential) wage. Note that an agent receives unemployment benefits according to his current labour market productivity. A more realistic assumption would be to have unemployment benefits depend on past labour earnings. We choose this benefit formula 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). Since the individual productivity process is very persistent, current productivity is a good proxy for previous labour earnings. Furthermore, to avoid counter-factual dis-saving behaviour, unemployment benefits can never be lower than means tested social income.

We now define the decision problem of agents in different labour market states recursively. To ease notation, we drop the time t dependency and country specific dependency i. As usual next period's values are denoted with a prime.

Employed Agents. The value function of an employed agent (a worker) with assets a and productivity z is given by

$$\begin{aligned} W(a,z) = \max_{a',c} \Big\{ & u(c) - \alpha + \beta \mathbb{E}_{z'} \left[(1-\sigma)\tilde{V}(a',z') + \sigma \left((1-\lambda_u) N_e(a',z') + \lambda_u V(a',z') \right) \right] \Big\} \\ \text{s.t.} \quad & c + a' = (1-\tau)\omega z + (1+r)a, \quad a' \geq 0. \end{aligned}$$

The continuation value depends on the future realization of labour market and productivity shocks and on assets a'. With probability $1-\sigma$ the worker remains attached to the current job with a value $\tilde{V}$, which is the value of a job while not being eligible for unemployment benefits. With probability σ the worker is separated from his job and becomes eligible for benefits, and faces two possible continuation histories. With probability λ_u he receives a new job offer, with a value V. With probability $1-\lambda_u$ he does not receive a new job offer and therefore has the value N_e for a jobless agent eligible for unemployment benefits.

Non-Employed Agents. Agents may begin a period without a job. Depending on past experience they may or may not be eligible for unemployment insurance. The value of an eligible agent is:

$$\begin{aligned} N_e(a,z) = \max_{a',c,s} \Big\{ & u(c) - \gamma(s) + \beta \mathbb{E}_{z'} \Big[\lambda(s)(\mu \tilde{V}(a',z') + (1-\mu)V(a',z')) + (1-\lambda(s))(\mu N_n(a',z') + (1-\mu)N_e(a',z')) \Big] \Big\} \\ \text{s.t.} \quad & c + a' = \max\{\bar{b}\omega z, \mathbb{I}_{\{a<\underline{a}\}} t_r\} + (1+r)a. \end{aligned}$$

The search effort choice $s \in \{0,1\}$ affects the utility cost $\gamma(s)$ and the continuation value via the job finding probability $\lambda(s)$. We assume that $\gamma(1) = \gamma$, $\gamma(0) = 0$, $\lambda(1) = \lambda_u$ and $\lambda(0) = \lambda_n$, as explained above. Effort is not observable so μ, the probability of continuing to be eligible for unemployment benefits, does not depend on s.

The last case is the one for jobless agents who are not eligible to collect unemployment insurance benefits. Their value is given by:

$$N_n(a,z) = \max_{a',c,s} \Big\{ u(c) - \gamma(s) + \beta \mathbb{E}_{z'} \Big[\lambda(s)\tilde{V}(a',z') + (1-\lambda(s))N_n(a',z') \Big] \Big\}$$

[9] In reality this duration is not stochastic but fixed. However, implementing a fixed duration is computationally expensive as it requires keeping track of the periods each unemployed agent already received benefits. To economize on the state space we use this stochastic process, as in Krusell et al. (2011) and Krusell et al. (2017).

$$\text{s.t.} \qquad c + a' = \mathbb{I}_{\{a<\underline{a}\}} t_r + (1+r)a.$$

Since non-eligibility for unemployment benefits is an absorbing state, one only needs to consider this case in the continuation value.

The decision problem is complete once we specify the job acceptance decision for eligible and non-eligible agents, respectively:

$$V(a,z) = \max\{W(a,z), N_e(a,z)\},$$
$$\tilde{V}(a,z) = \max\{W(a,z), N_n(a,z)\}.$$

Firms. The production sector is competitive. Firms produce output via a Cobb–Douglas technology:

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

where A_t^i denotes total factor productivity in country i, K_t^i the aggregate capital stock in country i and θ the capital share of output. L_t^i is aggregate effective labour in country i. In what follows, we generally assume no aggregate (country-specific) shocks, that is $A_t^i = A^i$ for all t.[10]

Government. The government taxes labour income, distributes unemployment benefits and means tested social transfers to low income agents, and spends an exogenous amount G^i. The government budget constraint in each country is

$$\int_z \int_a \tau \omega z \zeta^e(z,a) da\, dz = \int_z \int_a \left[\bar{b}\omega z + \max\{0, \mathbb{I}_{a<\underline{a}}(t_r - \bar{b}\omega z)\}\right] \zeta^{n^e}(z,a) da\, dz + \int_z \int_a \mathbb{I}_{\{a<\underline{a}\}} t_r \zeta^{n^n}(z,a) da\, dz + G, \tag{2}$$

where ζ^e (ζ^{n^e}, ζ^{n^n}) is the distribution over individual productivities and assets conditional on being employed (non-employed eligible, non-employed non-eligible).

Frictions. Before formally defining the equilibrium, we discuss briefly the main trade-offs that the design of unemployment insurance systems involves in this environment. Individuals face several shocks. They receive idiosyncratic productivity shocks and job separation shocks during employment. Furthermore, they face job finding risk, productivity risk and the risk of losing eligibility during periods of non-employment. Due to the incompleteness of financial markets, they cannot perfectly insure against these shocks. They can accumulate assets to alleviate the consequences of negative shocks and they can actively search to reduce the risk of long unemployment spells. Unemployment insurance provides insurance against job loss and job finding risk. However, this insurance is not without costs. Generous insurance provision will discourage agents from exerting search effort and will make them more picky in accepting offers. These features will limit the implementable scope of insurance. There are also indirect costs of generous unemployment benefits, which are financed through linear payroll taxes. Increasing those taxes reduces the attractiveness of employment and hence may lead to more quits and more rejected offers. Finally, more generous unemployment insurance crowds out private savings and hence may lead to more agents to qualify for means tested social benefits.

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 $x \in \{e, n^e, n^n\}$. The aggregate state in country i is described by the joint measure ζ_t^i over assets, labour productivity status and employment status. Let $\mathcal{B}(\mathbb{R}_+)$ be the Borel σ-algebra of $\mathbb{R}_+$, $\mathcal{P}(Z)$ the power set over $Z = \{\bar{z}_1, \bar{z}_2, \ldots, \bar{z}_{n_z}\}$ and $\mathcal{P}(X)$ the power set over $X = \{e, n^e, n^n\}$. 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 $\{r_t\}_{t=0}^\infty$, unemployment benefit policies $\{(\bar{b}_t^i, \mu_t^i)\}_{t=0}^\infty$ and social minimum income t_r^i and given an initial distribution ζ_0^i, a partial equilibrium in country i is defined by a sequence of value functions $\{V_t^i, \tilde{V}_t^i\}_{t=0}^\infty$, 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 functions V_t^i, $\tilde{V}_t^i$ and the policy functions for consumption c_t^i and savings a_{t+1}^i satisfy the Bellman equations for each $t \geq 0$.

(ii) Firms optimize: $r_t = F_K^i(K_t^i, L_t^i) - \delta$ and $\omega_t^i = F_L^i(K_t^i, L_t^i)$ for each $t \geq 0$.

(iii) The labour market clears:

$$L_t^i = \sum_{z \in Z} z \int_0^\infty \zeta_t^i(a,z,e) da \qquad \forall t \geq 0 \tag{3}$$

(iv) The government budget (2) is satisfied.

(v) The law of motion $\zeta_{t+1}^i = H_t^i(\zeta_t^i)$ holds for each $t \geq 0$: the function $H_t^i : \mathcal{M} \to \mathcal{M}$ 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 $t+1$.

[10] We deviate from this assumption only in Section 4.

Definition 2. General equilibrium in the union of countries: given a collection of sequences of unemployment benefit and social assistance policies $\{\{(\bar{b}_t^i, \mu_t^i)\}_{t=0}^{\infty}, t_r^i\}_{i=1}^I$ 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 $\{\{V_t^i, \tilde{V}_t^i, \}_{t=0}^{\infty}\}_{i=1}^I$, 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 $i \in \{1, 2, \ldots, I\}$ and in addition the capital market clears at the union level, i.e.

$$\sum_{i=1}^{I} m^i K_{t+1}^i = \sum_{i=1}^{I} m^i \sum_{x \in X} \sum_{z \in Z} \int_0^{\infty} a_{t+1}^i(a, z, x) \zeta_t^i(a, z, x) da \tag{4}$$

holds.

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

The general equilibrium under Definition 2 is consistent with the treatment of the Eurozone as a closed economy, in which the interest rate adjusts to ensure capital market clearing at the union level. While we calibrate our model to satisfy equation (4) in the initial steady state, we perform the quantitative experiments under the assumption that each country is a small open economy that takes the world interest rate as given. We discuss at the end of Sections 4 and 5 why the alternative assumption, according to which the capital market clears at the union level, would have only a minor impact on the welfare effects found in the policy experiments.

The model introduced in this section is well-suited to study UI policies in the presence of labour market risk. As will become clear in the next section, there is considerable heterogeneity across European labour markets not only across unemployment and labour force participation rates but also in terms of flows between labour market states. Our model provides a flexible and parsimonious way to approximate this rich heterogeneity. There are also substantial cross-country differences with respect to their existing unemployment insurance and social assistance policies. Allowing heterogeneity in both of these dimensions is crucial to establish a realistic status quo against which we can benchmark the effect of different policy proposals. Finally, in order to evaluate the welfare effects of different social insurance policies, we need to model appropriately the level of insurance (consumption smoothing) that households can obtain privately. The incomplete market framework allows households to partially rely also on their (precautionary) savings. In this regard, a key validation of our approach is that our modelling of the labour market risks and publicly provided insurance lead to a realistic wealth distribution in all our economies.

3. Calibration

We calibrate the model to quarterly data assuming that the union of $I = 16$ Eurozone countries is in a stationary general equilibrium.[11] Our model 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. We assume that in all countries the time discount factor β, the capital share of production θ, and the depreciation rate of capital δ are the same. Furthermore, we assume that idiosyncratic productivity follows the same Markov process for which we use a discrete version of an AR(1) process with persistence ρ_z and variance σ_z^2. During non-employment the mean of the innovation term is $\mu_s^n < 0$, to capture the depreciation of human capital. 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 work α^i and of job search γ^i, the exogenous job separation rate σ^i, as well as the job arrival rates λ_u^i and λ_n^i. The lower panel contains parameters that define country specific unemployment, tax, and minimum income policies $(\bar{b}^i, \mu^i, \tau^i, t_r^i)$.[12]

In total our model has $6 + 16 \times 10 = 166$ parameters. We interpret the three sets of parameters as a hierarchical structure in the degree to which policy can influence them. The policy parameters $(\bar{b}^i, \mu^i, \tau^i, t_r^i)$ can be changed relatively easily by governments, while it takes more complex labour market reforms to change the institutional parameters $(A^i, \alpha^i, \gamma^i, \sigma^i, \lambda_u^i, \lambda_n^i)$. Given the scope of this paper, in the policy experiments below we only vary unemployment benefit policies (and how these are financed). The institutional parameters can potentially be endogenized and/or can be changed through structural labour market reforms, but these experiments are beyond the scope of our paper.

A central aspect of our analysis is the transitions between employment, unemployment and inactivity. Flow statistics are a useful measure since they provide (indirect) information on job destruction and job creation (through job arrival rates) of these economies. In order to calibrate the model, we therefore use estimated quarterly transition probabilities, and the corresponding three average labour market stocks. 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.[13] 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.

[11] We calibrate the model to all Eurozone countries except Cyprus, Luxembourg and Malta, for which we do not have all necessary data.

[12] When we set the values for parameters in the lower panel, government consumption G is determined as a residual in the government budget constraint.

[13] The underlying data is from the EU-SILC dataset, except Germany which comes from the GSOEP. We thank the authors for sharing their estimates.

Table 1
Model parameters. Upper panel: preference and technological parameters that are homogeneous across countries; middle panel: country specific parameters that capture labour market institutions; lower panel: country specific policy parameters.

Parameter	Description
β	discount factor
θ	capital share
δ	capital depreciation rate
ρ_z	persistence of individual productivity
σ_z	standard deviation of individual productivity
μ_s^n	human capital depreciation during non-employment
A^i	total factor productivity
α^i	utility cost of work
γ^i	search cost
σ^i	exogenous separation probability
λ_u^i	job arrival probability for active searchers
λ_n^i	job arrival probability for non-searchers
$\bar{b}^i$	UI benefits replacement rate
μ^i	UI benefits duration
τ^i	employee's social security contribution rate
t_r^i	low-income transfer, relative to average worker earnings

Table 2
Common parameters. Values of country-invariant parameters.

Parameter	Description	Value
β	discount factor	0.9900
θ	capital share	0.3000
δ	capital depreciation rate	0.0100
ρ_z	persistence of individual productivity	0.9886
σ_z	standard deviation of individual productivity	0.1480
μ_s^n	human capital depreciation during non-employment	−0.0125

3.1. Calibration strategy

We now describe in detail how the model is calibrated. First, we calibrate the common parameters across the Eurozone countries we study (see Table 2). In particular, we set the technological parameters θ, δ, ρ_z and σ_z to the quarterly counterparts of Krusell et al. (2017), who use monthly data for the US economy to estimate them. We discretize the AR(1) process for individual productivity process by 25 different productivity states using the Rouwenhorst method. The discount factor β of 0.99 implies a union wealth-to-annual-income ratio slightly above 5, in line with the estimates of Piketty and Zucman (2014). We assume that the Eurozone capital market clears, implying a (plausible) annualized interest rate of 2.3%. However, we find that overall the calibrated parameters are not sensitive to this assumption, i.e. provided the interest rate is within a range close to 2%, the union capital market is always approximately balanced.[14]

The expected ability deterioration during non-employment is set to $\mu_s^n = -0.0125$. That is, the re-employment wage falls by on average 1.25% during a quarter of non-employment. This corresponds to the estimate of Burdett et al. (2020) who, using German data, find that due to human capital depreciation during non-employment as well as due to forgone human capital accumulation (learning-by-doing) during employment, a year of non-employment reduces the wage by 5%.[15]

The country specific parameters are summarized in Table 3. The policy parameters are set using the data counterparts. Specifically, the tax rate τ^i corresponds to the social security contribution rate in country i.[16] The parameter μ^i, which is the conditional probability of remaining eligible for unemployment benefits in the next period, is also the inverse of the expected duration of unemployment benefits eligibility in the model. We set $1/\mu^i$ to the duration of eligibility according to the law in country i. For the unemployment benefit replacement rates, we set $\bar{b}^i$ to the data equivalents in Esser et al. (2013). Specifically, we set $\bar{b}^i$ to equal the gross replacement rate (unemployment benefits relative to gross wage income) of the average single person in country i. In many countries unemployed are exempted from social security contributions and in those where they are not, they generally face a much lower contribution rate. We assume, for simplicity, that they are not taxed at all.

We take government transfers to low income households from Frazer and Marlier (2016). As with unemployment benefits we pick the values estimated for single individuals.[17] Dubois and Ludwinek (2015) report high non-take-up rates (19.9%–80%) of guaranteed

[14] Similarly, in none of the policy experiments (for which we keep the interest rate constant) do we observe large changes in any of the countries' savings or capital investment, implying that the European capital market is always approximately balanced.

[15] We use the estimate for low educated individuals, the one for medium educated is 4.5% and the one for highly educated is 5.6%. See their Table 3.

[16] In Estonia, Spain, Finland and Ireland this resulted in (slightly) negative equilibrium government expenditure G. In these countries we increased τ^i such that in equilibrium $G = 0$.

[17] A general nation-wide minimum income scheme was introduced in Greece only in 2017, for which we use data from Ziomas et al. (2017).

Table 3
Country specific parameters. Calibrated values to match targeted moments.

Country	A^i	α^i	γ^i	σ^i	λ_u^i	λ_n^i	$\bar{b}^i$	$1/\mu^i$	$\tau^i(\%)$
Austria	0.89	0.32	0.40	0.04	0.26	0.17	0.40	2.27	18.06
Belgium	1.00	0.43	0.01	0.02	0.11	0.10	0.50	19.70	14.00
Germany	1.00	0.28	0.00	0.02	0.10	0.10	0.42	3.94	20.85
Estonia	0.59	0.48	0.29	0.04	0.18	0.14	0.50	3.86	3.50
Spain	0.87	0.47	0.33	0.06	0.08	0.08	0.63	7.80	11.00
Finland	1.00	0.33	0.00	0.05	0.20	0.20	0.55	7.58	8.20
France	0.91	0.33	0.11	0.02	0.16	0.12	0.58	7.88	13.75
Greece	0.85	0.30	1.00	0.04	0.17	0.04	0.58	3.94	16.00
Ireland	1.00	0.35	0.54	0.03	0.14	0.07	0.48	3.94	6.05
Italy	0.93	0.60	0.45	0.03	0.13	0.07	0.50	2.57	9.50
Lithuania	0.47	0.50	0.47	0.03	0.16	0.06	0.34	1.59	7.00
Latvia	0.45	0.48	0.15	0.04	0.16	0.12	0.56	2.96	9.75
Netherlands	0.86	0.05	0.08	0.01	0.13	0.11	0.75	3.50	16.85
Portugal	0.78	0.43	0.80	0.07	0.20	0.09	0.65	5.91	11.00
Slovenia	0.75	0.44	0.08	0.02	0.14	0.11	0.70	1.97	22.10
Slovakia	0.55	0.60	0.33	0.02	0.13	0.08	0.47	1.97	13.40

income transfers in the EU. To account for this, we assume that government transfers in the model are 1/3 of what is in theory available. The inclusion of minimum income is crucial to match the fact that in all countries a substantial part of the population owns basically zero wealth. Absent such income, agents in the model save too much, relative to the data, as a buffer stock for potential periods of non-employment where they are not eligible to benefits.

The remaining six country specific parameters, A^i, α^i, γ^i, σ^i, λ_u^i, and λ_n^i, are calibrated in order to match six data moments: the differentials of average wages across countries, the shares of employed and unemployed individuals in the population, as well as the quarterly employment-to-employment, unemployment-to-employment, and non-active to employment flows.[18] Recall that in our model unemployed and inactive agents in a given period are those jobless individuals who are actively searching or do not search, respectively, regardless of their eligibility status.

Since in the calibration we target both the share of agents in employment and unemployment, by design we match all three stocks. Fig. 1 shows the unemployment rates in the model and the data across all studied Eurozone countries. While the average unemployment rate in Austria, Germany and the Netherlands is between six and eight percent, it is above 15 percent in Spain, Greece, and Portugal.

3.2. Quality of the fit

In this section we investigate how well the model fits the data along dimensions that are not explicitly targeted but relevant for the model to deliver credible policy prescriptions.

Regarding the flows across labour market states, we only target the flows into employment. The remaining six flows are summarized in Fig. 2, where the left panel depicts the flows into unemployment, and the right panel the flows into inactivity. Overall, the model does very well in replicating the patterns observed in the data in most of the countries.

We observe that the three high unemployment countries mentioned above – Spain, Greece and Portugal – are also the countries with the highest flows from employment to unemployment each quarter. Interestingly, Finland has the second highest flow from employment to inactivity. However, flows from unemployment to inactivity are generally small both in the model and in the data.

The model also matches the persistence of unemployment very well, though it slightly underpredicts it in some countries. In all countries but Austria and Finland this flow is above 75 percent per quarter that is, 75% of individuals who are unemployed in a given quarter remain unemployed also in the following quarter. The flipside of the slight underprediction in persistence is an overprediction in the flow from unemployment to inactivity. However, flows from unemployment to inactivity are very small in absolute value.

The flows from inactivity to unemployment as well as the persistence of inactivity are well matched in most countries. In all countries but Finland the persistence in inactivity is around 90%–95%. However, note that in Finland – as well as in Germany and Belgium – unemployment and non-activity are almost observationally equivalent to the extent to which agents were exogenously separated (rather than through quitting) from their last job. This is because, in these countries, the job search cost is almost zero and the two job arrival rates are almost the same. Hence the observed low persistence of inactivity in Finland has little economic significance.

Finally, the model should deliver a reasonable wealth distribution. It should match the fact that a substantial share of the population has very little wealth and thus relies on unemployment benefits or social assistance in times of non-employment. The upper panel of Fig. 3 shows the wealth shares of the five quintiles of the wealth distribution according to Eurostat data (data from

[18] Earnings data is taken from Eurostat's Structure of Earnings Survey (2006–2014 average, in PPS). We picked Germany, the largest country in the European Union, as our reference country. That is, TFP in Germany is set equal to one and for the other countries it is calibrated in order to match the average wage relative to the one in Germany.

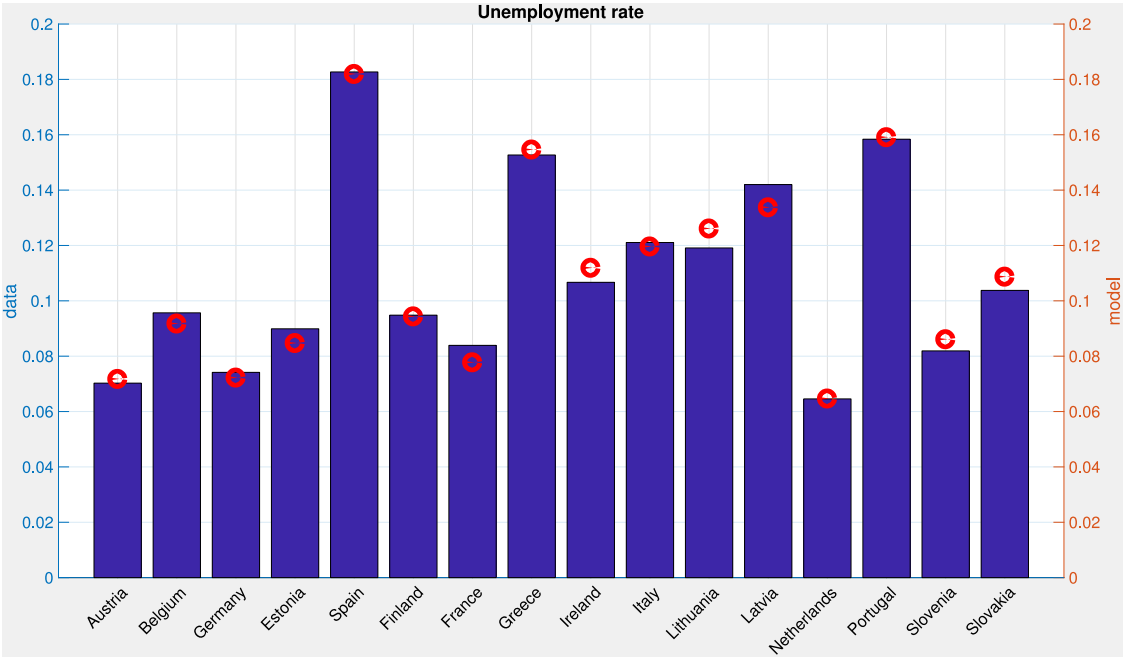

Fig. 1. Unemployment rates. Data averages 2006–2014 from Eurostat.

Italy and Lithuania is missing). The lower panel depicts the model counterparts. Given that in our calibration strategy we did not target any moment related to the wealth distribution, we consider the model very successful in replicating the patterns of the data. In particular, it captures the fact that the bottom quintile owns virtually no wealth while in most countries the upper quintile owns the vast majority of wealth.

Wealth inequality in the model is more homogeneous across countries than in the data. The model predicts a wealth share of the upper quintile of around 80% almost everywhere, whereas in the data this share is substantially lower in some countries, in which instead the three middle quintiles own more wealth. For example, in Slovenia 40% of wealth is owned by the three middle quintiles and only 60% by the top quintile. In Slovakia total wealth is shared evenly between these two groups of agents. To explain these discrepancies between the data and the model, it is important to remember that the model abstracts from different types of assets, in particular from real estate. There is a well documented negative relationship between wealth inequality and home ownership rates in the Eurozone. Kindermann and Kohls (2018) attribute the high ownership rates in countries such as Slovenia and Slovakia to inefficiencies in their rental housing markets. In these countries, households save more than they otherwise would in order to be able to make the necessary downpayment and buy a house. Hence, in these countries the lower middle class owns a higher fraction of total wealth, reducing wealth inequality.[19] By contrast, the authors find that rental markets in countries like Germany or France are very efficient resulting in low home ownership rates and consequently a lower share of wealth held by the poor.

Given that we want to capture households' ability to maintain consumption using their assets in times of non-employment, liquid (non-housing) wealth is the more relevant measure. While Eurostat does not separately report the ownership of different types of assets across the wealth distribution, for the reasons mentioned above we expect the distribution of liquid wealth to be both more unequal within each European country but at the same time more homogeneous across European countries, as the model suggests.

We conclude that the model does a good job in replicating the wealth distributions, in particular the fact that a substantial part of the population does not own any wealth and thus relies on welfare payments in times of non-employment, which is the most crucial feature for the welfare evaluation of policy changes we present below.

3.3. Diversity of labour market institutions

One contribution of our calibration exercise is that it provides a parsimonious diagnosis of the diversity of European labour market institutions. We visualize it in Figs. 4 to 6. Fig. 4 shows the job arrival rate for non-searchers (λ_n^i, horizontal axis) and searchers (λ_u^i, vertical axis) for each of the calibrated economies. We observe that these two rates differ substantially across countries (λ_n^i ranges from 4 percent to 2 percent while λ_u^i ranges between 10 percent and 26 percent. These parameters provide a reduced

[19] Home ownership rates are also high in Spain. While there the top quintile owns almost 80% of wealth as predicted by the model, wealth in the data is more equally distributed across the three middle quintiles. Presumably for the same reasons, there the second and third quintile of the distribution hold more wealth than predicted by the model.

Fig. 2. Untargeted labour market flows. Data averages 2006–2014 from Eurostat.

form description of institutions related to job creation and job search effectiveness. High arrival rates indicate dynamic labour markets and a larger difference between the two arrival rates signal higher returns to actively searching. Job arrival rates tend to be considerably higher for the unemployed with three notable exceptions, Germany, Belgium and Finland, where the difference is negligible. This implies that, in these countries, there are little efficiency gains from agents actively search.

Fig. 5 plots average the job arrival rate for the non-employed ($(\lambda_u^i + \lambda_n^i)/2$) on the x-axis, but this time against the job separation rate σ^i on the y-axis.[20] It gives an idea of the rigidity of the respective labour markets. Here the correlation is stronger: countries with higher separation rates tend to have higher job arrival rates. For example, Germany is characterized by a very rigid labour market while Finland's high turnover in both dimensions implies a more dynamic market. However, this correlation is not perfect: for instance, while France and Spain have similar job arrival rates for the non-employed, job destruction in Spain in roughly 3 times higher, contributing to higher unemployment in Spain. The higher job destruction rate is largely due to the high prevalence of temporary labour contracts with very low firing costs in Spain.

Finally, Fig. 6 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.[21] We find countries with unemployment benefits that provide little insurance both in terms of duration and replacement rates (Lithuania and Austria), others with generous replacement rates but short durations (Netherlands and Slovenia), and others with longer durations but less generous

[20] Note that the flows between unemployment, inactivity and employment do not directly determine λ_u^i, λ_n^i and σ as not all job offers are accepted and, potentially, there are voluntary quits as well.

[21] Note that, for better visibility, we have omitted Belgium from this figure since although it has average replacement rate of 50 percent, UI has by far the longest duration (20 quarters) there.

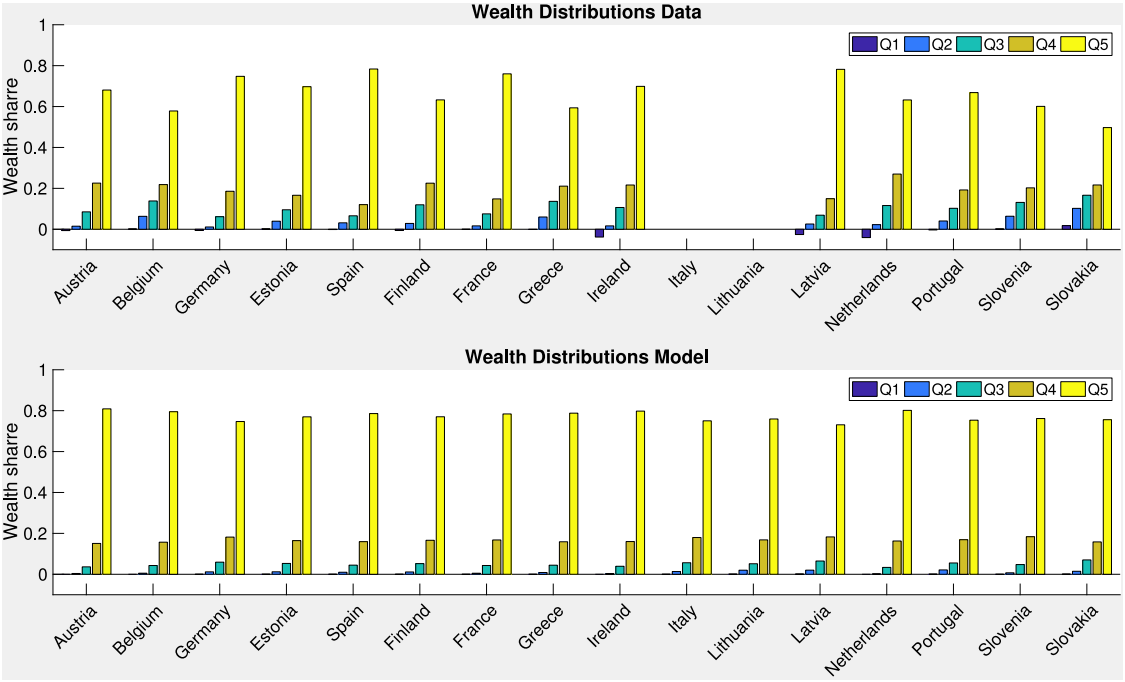

Fig. 3. Wealth distributions. Share of wealth owned by each of the five quintiles (Q1–Q5) of the wealth distribution; Eurostat data.

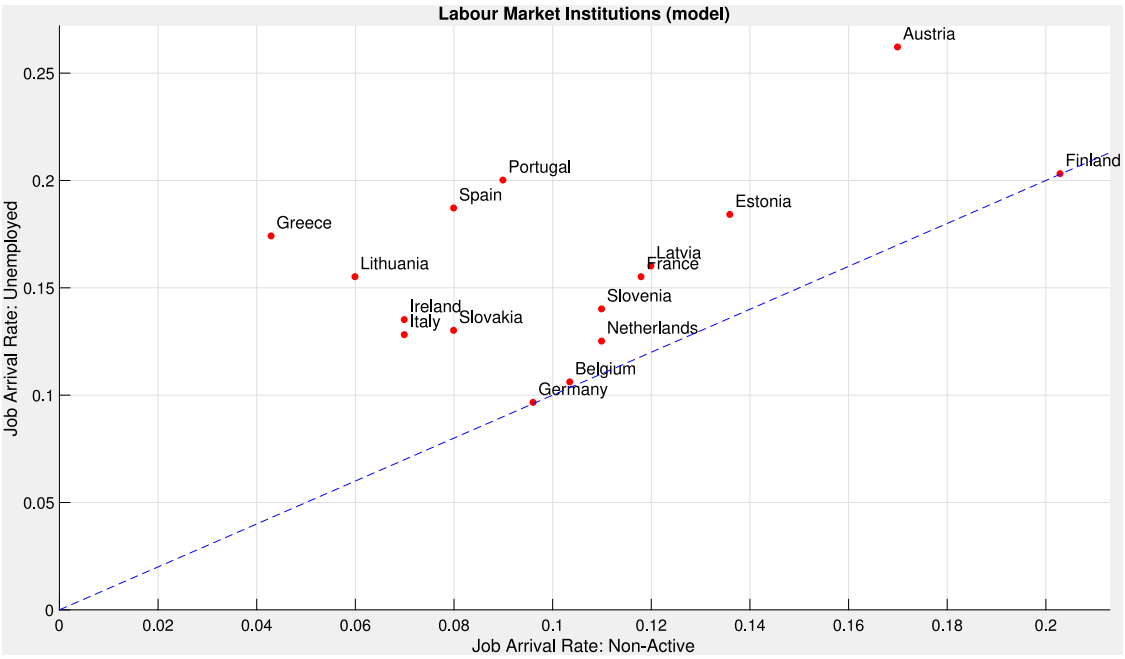

Fig. 4. Job Arrival rates. Model implied parameters.

Fig. 5. Labour Market Rigidity. Model implied parameters.

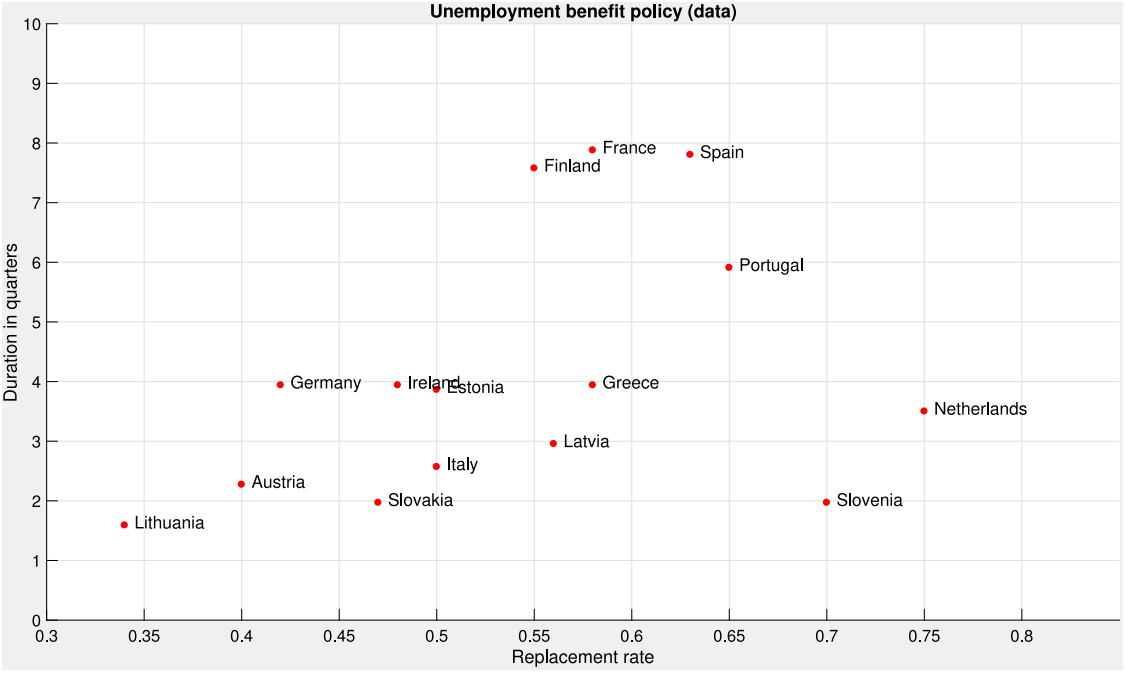

Fig. 6. National unemployment benefit systems: policy parameters from Esser et al. (2013).

replacement rates (Finland, Portugal, France and Spain). Given that the parameters representing the effectiveness of labour market institutions are so different across countries, it is not necessarily surprising that they implement substantially different unemployment insurance schemes. However, there is no clear pattern across countries that would connect the dispersion of institutional parameters with the parameters of the UI policies. This indicates that national policies are not necessarily designed using the same criterion.

This calibration, which initializes the economy in $t = 0$, allows to perform several experiments and analyse the evolution of countries' labour markets and other macroeconomic variables under different configurations of unemployment policy for $t \geq 1$, which we now turn to.

4. European unemployment insurance for crisis events

In this section we show how a simple EUIS can provide insurance against severe crisis events. It is simple, in the sense that its only task is to provide this type of insurance, as a permanent version of SURE, with the difference that EUIS has country specific accounts (or contracts) where the excessive costs, for unemployment benefits in case of a severe crisis, are covered with the revenues of country specific smooth (constant) payroll taxes. That is, the EUIS has the capacity to assess countries' risks and provide actuarially-fair insurance, either with its own funds or borrowing in international capital markets. As a permanent EU institution, its contracts with participating countries can be long-term contracts, satisfying a long-term balanced budget.[22] In our experiments UI benefits are financed with payroll taxes and, hence, a main effect of introducing a EUIS is the establishment of constant – country specific (experience-rated) – payroll taxes. This can be implemented as a EUIS design agreed with participating countries, since EU institutions can monitor and enforce the proper use of its financial support, but not the exact revenue source of its members payments. An alternative could be long-term country-specific debt, but the payroll-tax design is more transparent (i.e. workers finance 'their' unemployment benefits) and make welfare comparisons more meaningful. We model a severe crisis as an unanticipated large one-time negative shock affecting all countries. The methodology of this experiment can be extended in future work for the study of recurring fluctuations, or non-aggregate shocks, or shocks of lower intensity. The EUIS, with country specific actuarially fair accounts, allows ample flexibility to adjust to different country insurance needs (e.g. a country with a higher insurance coverage will need a higher payroll tax to cover it).

4.1. The experiment

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 an unanticipated severe negative shock. One can think of $t = 0$ as the first quarter of 2020, in which it became apparent that several countries will face a severe economic downturn caused by the coronavirus outbreak. After the shock hits, the country returns to its steady state in a deterministic and gradual way.[23]

Similarly to Krusell et al. (2017), we model shocks as hitting simultaneously TFP (A) and exogenous labour market flows (σ, λ_u and λ_n).[24] 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 fluctuations of TFP alone are not able to generate large enough fluctuations of unemployment if output fluctuations are reasonable (see also Krusell et al., 2017). This issue is amplified in our framework by the fact that job creation and job destruction are not modelled endogenously.

Balanced budget vs. EUIS. We consider two cases: balanced budget and insurance through the EUIS. Under a balanced budget, along the transition the tax rate needs to adjust to balance the national government budget constraint period by period.[25] This should capture the fact that in deep recessions national governments often have very little borrowing capacity. To sharpen the exposition, we make the stark assumption that in such an event single governments cannot borrow at all, while the eurozone as a whole can. At the end of this section, we discuss how our results are affected by this assumption. Formally, in a balanced budget transition, the tax rate $\tau_t \equiv \tau_t^A$ needs to adjust over time to ensure period-by-period government budget clearing, that is in each period $t = 1, 2, \ldots$

$$\int_z \int_a \tau_t^A \omega_t z \zeta_t^e(z,a) da dz = \int_z \int_a \left[\bar{b}\omega_t z + \max\{0, \mathbb{I}_{a<\underline{a}}(t_r - \bar{b}\omega_t z)\}\right] \zeta_t^{n^e}(z,a) da dz + \int_z \int_a \mathbb{I}_{\{a<\underline{a}\}} t_r \zeta_t^{n^n}(z,a) da dz + G.$$

In the case of the EUIS, we assume that governments only need to balance their budgets in present value. Through borrowing from a European fund, national governments are able to inter-temporally smooth their expenditures on unemployment benefits. In this case the tax rate increases by a constant and permanent amount such that in net present value terms each country's net position relative to the fund is zero. Formally, a time-invariant tax rate $\tau_t \equiv \tau^{EUIS}$ for $t \in \{1, 2, \ldots\}$ is set such that

$$\sum_{t=0}^{\infty} \frac{1}{\prod_{s=1}^{t}(1+r_s)} \left[\tau^{EUIS} \int_z \int_a \omega_t z \zeta_t^e(z,a) da dz - \int_z \int_a \left[\bar{b}\omega_t z + \max\{0, \mathbb{I}_{a<\underline{a}}(t_r - \bar{b}\omega_t z)\}\right] \zeta_t^{n^e}(z,a) da dz \right.$$
$$\left. - \int_z \int_a \mathbb{I}_{\{a<\underline{a}\}} t_r \zeta_t^{n^n}(z,a) da dz - G \right] = 0.$$

Hence, as with the SURE instrument, countries are required to repay their withdrawals.

[22] More sophisticated contracts can be envisioned, accounting for state-contingent repayments, avoiding *ex-post* expected losses, etc. – as in, Ábrahám et al. (2021) – but this is not the focus of our inquire here.

[23] Of course, the latter assumption is a simplification in comparison to the prolonged uncertainty experienced throughout 2020 and 2021.

[24] 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 section we deviate from this assumption.

[25] In the policy exercises, we fix government consumption G at the initial level and vary the income tax rate to balance the budget either period-by-period or intertemporaly.

It should be emphasized that this requirement to repay provides a lower bound to risk-sharing benefits that could be achieved if countries' contribution payments were instead based on an ex-ante perspective, under which countries would pay a yearly actuarially fair contribution as if intertemporal budget constraint clears only in expectation, rather than actually.[26]

Given all these assumptions note that, after the shock hits, the economy follows a deterministic pattern and along the transition agents have perfect foresight when solving their dynamic optimization problems. We calculate the difference in aggregate social welfare of going through the recession with the EUIS in place versus the same negative shock with a balanced budget period by period.

Finally observe that, since each country is assumed to be a small open economy within the union, we can ignore the correlation structure of the modelled crisis event across countries. Conditional on the appearance of the shock in any given country, the welfare effects we compute measure this country's benefit of participating in the EUIS, which – assuming unlimited borrowing capacity of the eurozone – is independent of other countries' state of the economy at that time.

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 ϵ_A hits,

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

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

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

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 20% in the initial quarter ($\epsilon_A = 0.2$), 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 $\rho_A = \rho_\sigma = \rho_{\lambda_u} = \rho_{\lambda_n} = 0.75$. Fig. 7 depicts the evolution of the shock in the case of France. As we see in the following figures this shock process induces dynamics in terms of labour market aggregates that resembles the responses to big crises such as the Financial Crisis or the current pandemic.

The shock induces changes in labour markets, which are depicted in Figs. 8 and 9. Fig. 8 shows the share of agents in employment (upper panel). The recession induces gradual decline in the employment rate from around 82.5% in the initial steady state to around 78% at the trough of the recession five to six quarters after the shock hits. From quarter seven, employment gradually rises, although it remains significantly lower than in the initial steady state for more than five years. The lower panel of this figure shows the share of non-employed agents. These agents are either unemployed or inactive. The share of non-employed agents increases from around 17.5% in the original steady state to almost 22% at the trough of the recession.

To some extent these responses are driven by the exogenous shock. In particular, a higher separation rate mechanically reduces employment and lower job arrival rates prevent more agents from finding new jobs. However, to a substantial degree they result from endogenous decisions of agents. The two right panels of Fig. 9 decompose the share of non-employed agents into actively searching and not actively searching agents. The former are those who according to our definition are unemployed, while the latter are those who are inactive. We observe that unemployment decreases at impact and only later rises above its steady state value (upper right panel). At the same time inactivity increases at impact and gradually decreases later (lower right 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. As economic conditions gradually improve, more and more agents start searching for a job again. Furthermore, some employed workers decide to quit working because of the reduction in wages.

The two left panels of Fig. 9 decompose the share of non-employed into those who are eligible for unemployment benefits (upper left panel) and those who are not (lower left panel). We observe that in the initial steady state, about 12.7% of agents are not eligible for benefits, while around 4.7% are eligible. During normal terms almost three quarters of agents without job do not receive benefits. The reason is that in France many agents lose eligibility before they find a job. The initial eligibility of newly laid-off workers explains why the share non-eligible agents peaks relatively late, more than two years after the initial shock hits. By contrast, the share of agents who are eligible for benefits peaks around one year after the initial shock, at which point it reaches 7.6%, up from 4.7% in the initial steady state. Leaving the benefit system fixed, this implies a large increase of the government's expenditure on unemployment benefits by more than 60%.

[26] Finding the actuarially fair contribution may be difficult in practice, however.

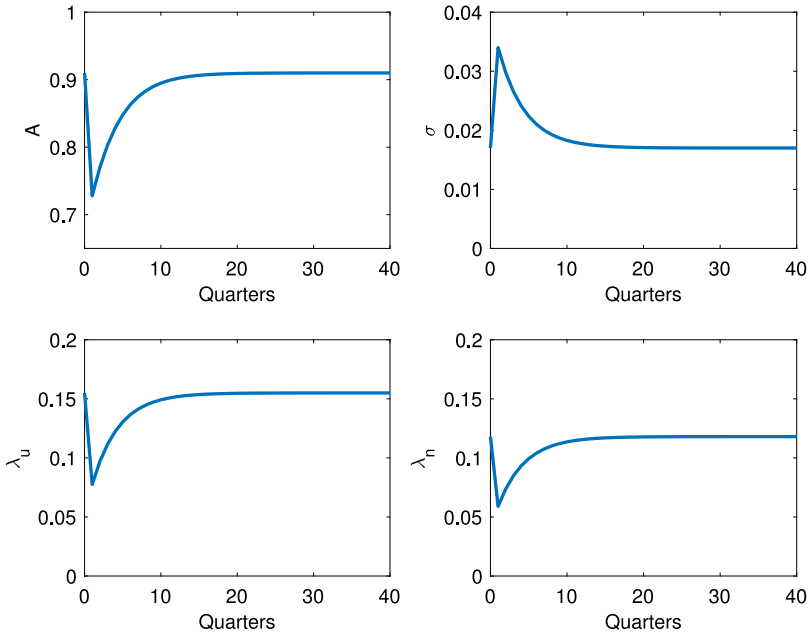

Fig. 7. Shock process in France. Unexpected shock to total factor productivity (A), separation rate (σ), as well as to job arrival rates for searchers (λ_u) and non-searchers (λ_n).

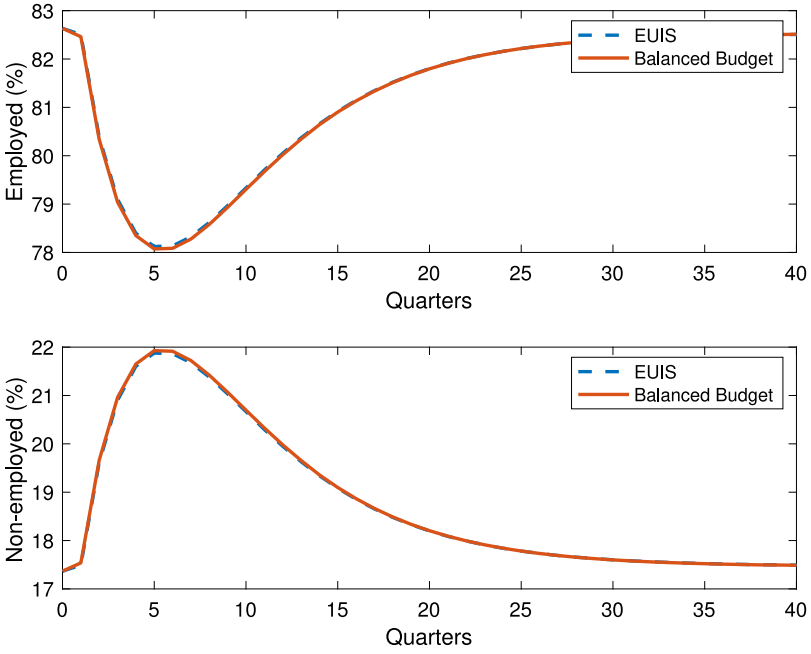

Fig. 8. Employment and non-employment in France. Equilibrium response to shock under balanced budget (solid red line) and with EUIS (dashed blue line).

The impact on the government's budget becomes most apparent when looking at the tax increases necessary to finance the additional expenditures. The solid line in Fig. 10 depicts the evolution of the tax rate in France for the case of balanced budget, where we assume the government's budget needs to clear period by period. The tax rate increases from 13.75% in the initial steady state to 19.6% two quarters after the shock hits, an increase of almost six percentage points.[27]

[27] It peaks earlier than the share of eligible unemployed because of gradual wage increases after the initial shock.

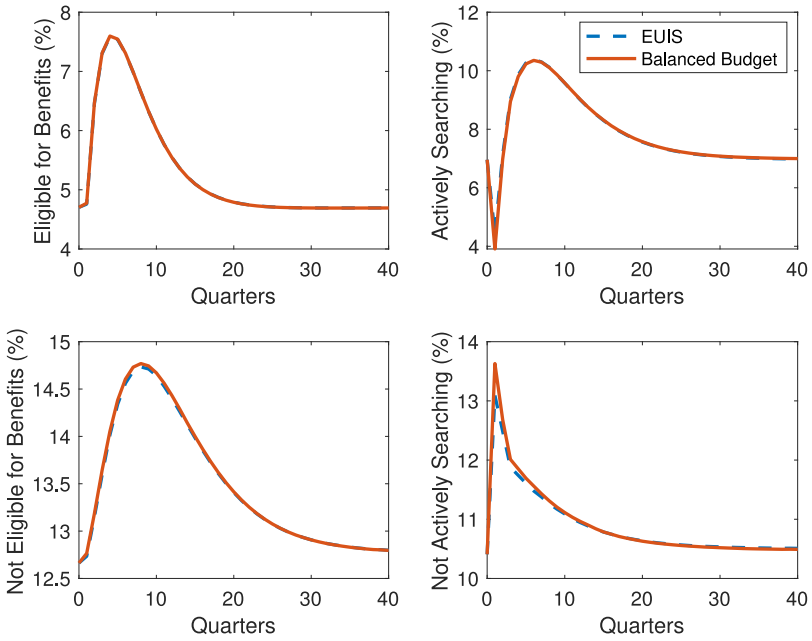

Fig. 9. Decomposition of non-Employment in France. Equilibrium responses to shock under balanced budget (solid red line) and under EUIS (dashed blue line).

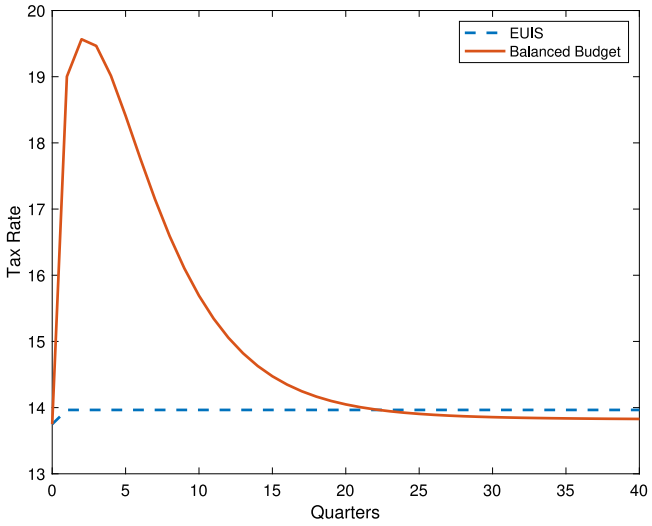

Fig. 10. Taxes in France. Equilibrium response to shock under balanced budget (solid red line) and under EUIS (dashed blue line).

By contrast, the dashed line shows the rise in the tax rate when the country is able to borrow from the EU fund, e.g. the SURE instrument, and is allowed to pay back these withdrawals gradually over time. We computed the constant tax increase that is necessary to balance the countries' budget inter-temporally. Rather than a sharp increase by six percentage points, followed by a gradual and slow decline back to its original steady state value, under the EUIS the tax increases by only 0.2 percentage points, from 13.75 to 13.96%.

Note that these tax differences also induce differences in behaviour, in a way that dampens the recessionary impact of the initial shock. Most apparently, in the lower right panel of Fig. 9 we observe that the initial increase in inactivity is around half a percentage point less in the case of the EUIS than under balanced budget. The reason is that the lower tax rate makes it more attractive to start searching immediately after being laid off, as the prospective net income in case of re-employment is higher. However, behavioural responses to the tax changes are an order of magnitude smaller than those induced by the shock, since in most of the other Figures above the solid line almost overlaps with the dashed line.

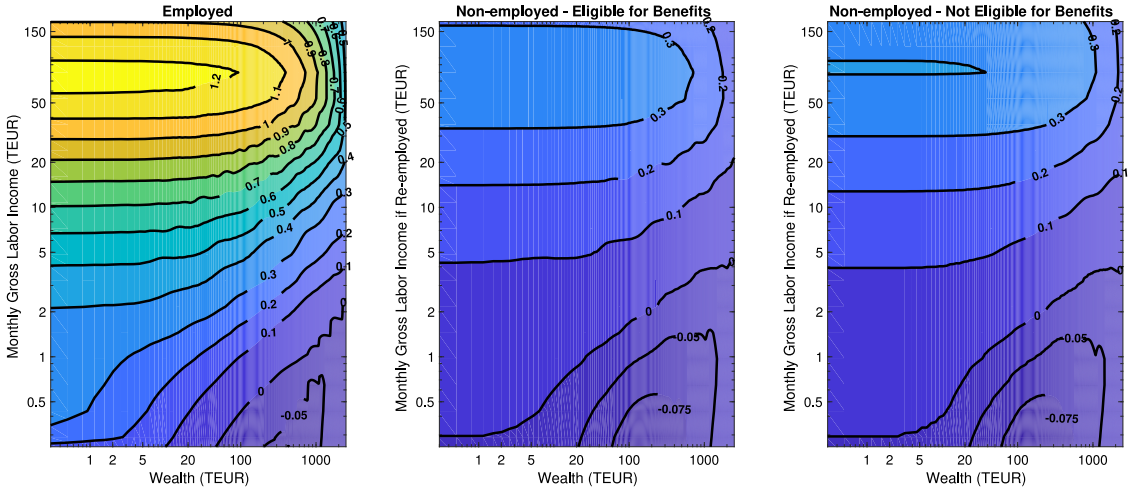

Fig. 11. Welfare gains in France. Contour lines depict heterogeneity effects on agents with different wealth (x-axis) and labour income (y-axis), three panels correspond to agents in the three labour market states (employed; non-employed eligible; non-employed non-eligible); numbers in percent of consumption equivalent variation.

4.2. The welfare effects

Yet, the tax changes have a significant impact on welfare, which is the relevant measure to evaluate the desirability of such a European unemployment risk sharing mechanism. In order to be able to interpret the welfare gains associated with the introduction of a EUIS, we translate them into consumption equivalent variation. In particular, $\Delta^i(a,z,x)$ defines the per period percentage increase in consumption that would need to be given to an individual with initial idiosyncratic state (a,z,x), such that she is indifferent whether her country of residence (i) joins the EUIS or not.[28] Fig. 11 depicts the contour lines of these welfare gains.

The left panel shows the welfare gains for all agents who are initially employed, where the x-axis corresponds to wealth a (in thousand Euro) and the y-axis to monthly gross labour income $\omega_0 z$ (log scales in both cases). Almost all these agents gain if the country decides to join the EUIS. The depicted welfare losses for wealthy agents with very low productivity rarely realize as most of these agents decide not to work in equilibrium. Furthermore, we observe that the welfare gains tend to increase with productivity, while they tend to decline in wealth. Intuitively, the main beneficiaries from the smoothing of income taxes during the recession are those agents who finance most of their consumption with net labour income rather than assets. The gains tend to increase in labour income since the tax savings increase in wages. The welfare gains are particularly pronounced for agents with zero or close to zero wealth, who have no or limited capacity to smooth out temporarily high tax liabilities by running down their assets. Thus, for these agents, the tax smoothing effect of the EUIS (compare Fig. 10) translates directly into a smoother consumption path over time. They are the main beneficiaries of the insurance scheme.

The other two panels depict the welfare gains (losses) of initially non-employed agents, where we plot again $\omega_0 z$ on the y-axis. Note that for initially non-employed agents this is the monthly gross labour income they would get if they would be re-employed immediately, with the initial productivity and the initial wage rate. Both the gains of agents eligible for unemployment benefits (middle panel) as well as the gains of non-eligible agents (right panel) are smaller than the welfare gains of employed agents. In fact, some of the non-employed agents even lose if the country decides to join the EUIS. By design, non-employed agents do not immediately benefit from the tax relief as they are currently not paying any income taxes. Whether they gain or lose depends on their expected time of re-employment. An agent who expects to be re-employed relatively soon gains for the same reason as the initially employed agents. In particular, she will save labour income taxes, though to a lesser extent than agents who are employed all the time. However, if she expects to become re-employed relatively late, say five years after the initial shock, she will not at all benefit from the temporary tax relief during the recession, but instead only bear the cost of having to contribute to the country's obligation to repay the initial withdrawals from the fund. However, the general pattern of welfare gains that tend to increase in productivity but decrease in wealth is the same as with employed agents.

Lacking a Pareto improvement, that is a positive welfare gain for every agent in the country, a normative welfare criterion is needed to evaluate the desirability of joining the EUIS. For this we define the aggregate welfare gain as the average over all individual gains:

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

[28] Note that $x \in \{e, n^e, n^n\}$.

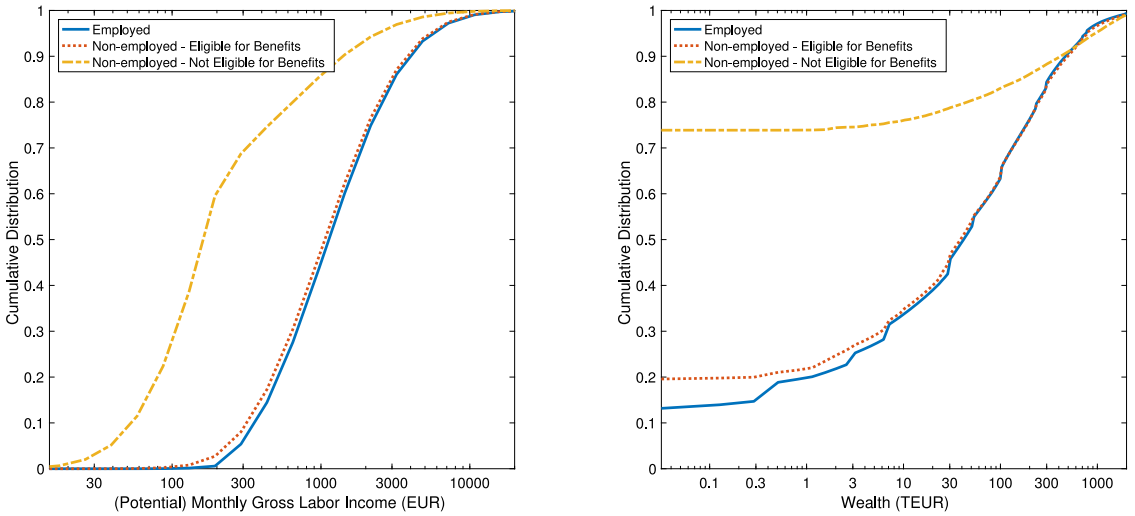

Fig. 12. Composition of agents in France. Cumulative distribution of labour income (left panel) and wealth (right panel) conditional on employment state.

We also define the aggregate welfare gain separately for the group of employed, non-employed eligible and non-employed non-eligible agents,

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

We find that if France decided to join the EUIS, the aggregate welfare gain is $\Delta^{FR} = 0.22$, that is the average French would experience a gain equivalent to a permanent consumption increase of 0.22 percent. Thereby, the average gain of employed individuals is $\Delta_e^{FR} = 0.27$. The average gain for non-employed individuals, who are eligible for unemployment benefits, is $\Delta_{n^e}^{FR} = 0.02$, while the non-employed agents, who already lost eligibility, experience a small loss of $\Delta_{n^n}^{FR} = -0.04$ on average.

Another dimension to assess the viability of a EUIS is to measure the popular support in each country, that is the share of agents who would benefit from its introduction. We find that in such a referendum, where each agent votes in support of joining the EUIS if and only if she has a strictly positive welfare gain, 87% of the population would be in favour. However, there is substantial heterogeneity across groups. As mentioned above almost all employed agents (98%) would vote "yes" in such a referendum, while the share of eligible non-employed in favour of the EUIS is around two thirds (67%). By contrast, with only 20% in support the EUIS is clearly rejected by the non-eligible non-employed.

In light of Fig. 11 these stark differences in the support of eligible vs. non-eligible agents may seem surprising. According to the Figure any non-employed agent with a given combination (a, s) of initial assets and productivity should experience about the same welfare gain (loss), irrespective whether she is eligible for benefits or not. The difference in the support from these two groups comes from the fact that the composition of eligible agents is very different from the composition of non-eligible agents.

The left panel of Fig. 12 shows the cumulative distribution functions for productivity conditional on employment and eligibility status. As before, we convert productivity into gross monthly labour income, where for non-employed agents we use the income they would receive for the hypothetical case if they would be immediately re-employed at their current productivity. We observe that there are basically no employed agents with an income of less than 200 EUR per month. For these agents it is not worth suffering the utility cost of working. We also see that the distribution of productivity for employed agents first order stochastically dominates the one for eligible non-employed agents, which in turn dominates the distribution for the non-eligible non-employed. Importantly, the productivity distribution of eligible agents is very close to the one of employed agents, while the distribution of non-eligible agents is skewed much more to the left. The reason is that after being separated from a job, agents have eligibility only for a limited time during which, on average, their human capital does not depreciate much. However, those who are non-eligible tend to be long-term unemployed agents, whose human capital depreciated. Hence, a substantial share of non-eligible unemployed has a very low potential wage income. Only sequences of positive productivity shocks would help such agents to reach a level at which they would again be willing to accept offers. As this takes time, their expected non-employment spell is long. For many of them it will be so long that they do not benefit from the tax relief during the recession at all. This difference in the composition of productivity explains why the welfare gains of non-eligible non-employed are lower than those for eligible non-employed. Consequently, the EUIS is rejected by the non-eligible while it is approved by the eligible agents.

The right panel of Fig. 12 shows the cumulative distributions for wealth. We see that the share of agents with zero wealth substantially differs across the three groups. In particular, around 74% of non-eligible non-employed agents does not own any wealth, while this share is less than 20% for the other two groups. Long-term unemployed with poor job prospects have already decumulated their assets and often live off social transfers provided by the government. Interestingly, there are also more very rich

Table 4
Welfare Gains from the EUIS. Columns 2–5 refer to different subgroups of the population; welfare gains in percent of consumption equivalent variation (share of agents supporting the reform in brackets); last column characterizes the change in the tax rate (relative to pre-shock steady state) required to clear government budgets inter-temporally.

Country	Employed	Eligible non-employed	Non-eligible non-employed	Whole population	Change in τ (in%)
Austria	0.38 (96.6%)	0.05 (73.0%)	−0.06 (27.2%)	0.29 (84.2%)	0.45
Belgium	0.35 (99.1%)	0.03 (74.5%)	−0.04 (27.6%)	0.27 (86.0%)	0.26
Germany	0.37 (98.4%)	0.01 (68.4%)	−0.01 (49.0%)	0.31 (90.6%)	0.26
Estonia	0.11 (93.3%)	−0.03 (6.5%)	−0.05 (5.4%)	0.07 (74.7%)	0.18
Spain	0.48 (97.0%)	−0.01 (47.8%)	−0.07 (26.7%)	0.33 (79.2%)	0.41
Finland	0.30 (95.9%)	0.04 (76.0%)	−0.02 (47.6%)	0.24 (88.7%)	0.31
France	0.27 (97.9%)	0.02 (66.9%)	−0.04 (20.4%)	0.22 (86.7%)	0.21
Greece	0.56 (98.6%)	0.03 (60.7%)	−0.03 (27.8%)	0.39 (80.2%)	0.35
Ireland	0.25 (99.8%)	0.04 (86.9%)	0.01 (45.0%)	0.18 (85.7%)	0.15
Italy	0.25 (99.3%)	0.01 (58.3%)	−0.02 (28.1%)	0.17 (79.7%)	0.18
Lithuania	0.11 (97.1%)	−0.03 (7.0%)	−0.03 (5.0%)	0.07 (76.0%)	0.18
Latvia	0.21 (97.2%)	−0.02 (17.2%)	−0.03 (14.4%)	0.16 (77.5%)	0.24
Netherlands	0.28 (97.9%)	0.00 (64.1%)	−0.03 (27.2%)	0.23 (87.6%)	0.21
Portugal	0.51 (96.5%)	−0.05 (16.2%)	−0.04 (27.1%)	0.33 (71.9%)	0.41
Slovenia	0.39 (98.1%)	0.01 (66.6%)	−0.04 (34.4%)	0.32 (89.0%)	0.28
Slovakia	0.32 (99.6%)	0.04 (88.6%)	0.01 (50.2%)	0.25 (89.3%)	0.17

agents among the non-eligible non-employed, which is driven by a wealth effect. Some agents with high incomes in the past have accumulated a high enough level of wealth and these agents decide to quit jobs, after which they are not eligible for unemployment benefits.

4.3. The Eurozone

We performed the same exercise for all 16 countries. Table 4 shows the average welfare gains and the popular support for the employed, eligible non-employed, non-eligible-non-employed as well for the whole population in each country. We see that the French case is representative for the whole Eurozone. The aggregate welfare gains are substantial, in most countries around 0.2%–0.3% of consumption equivalent variation. We also observe that in every country the gains for the employed are the highest. Furthermore, in most countries the eligible non-employed experience moderate welfare gains, while the non-eligible non-employed experience moderate welfare losses.

In terms of popular support, in each country at least 96% of initially employed agents are in favour of the EUIS. There is substantial cross-country variation in the support of eligible non-employed, which ranges from 7% in the Baltic countries Estonia and Lithuania to almost 90% in Ireland and Slovakia. This variation comes from the fact that the welfare change for eligible agents is close to zero in most of the countries. The non-eligible non-employed, by contrast, clearly reject the EUIS in most countries. Only in Slovakia are they slightly in favour, while in Germany and Ireland their support is just under 50%. In aggregate terms, the EUIS is supported by a clear majority in all countries, a simple consequence of the fact that most agents are employed. The support is the lowest in Portugal (72%) and highest in Germany (91%).

The column describes the permanent change in the tax rate under the EUIS. It is a measure of the required country specific contribution and it depends on how sensitive the total unemployment benefit payments are to aggregate shocks. In countries where the labour market is less resilient to aggregate shocks (e.g. Spain, Greece and Portugal) these contributions need to be higher. At the same time, for the same reason, welfare gains are also higher in these countries as less flexible labour markets imply a higher increase in the tax burden of unemployment insurance when aggregate shocks hit.

In sum, the analysis suggests that a European Unemployment Insurance System, which insures countries against fluctuations in their expenditures on unemployment benefits, results in substantial aggregate welfare gains in all participating countries. In all countries a clear majority of agents should be in support of such a scheme.

A remark on our assumptions

In our analysis we assume that single governments cannot borrow by themselves. While this is a simplification, it reflects the observation that countries' borrowing costs tend to increase during recessions. Thus, precisely in times when funds are most valuable, they are harder to obtain. We consider the extreme case where the increase in borrowing costs is prohibitive. However, more generally, if countries like Italy and Spain, both heavily affected by the COVID pandemic, withdraw substantial amounts from SURE, it is because this allows them to borrow at lower costs than they otherwise could. As we show, such a mechanism significantly reduces the recessionary impact of adverse economic shocks. Our main argument is that the EU or euro area institutions have a much greater borrowing capacity than most individual governments, as it has been shown in the success of the European Commission emissions

of 'SURE social bonds', as well as of 'eurobonds' to finance NGEU programmes.[29] Furthermore, from a modelling perspective, the capacity of EU institutions to borrow in international financial markets dilutes the distinction of the EU as an open or closed economy; we have assumed the former. Even if at the steady-state there could not be permanent current account imbalances between the EU and the rest of the world, the capacity to smooth the consequences of severe shocks would remain. Therefore, our welfare gains can be seen as an upper-bound, but not out of sync with the gains that most euro area countries can achieve with a risk-sharing EUIS, particularly since we do not account for other social and political gains that a permanent EUIS can entail.[30]

5. Harmonization

In the previous section we studied a European unemployment insurance system which provides relief to national government budgets in crisis. However, the public policy debate also features arguments that propagate a reform of European unemployment insurance along a different dimension: the harmonization of UI policies across member states. A common system could potentially have other benefits, even under the observed heterogeneous labour market institutions. For instance, it would make it possible for individuals to carry their benefit entitlements across countries, which could increase mobility, perhaps even result in a better allocation of labour across European countries. It may strengthen social/political cohesion across Europe. Again, the explicit modelling of these reasons is beyond the scope of this paper. Nevertheless, our calibration showing a high degree of heterogeneity across euro area countries could be seen as an argument against harmonization. Therefore, a simple question needed to be addressed: would a fully harmonized system across Europe be politically feasible (i.e. be acceptable by all member states compared to their current system), given the documented heterogeneity in European labour market institutions? A positive answer (that we will obtain) does not necessarily indicate a need for a European mandate for introducing such policy, as each country would already have private incentives to introduce it. However, a positive answer gives a very strong indication that a common system, put in place to capture the mobility and non-economic benefits described above, has a good chance to emerge.

In Section 3 we have seen that the countries' current unemployment benefit policies $(\bar{b}, \mu)$ vary widely with replacement rates between 35% (Lithuania) and 77% (Netherlands), and durations of eligibility from less than 1.6 quarters (Lithuania) to almost 20 quarters (Belgium). The question now is whether these differences in unemployment benefits are a reflection of the countries' different labour market institutions, that is whether they are (approximately) optimal given the structure of the respective economies or whether one could change these policies in a mutually agreeable way.

In this section we search for a combination of $(\bar{b}, \mu)$ which makes all countries at least as well off as in the status quo. Importantly, we keep the means tested transfer policies at the status quo levels. In these computations we take full account of the transitional dynamics to the new steady state implied by changing the benefit policy. We find that a system with a lump-sum payment at the beginning of the unemployment spell of around $\bar{b} = 3$, that is three quarters of income, and no benefit payments thereafter $(\mu = 1)$ achieves this goal.

5.1. National optima

The reason for this – at first glance surprising – result is best understood by studying optimal policies for individual countries in more detail.[31] Fig. 13 does so for the case of Spain. The upper panel depicts the optimal replacement rate $\bar{b}(\frac{1}{\mu})$ conditional on a given duration $1/\mu$ (solid line). The current policy is indicated by the red dot. We observe that conditional on the current duration of around 7.8 quarters, the current replacement rate of 63% is about optimal.

The inverse relationship between duration and its corresponding optimal replacement rate $\bar{b}(\frac{1}{\mu})$ is to a large extent a reflection of the fact that the overall generosity of the benefit system, and hence the government's costs per separated agent is increasing in both. Specifically, the dotted line depicts the replacement rate, which would leave the costs at the current level if there were no behavioural responses of agents in terms of search, job acceptance, and quitting behaviour. In the case of Spain (and most other countries) these behavioural responses are not that large.

The lower panel depicts the welfare gains corresponding to the reforms of the upper panel. It shows on the y-axis the welfare gain of reforming the system to $(\bar{b}(\frac{1}{\mu}), \frac{1}{\mu})$ for each given duration $1/\mu$ on the x-axis. We see that in Spain the welfare gain is the highest at the minimal duration, where the separated agent receives a lump-sum payment of around 3.15 quarters of income in the beginning of the unemployment spell and no payments thereafter. We further observe that the welfare gain as function of duration, given the optimal replacement rate $\bar{b}(\mu)$, is U-shaped. For durations between 8 and 12 quarters the welfare gain is slightly negative, while it is increasing for durations of 12 quarters or higher.

The observation that the overall generosity of the current system in Spain is close to optimal is specific to this country. However, the U-shaped behaviour of the welfare gain with respect to the duration is a general pattern that we observed in many countries. In most countries the optimum is at the minimal duration with just a one-time payment, as in Spain. However, there are also countries, e.g. Germany, where an unlimited duration is optimal.

[29] During the European financial and sovereign debt crisis, lending facilities created by the ECB played a similar role. However, is not part of the ECB mandate to provide insurance to EU governments against shocks with severe fiscal consequences, while a permanent version of SURE could be.

[30] At the end of Section 5 and, in more detail, in Appendix A.2, we argue that, more generally, the aggregate differences of considering the euro area an open or closed economy are minimal.

[31] They are computed using a utilitarian social welfare function at the level of each country taking into account the transition between the status quo steady state to a new steady state.

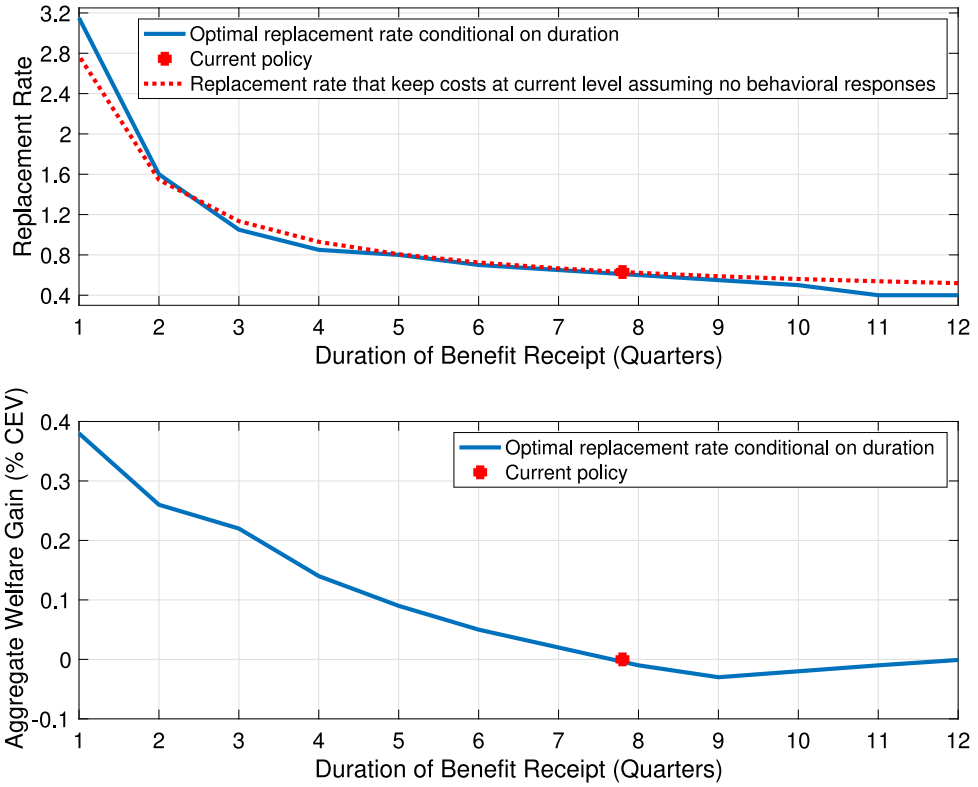

Fig. 13. National optimum in Spain. Upper panel: optimal replacement rate (y-axis) conditional on any given average duration of benefit receipt (x-axis); lower panel: corresponding welfare gain in percent of consumption equivalent variation.

Intuitively, whenever the duration is interior, agents face a risk of losing eligibility before the receipt of benefits ends. This risk is trivially eliminated when the benefit is a one time payment in the beginning of the non-employment spell or an indefinite constant payment throughout the spell. Which of the two corner solutions is optimal depends on an insurance vs. incentive trade-off. An unlimited duration with a low replacement rate provides better insurance against tail events, i.e. a long spell of not receiving offers. However, a large one time payment in the beginning of the spell, making the amount of benefits independent of the duration of non-employment, provides better incentives to search for a job and to accept offers. In contrast, this policy is ex post *wasteful* on those who find jobs very fast.

Whether the insurance-incentive trade-off calls for a one time payment or for an unlimited duration depends on (i) the labour market institutions in the respective countries, and (ii) the generosity of means tested transfers, which any agent without wealth is entitled to collect. When the latter is sufficiently high, a one time payment at the beginning of the spell is optimal, because the transfer is a close substitute to constant UI and therefore provides enough insurance against long-term unemployment. When search is less effective and job arrival rates are low, unlimited duration of insurance payments may be more efficient.

In our numerical computations we exogenously impose that the replacement rate is time-constant throughout the duration of eligibility, as is currently the case in most countries of the Eurozone. Nevertheless, it is useful to relate our results to the mechanism design literature on optimal unemployment insurance, in which policy instruments are not restricted and instead optimal consumption allocations are governed solely by informational frictions. Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997) show in an environment without savings that consumption is optimally decreasing throughout the spell. Intuitively, the longer the non-employment spell, the more likely it is that the agent did not exert search effort throughout, a behaviour which is optimally punished by the planner. For the same reason, in our framework it is optimal to front-load all benefits to the beginning of the spell in most countries. The declining consumption profile then emanates from agents' optimal savings decisions.

Similarly, in an environment with savings, Shimer and Werning (2008) also find that consumption is optimally decreasing throughout the unemployment spell. However, contrary to our setting they show that such allocation can be implemented by a policy which offers an indefinite constant benefit throughout the (arbitrary long) spell. The difference comes from their assumption that unemployed agents are never liquidity constrained, and therefore able to consume more than their benefits in the beginning of the spell. By contrast, in our calibration a substantial share of households is liquidity constrained.[32]

[32] In a previous version of the paper, the absence of means tested social transfers led to a high amount of precautionary savings. As a consequence most households were not liquidity constrained upon separation and, within the restricted set of studied policies, an unlimited but low constant benefit was optimal,

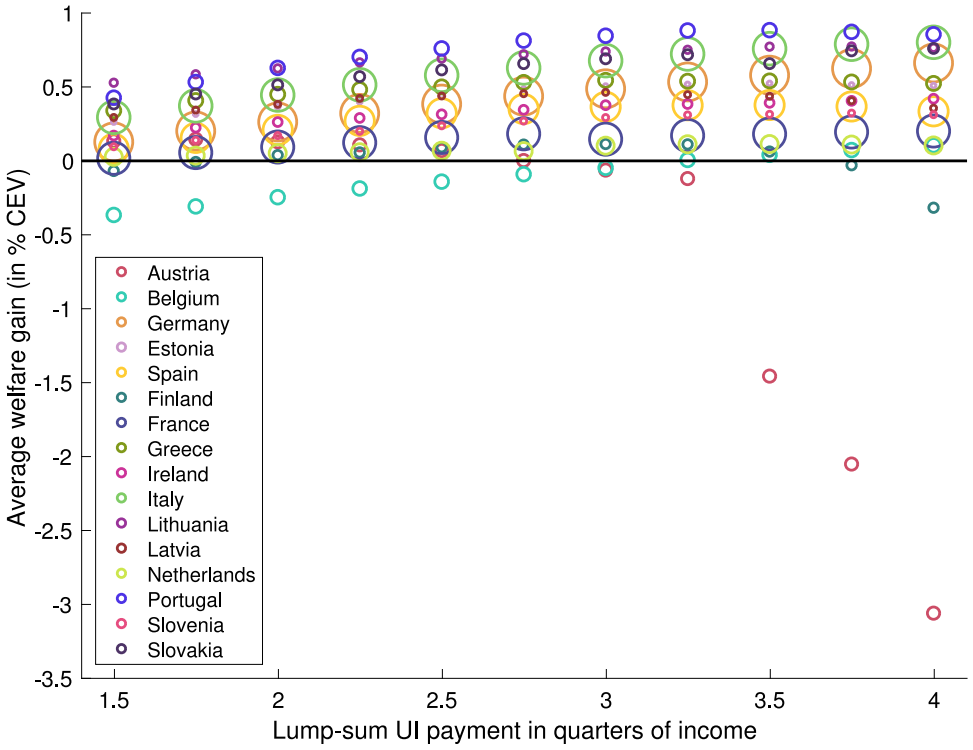

Fig. 14. Harmonized system. Moving from current UI systems to a one-time payment at the beginning of the unemployment spell; x-axis refers to the monetary equivalent of x quarters of income; welfare gains in percent of consumption equivalent variation on y-axis; circle sizes are proportional to countries' population sizes.

In sum, whenever the social costs of agents' search and job acceptance behaviour are very different from the private ones, e.g. when $\lambda_u \gg \lambda_n$ and $\gamma \gg 0$, or when $z \gg 0$, a one time payment at the beginning of the spell is optimal. In contrast, in some countries like Germany where the moral hazard problem of search is not so relevant, because $\lambda_u \approx \lambda_n$ and $\gamma \approx 0$, the insurance aspect is the more relevant one, calling for an indefinite duration.

Nevertheless, we find that for *all* countries there exists a replacement rate which, if payed only at the beginning of the non-employment spell, yields a welfare improvement relative to the status quo. The reasons are (i) that even in those (few) countries where an unlimited duration with low benefits is optimal, the welfare gains exhibit the described U-shaped behaviour in duration, and (ii) the overall generosity of the system is currently not optimal that is, fixing the current duration, the replacement rate should be much higher (Germany, Finland), or lower (Belgium).

5.2. An agreeable harmonized benefit scheme

Fig. 14 summarizes the results for all countries. It shows the average welfare gains in percent of consumption equivalent variation for reforms that change the system from the countries' status quo policies to a one time payment at the beginning of the spell. The x-axis indicates the magnitude of this payment, which we vary from 150% to 400% of quarterly income.

With none of the depicted policies do more than two countries experience aggregate welfare losses. With a replacement rate between 175% and 275% only Belgium has welfare losses, while with a replacement rate between 325% and 350% only Austria experiences a loss. At precisely 300% both countries are almost indifferent whether to introduce the reform or not, although they have (insignificant) welfare losses. However, it should be emphasized that we introduced this reform abruptly. In particular, we entitled not only the newly separated but the whole stock of initially non-employed eligible agents to this lump-sum payment, resulting in a substantial tax hike for the employed at time $t = 1$. We expect that if instead one introduced the reform in a gradual way, where only newly separated are entitled to the lump-sum payment, while the stock of originally eligible unemployed remains in the old system, also Austria and Belgium would experience gains from the reform. Furthermore, it should be emphasized that with higher lump-sum payments Austria, and eventually Finland, experience welfare losses merely because these are the countries with the most dynamic labour markets (see Fig. 5), in which a substantial share of agents gets separated, re-matched and separated

similarly to Shimer and Werning (2008). As shown in Section 3 the current calibration matches the fact that a substantial share of agents does not own any wealth.

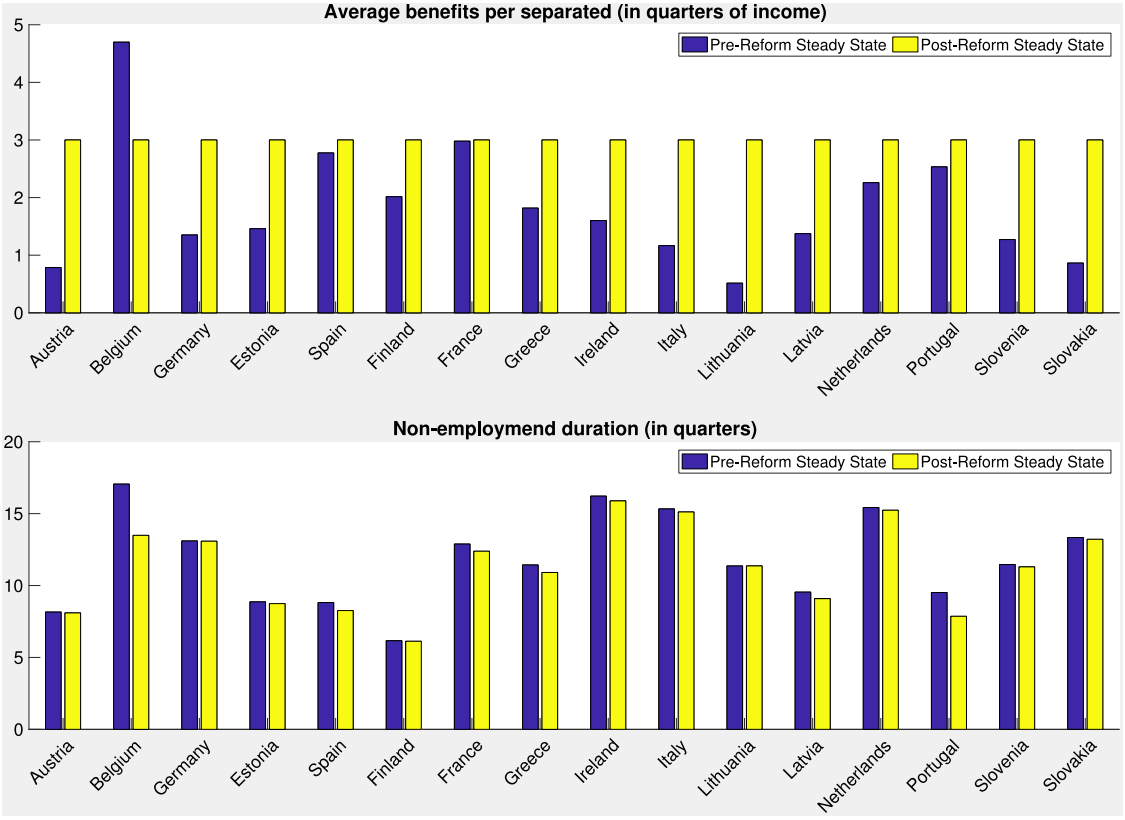

Fig. 15. Generosity of benefits and duration of unemployment. Upper panel: average unemployment benefits per separted worker; lower panel: average unemployment duration; blue columns refer to values in the steady state with current UI policies, yellow columns to the new steady state after the harmonized system (one time payment of three quarters of income upon separation) was introduced. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

again within short periods of time. Limiting the payout of the lump-sum transfer to at most once within a given pre-specified time (e.g. two years) would avoid frequent multiple payments to the same agents and yield significant welfare gains with a lump sum of three to four quarters of income also in these countries.[33] Similar qualification periods are part of the existing unemployment schemes in many countries.[34]

As mentioned before, the lump-sum payment has the disadvantage that some agents, who quickly find jobs, are overpaid by the government, which is costly. However, it has the advantage that the agents immediately have a higher incentive to search and accept job offers. The effects of front-loading UI have been empirically investigated recently by Lindner and Reizer (2020), who exploit a quasi-experiment emanating from a 2005 reform in Hungary. The authors show that although the front-loading of benefits resulted in a mechanical cost to the government, there were positive revenue effects of the associated behavioural responses, which in their case outweighed the mechanical costs. In particular, the reform significantly reduced the duration of non-employment and increased re-employment wages. In what follows, we show that similar effects are at work in our setting.

The upper panel of Fig. 15 depicts the overall generosity of the benefit system before and after the reform. In particular, it shows the amount of benefits (in quarters of income) a separated agent receives, on average. For the pre-reform calculations we take into account that non-employed agents may run out of benefits before they find a job or that they may find a job before eligibility ends. Post reform, each separated receives exactly 3 quarters of income since eligibility ends immediately. Using this definition of generosity, we observe that the new system is more generous in all countries but Belgium. Furthermore, the increase in generosity is substantial in all countries aside from France, and perhaps Spain, where the increase is moderate. Nevertheless, the front-loading of

[33] Numerically, a transitional introduction of the new system would require to introduce an additional state that indicates whether the agent was unemployed before the reform was introduced, while the prevention of paying out multiple times within two years to the same individual requires an additional state that indicates the number of quarters $\{1, 2, \ldots, 7, 8\}$ since the last payout. Both of this is relatively straightforward to implement but computationally quite heavy, which is the reason why we abstracted from studying such modifications.

[34] One further justification for such qualification periods is the concern that in reality generous and frequent layoff payments from the government may cause workers and their employers to collude and agree on repeated separations and recalls to take advantage of those. We do not explicitly model this type of moral hazard. However, aside from qualification periods the concern could be further mitigated by requiring the employers to contribute to the layoff payment.

Table 5
Long run changes. Numbers refer to changes in the new steady state after the harmonized system (one time payment of three quarters of income upon separation) was introduced, relative to the old steady state with current national UI policies.

Country	Change in ...			
	Employment rate (pp)	Productivity (%)	Average wage (%)	Tax rate (pp)
Austria	−0.16	−0.07	+0.16	+6.86
Belgium	+4.72	+2.58	−2.78	−1.08
Germany	+0.02	+0.02	+0.01	+2.28
Estonia	+0.14	+0.22	+0.32	+4.91
Spain	+1.29	+1.45	+1.10	+3.41
Finland	−0.07	−0.04	+0.04	+5.50
France	+0.50	+0.33	−0.11	+1.12
Greece	+0.97	+1.05	+0.68	+4.87
Ireland	+0.43	+0.49	+0.32	+3.82
Italy	+0.33	+0.32	+0.14	+4.63
Lithuania	−0.07	−0.11	−0.11	+6.33
Latvia	+0.74	+0.53	−0.16	+5.54
Netherlands	+0.16	+0.11	−0.04	+1.05
Portugal	+4.04	+4.98	+4.57	+3.64
Slovenia	+0.21	+0.15	−0.03	+2.49
Slovakia	+0.16	+0.07	−0.13	+4.53

benefits encourages search effort and job acceptances. In the lower panel we observe that the duration of non-employment decreases in every single country.

Table 5 summarizes the changes in employment, productivity, wages and taxes from the initial steady state to the post-reform steady state. In the last column we see that the tax rate increases in all countries but Belgium, reflecting the fact that only in Belgium is the overall generosity of benefits reduced.[35]

The positive effect of front-loading UI on search and acceptance behaviour impacts positively on the employment rate. Naturally, the increase is biggest in Belgium, where on top of front-loading also the reduction in the generosity incentivizes employment. However, also in Portugal employment rises by more than 4 percentage points despite an increase in generosity. In all but three countries, Austria, Finland, and Lithuania is the overall effect on employment positive. In these three countries the persistence in employment decreases. In particular, more of those separated agents, who are immediately matched with a new job, and before transitioned from job to job without receiving benefits, are now rejecting the new offer in order to receive the big lump-sum payment. In Austria and Finland the job arrival rates are high and therefore these agents can expect to be rematched quickly, while in Lithuania the increase in generosity is the highest among all countries. In any case, the negative impact on the employment rate in these three countries is small and overall employment in the Eurozone increases substantially.

We observe that productivity increases in all but the same three countries. The reason is that shorter non-employment spells imply a lower decline of human capital and therefore a more productive labour force. Furthermore, in all countries but Austria, Finland and Lithuania the wage change is smaller than the productivity change. The reason is that now more jobs, and more lower paying jobs in particular, are accepted. As also discussed in Lindner and Reizer (2020) the overall effect on wages is ambiguous, despite an increase in productivity. In Austria and Finland, by contrast, we observe the opposite. There wages increase, despite a fall in average productivity. The reason is that of those agents who are separated and immediately rematched, the ones who accept the new offer tend to have higher productivity than their peers, which has a positive effect on the average wage. With around 4.5%, the wage increase is highest in Portugal, which is why this country experiences the highest welfare gain. Overall wages in the Eurozone increase.

In sum, it seems possible to introduce a common European benefit system to which all countries could agree. If one would consider a more gradual introduction, in which initially non-employed remain in the old system, reducing the initial costs on the employed, it would increase welfare further.

The harmonized system resembles a severance payment system that exists in some European countries (e.g. Spain, Portugal or France) with two important differences. First, instead of a government provided provision, severance payments are imposed on employers in most countries. It is well-known that this type of firing costs creates adverse incentives for job creation and reduce endogenous separation rates (e.g. Ljungqvist, 2002). These effects are summarized (in a simplified way) in our country specific institutional parameters, λ_u^i, λ_n^i and σ^i. Second, there is lot of heterogeneity in the eligibility of these payments not only across but within countries depending on the type of contract, employment duration, sector, etc. For example, in Spain, employees on temporary contracts are not eligible for severance payments, although most of the flows into and out from unemployment are associated with this type of labour contracts. We have decided to abstract from this dimension of within- and between country heterogeneity to keep our model and calibration tractable. This implies that our welfare gains may be exaggerated for those individuals who are eligible

[35] This contrasts the empirical results in Lindner and Reizer (2020), who found that the Hungarian reform was self-financing. However, there the increase in overall generosity was very small (US$ 119 per unemployed), whereas our reform is much larger with expected benefits more than doubling in most of the countries. Furthermore, Lindner and Reizer (2020) do not account for the general equilibrium effect that agents, who are separated post-reform, receive on average higher wages and hence need to be paid higher benefits, which has a negative revenue impact.

for severance payments upon losing their job. We believe that studying further the insurance role of existing severance packages across Europe is a very valuable future research agenda.

Insurance for crises in the presence of the harmonized system

It is important to note that the harmonization of benefit schemes does not stand in the way of simultaneously implementing an insurance mechanism of the kind we discussed in Section 4. To the contrary, once the proposed harmonized system is in place, the welfare gains from inter-temporally smoothing fluctuations in unemployment expenditures tend to be even higher than the ones we found in Section 4 with the status-quo policies (see Appendix A.1 for details).[36]

Open vs. Closed capital markets

In the computations above we fixed the interest rate, that is we effectively assumed that the each country and the Eurozone as a whole is a small open economy, in which agents take the world interest as given. The alternative polar assumption would be to treat the Eurozone as a large closed economy, with the interest rate adjusting such that the capital market clears period by period at the European level. As it turns out, this alternative assumption does not have any important quantitative, let alone qualitative, effects. In particular, assuming an open economy results in a gradual increase of total European capital supply (savings) of 0.25% and an increase of total European capital demand of 0.95%. This implies that in the final steady state the excess demand for capital is only 0.7% of the initial capital stock. If instead we treat the Eurozone as a large closed economy, such small changes in the excess demand for capital have negligible effects on the equilibrium interest rate and hence on agents' optimal choices, the allocation and welfare. In particular, in Appendix A.2 we compute an *upper bound* for the interest rate increase that would be required to clear the capital market at the union level. We find that across steady states, the interest would increase by *at most* 3 basis points from 2.27% p.a. in the initial to 2.30% in the final steady state.

6. Conclusion

We develop a rich multi-country heterogeneous agent model, in which agents face all the relevant decisions that are typically affected by unemployment insurance policies. The model, which we calibrate to the Eurozone economies, successfully replicates several salient features of European labour markets, in particular the cross-country differences in the flows between employment, unemployment and inactivity. It thus allows for a credible welfare assessment of factual and counterfactual European unemployment insurance schemes.

We then evaluate an intertemporal insurance mechanism that closely resembles the Temporary Support to Mitigate Unemployment Risks is an Emergency (SURE), which the European Comission introduced in 2020 in response to the coronavirus outbreak, as a tool to alleviate budgetary pressure through the recessionary increase in unemployment expenditures. Contrary to the conventional classical view, which suggests that such automatic stabilizers should have little impact on welfare due to the low costs of business cycles (Lucas, 2003), our analysis of heterogeneous workers in an economy with labour market frictions finds significant benefits from such an instrument. Replicating the wealth distributions, in particular the fact that a substantial share of the population owns almost zero wealth, is crucial for this finding. Our analysis provides support for this European policy.

Finally, we consider an even more integrated counter-factual European unemployment insurance system that involves the harmonization of unemployment benefit policies. We find that despite the large heterogeneity in European labour market institutions, relative to the status quo, a harmonized policy that gives each separated agent a lump-sum payment of around three quarters of income, but no payments thereafter, would be welfare improving in all countries. Crucial for the efficacy of such a policy is the existence of means tested minimum income, which serves as an insurance of last resort for the very long term unemployed.[37]

Importantly, the European unemployment insurance systems we study are maintained without any cross-country transfers, which should facilitate the political process until their (potential) implementation. In fact, the implementation can start by making SURE a permanent facility for relatively large country shocks, maintaining country specific actuarially fair accounts.[38] Then if as our findings suggest there is agreement, the process of harmonization can start and workers can freely move across EU without losing their unemployment benefit claims. This way the augmented SURE would become a central element of EU social protection policy.

As any study, ours comes with some assumptions and simplifications, which future research may relax. For the risk-sharing experiment we assumed that the deep recession is unanticipated, but agents have perfect foresight regarding the full transition path towards the steady state after the shock hits. This is, for tractability reasons, the standard approach for studying large shocks in quantitative heterogeneous agent models such as ours. We believe that the unexpected nature of these shocks is consistent with the underlying characteristics of the two recent large disturbances Europe and the global economy experienced (the Great Recession and the COVID-19 pandemic).

[36] In the exercise, only one country, Austria, experiences a welfare loss. However, again also in Austria a gain can be achieved whenever the same agent gets the lump-sum payout at most once within a given pre-specified time.

[37] We have also considered a baseline economy without accounting for the minimum income transfer programs, and the resulting optimal EUIS in that economy features a low replacement rate and unlimited duration of benefits. The reason being that risk-averse unemployed workers prefer long duration of benefits if there is no other government transfer program to guarantee a minimum income level, during long unemployment spells.

[38] Beetsma et al. (2021)

Furthermore, while labour mobility is indeed limited across countries, we make the more stringent assumption that euro area labour markets are fully segmented. This is partially for practical (feasibility) reasons: the need of more granular data on employment flows not only within countries but also across countries. As far as we know, this data does not exist. Even if this data existed, the calibration of our model would require the introduction of pairwise stochastic migration costs making calibration and identification much harder. The quantification of insurance benefits in the presence of cross-country mobility would require to model the correlation structure of aggregate shocks. Historically, severe crises events were highly correlated, which leaves limited scope for migration to crowd out the risk sharing benefits of the EUIS. Regarding harmonization, introducing mobility and accounting for the implied easement in carrying of benefit entitlements across countries would potentially lead to even higher welfare gains.

We also assume that national labour market institutions do not change with the introduction of a EUIS. In reality, the resulting tax differences across countries, reflecting their structural labour market differences, in terms of job creation and destruction, may provide incentives for labour market reforms. Addressing these feedback effects would require to endogenize some of the parameters representing these institutions. We leave these interesting tasks for future research.

Data availability

Data will be made available on request.

Appendix

A.1. Smoothing unemployment expenditures when the harmonized system is in place

In this section we repeat the exercise performed in Section 4 with the difference that the welfare gains are computed around the steady state to which the economy converges if the harmonized system of Section 5.2 is introduced. That is, instead of the status quo benefit policies, newly separated agents immediately receive three quarters of their last income but no unemployment benefits thereafter. The results of this exercise are summarized in Table 6.

There are welfare gains in all countries but Austria, the reasons for which we discuss below. The gains tend to be even higher than under status-quo policies. Interestingly, the fraction of agents who would support their country joining such a fluctuations smoothing fund is slightly lower than for the case where the original benefit systems are in place. However, in every country but Austria more than two thirds of the population support such a scheme. Support in Portugal remains the lowest among all countries and is reduced from 72% to 67%. Again, the initially employed are the main beneficiaries and as before their level of support is above 93% in every singly country.

The welfare gains of non-employed eligible now are slightly lower than before. Since they were about zero before, this results in a substantial drop of the approval across this group. However, note that under the new benefit policies only newly separated agents are eligible, that is the share of eligible agents is much lower than before. Therefore, the large drop in the approval of eligible non-employed has a very limited effect on the overall approval. However, the gains for the non-eligible non-employed, that is all agents who are non-employed for longer than one quarter, slightly decline too, resulting in lower approval ratings among this group, which has a noticeable effect on the aggregate approval ratings.

The main reason why the employed experience higher gains than before is that now, absent a tax smoothing mechanism, the initial separation shock paired with the policy that all benefits are paid immediately upon separation causes a much larger cost to

Table 6
Welfare Gains from the EUIS. Columns 2-5 refer to different subgroups of the population; welfare gains in percent of consumption equivalent variation (share of agents supporting the reform in brackets); last column characterizes the change in the tax rate (relative to pre-shock steady state) required to clear government budgets inter-temporally.

Country	Employed	Eligible non-employed	Non-eligible non-employed	Whole population	Change in τ (in %)
Austria	−1.01 (0.3%)	−1.60 (0.0%)	−1.28 (0.0%)	−1.07 (0.2%)	2.55
Belgium	0.34 (98.3%)	−0.04 (10.4%)	−0.06 (8.2%)	0.27 (81.0%)	0.28
Germany	0.50 (98.0%)	−0.04 (13.7%)	−0.05 (12.0%)	0.41 (83.3%)	0.33
Estonia	0.29 (92.2%)	−0.11 (1.3%)	−0.11 (0.9%)	0.21 (72.9%)	0.32
Spain	0.59 (97.2%)	−0.08 (10.7%)	−0.11 (8.1%)	0.40 (72.6%)	0.45
Finland	0.48 (95.1%)	−0.09 (7.3%)	−0.11 (6.0%)	0.36 (75.9%)	0.47
France	0.32 (98.0%)	−0.02 (19.9%)	−0.05 (15.1%)	0.26 (84.1%)	0.23
Greece	0.71 (97.0%)	−0.10 (9.4%)	−0.13 (7.5%)	0.47 (71.8%)	0.52
Ireland	0.36 (98.0%)	−0.06 (7.1%)	−0.07 (4.5%)	0.24 (70.8%)	0.31
Italy	0.45 (98.5%)	−0.06 (8.5%)	−0.08 (6.7%)	0.30 (72.4%)	0.31
Lithuania	0.36 (96.2%)	−0.08 (3.9%)	−0.08 (2.6%)	0.26 (74.7%)	0.33
Latvia	0.46 (95.4%)	−0.08 (4.2%)	−0.08 (3.5%)	0.34 (74.0%)	0.38
Netherlands	0.35 (98.2%)	−0.01 (26.7%)	−0.04 (27.0%)	0.29 (87.0%)	0.22
Portugal	0.62 (94.5%)	−0.19 (1.5%)	−0.19 (1.6%)	0.38 (67.2%)	0.50
Slovenia	0.51 (97.9%)	−0.03 (27.2%)	−0.07 (26.9%)	0.43 (87.1%)	0.35
Slovakia	0.47 (98.2%)	−0.06 (7.4%)	−0.07 (6.9%)	0.35 (77.2%)	0.34

Table 7
Long run changes in supply and demand of capital. Numbers refer to changes in the new steady state after the harmonized system (one time payment of three quarters of income upon separation) was introduced, relative to the old steady state with current national UI policies.

Country	Change in ...	
	Savings (%)	Capital (%)
Austria	−2.53	−0.06
Belgium	+9.67	+3.30
Germany	−2.95	+0.03
Estonia	−0.20	+0.50
Spain	+5.57	+2.93
Finland	+1.08	−0.05
France	+2.87	+0.49
Greece	+2.87	+2.07
Ireland	−0.61	+0.94
Italy	−2.24	+0.60
Lithuania	−3.39	−0.20
Latvia	−7.58	+0.82
Netherlands	−0.51	+0.16
Portugal	+14.35	+11.03
Slovenia	−3.91	+0.22
Slovakia	−4.14	+0.08
Eurozone	+0.25	+0.95

the initially employed. By contrast, initially non-employed, or newly separated agents, are better off in a balanced budget transition because they do not directly benefit from the tax smoothing and in expectations they will find a job only when the taxes under the EUIS are higher than in balanced budget. Only in Belgium the gain to the employed is the same as before. The reason is that there the mentioned effect is offset by the fact that in Belgium the overall generosity of the system is reduced, which leads to a lower cost increase in crises times.

Now, why does Austria experience welfare losses? The reason again has to do with the fact that Austria, along with Finland, has the most dynamic labour market, in which a substantial share of agents gets separated, re-matched and again separated within a short period of time (Fig. 5). As discussed in Section 5.2 this implies that a substantial share of agents receives the big lump-sum payment multiple times within a short period of time. However, as also discussed in the main text, this can be solved by paying out the lump-sum at most once every two years, for example. The policy studied in this section reduces recessionary taxes and thus incentivizes search and job acceptance precisely in times when job-separations are high. While this amplifies the problem when having to payout the lump-sum each time an agent loses his/her job, the solution is again to only pay it out the first time unless a sufficient amount of time since the last payout has passed.

Interestingly, Finland, despite having a similarly dynamic labour market as Austria, does not experience the same problem. The reason for the difference is that in contrast to Austria, the job-arrival rate for non-searchers in Finland is virtually the same as for searchers (see Fig. 4). Consequently, the policy studied in the present section does not change search incentives and thus does not result in a significantly higher turn-over of agents that causes the problem in Austria.

In sum, while total approval ratings for the introduction of a tax-smoothing mechanism are slightly reduced relative to the situation where the current benefits are in place, a vast majority of European households remains in favour. Furthermore, the aggregate welfare gains are higher than before. These gains are concentrated among the initially employed, while the initially non-employed experience very small welfare losses.

A.2. Changes in capital supply and demand

The Eurozone is neither a small open nor a large closed economy. While in reality, the capital market does not exactly clear at the European level, it is a large enough player to potentially affect world interest rates. We performed several robustness checks on the assumption that the interest rate is fixed. As it turned out, even the extreme polar assumption, according to which the capital market exactly clears at the Eurozone level does not significantly affect any of our results. In this section we show how.

Table 7 shows the changes in capital supply and demand after the harmonized reform of Section 5.2 is introduced (assuming a fixed interest rate). The reform is large, as the unemployment benefit system in terms of replacement rate and duration changes substantially in all countries. Nevertheless, the responses in capital supply and demand are very small. Assuming a constant interest rate, any change in effective labour supply is absorbed one for one by an equal change in the demand for capital, that is the capital-labour ratio is fixed due to the first order condition of the firm. However, in the present context this leads to an overall long-run increase in the demand for capital of only 0.95%. Moreover, at the same time total European savings increase by 0.25%, implying that under the open economy assumption European firms only need to borrow 0.7% of the initial capital stock from the rest of the world.

Looking at it differently, under the closed economy assumption, the required increase in the interest rate to maintain European capital market clearing is minuscule. Specifically, from the first order condition of the firm, we know that the elasticity of capital demand with respect to the cost of capital is given by

$$\frac{\partial \ln(K)}{\partial \ln(r+\delta)} = \frac{1}{\theta - 1} = \frac{1}{0.3 - 1} = -1.43.$$

Conservatively assuming that the supply of capital is completely inelastic to changes in the interest rate, the cost-of capital, $r + \delta$, would therefore need to increase by less than half a percent such that the firms' excess supply of capital, that is 0.7% of the initial capital stock, vanishes. With an assumed annual depreciation rate of 4%, this implies an insignificantly small increase in the annual interest rate from 2.27% in the original steady state to 2.30% in the final steady state. In none of our computations did such a small change have a significant effect.

Appendix B. Supplementary data

Supplementary material related to this article – in particular the Codes corresponding to Sections 3, 4 and 5 – can be found online at https://doi.org/10.1016/j.euroecorev.2023.104469.

References

Ábrahám, Á., Carceles-Poveda, E., Liu, Y., Marimon, R., 2021. On the Optimal Design of a Financial Stability Fund. Working Paper, European University Institute, Florence.

Beblavy, M., Lenaerts, K., 2017. Feasibility and Added Value of a European Unemployment Benefits Scheme. CEPS Special Report.

Beetsma, R., Cimadono, J., van Spronsen, J., 2021. One Scheme Fits All: A Central Fiscal Capacity for EMU Targeting Eurozone, National and Regional Shocks. Working paper, University of Amsterdam.

Burdett, K., Carrillo-Tudela, C., Coles, M., 2020. The cost of job loss. Rev. Econom. Stud. 87 (4), 1757–1798.

Cimadono, J., Ciminelli, G., Furtuna, O., Giuliodori, M., 2020. Private and public risk-sharing in the euro area. Eur. Econ. Rev. 121 (100).

Claveres, G., Clemens, M., 2017. Unemployment Insurance Union. Working Paper, German Institute for Economic Research (DIW).

Dolls, M., Fuest, C., Neumann, D., Peichl, A., 2018. An unemployment insurance scheme for the euro area? A comparison of different alternatives using micro data. Int. Tax Public Finance 25 (1), 273–309.

Dubois, H., Ludwinek, A., 2015. AcceSs to Social Benefits: Reducing non-take-up. Technical report, Publications Office of the European Union, Luxembourg.

Enders, Z., Vespermann, D.A., 2021. Cross-country unemployment insurance, transfers, and trade-offs in internationa risk-sharing. Working paper, Heidelberg Univeristy.

Esser, I., Ferrarini, T., Nelson, K., Palme, J., Sjöberg, O., 2013. Unemployment Benefits in EU Member States. Technical report, Directorate-General for Employment, Social Affairs and Inclusion, EC.

European Fiscal Board, 2018. Assesment of the Fiscal Stance Appropriate for the Euro Area in 2019. EFB. Brussels.

Ferrari, A., Rogantini, A., 2021. Risk Sharing and the Adoption of the Euro. Working paper, University of Zurich.

Frazer, H., Marlier, E., 2016. Minimum Income Schemes in Europe. A study of national policies. European Commission, Directorate-General for Employment. Technical report, Directorate-General for Employment, Social Affairs and Inclusion, EC..

Furceri, D., Zdienicka, A., 2015. The euro area crisis: Need for a supranational. Open Econ. Rev. 26 (4), 637–710.

Hopenhayn, H., Nicolini, J.P., 1997. Optimal unemployment insurance. J. Polit. Econ. 105 (2), 412–438.

Ignaszak, M., Jung, P., Kuester, K., 2018. Federal Unemployment Insurance: Theory, and an Application to Europe. Working Paper, Technical University of Dortmund.

Juncker, J.C., Tusk, D., Dijsselbloem, J., Fraghi, M., 2015. Completing Europe's Economic and European Union. Technical report, European Council. Brussels.

Kindermann, F., Kohls, S., 2018. Rental Markets and Wealth Inequality Across Europe. Working paper, Northwestern University.

Kolsrud, J., Landais, C., Nilsson, P., Spinnewijn, J., 2018. The optimal timing of unemployment benefits: Theory and evidence from Sweden. Amer. Econ. Rev. 108 (4–5), 985–1033.

Krusell, P., Mukoyama, T., Rogerson, R., Şahin, A., 2011. A three state model of worker flows in general equilibrium. J. Econom. Theory 146, 1107–1133.

Krusell, P., Mukoyama, T., Rogerson, R., Şahin, A., 2017. Gross worker flows over the business cycle. Amer. Econ. Rev. 107 (11), 3447–3476.

Lalé, E., Tarasonis, L., 2017. The Life-cycle Profile of Worker Flows in Europe. Working Paper.

Lindner, A., Reizer, B., 2020. Front-loading the unemployment benfit: An empirical assessment. Am. Econ. J. Appl. Econ. 12 (3), 140–174.

Ljungqvist, L., 2002. How do layoff costs affect employment? Econom. J. 112, 829–853.

Lucas, R., 2003. Macroeconomic priorities. Amer. Econ. Rev. 93 (1), 1–14.

Moyen, S., Stähler, N., Winkler, F., 2019. Optimal unemployment insurance and international risk sharing. Eur. Econ. Rev. 115, 144–177.

Müller, A., Storesletten, K., Zilibotti, F., 2019. Sovereign debt and structural reforms. Amer. Econ. Rev. 109 (12), 4220–4259.

Pennings, S., 2021. Cross-region transfer multipliers in a monetary union: Evidence from social security and stimulus payments. Amer. Econ. Rev. 111 (5), 1689–1719.

Piketty, T., Zucman, G., 2014. Capital is back: Wealth-income ratios in rich countries 1700–2010 *. Q. J. Econ. 129 (3), 1255–1310.

Rompuy, H.V., Barroso, J., Juncker, J., Draghi, M., 2012. Towards a genuine economic and monetary union. Technical report, European Council. Brussels.

Shavell, S., Weiss, l., 1979. The optimal payment of unemployment insurance benefits over time. J. Polit. Econ. 87 (6), 1347–1362.

Shimer, R., Werning, I., 2008. Liquidity and insurance for the unemployed. Amer. Econ. Rev. 5 (98), 1922–1942.

Stepner, M., 2019. The Insurance Value of Redistributive Taxes and Transfers. Working paper, M.I.T..

Ziomas, D., Antoinetta, C., Danai, K., 2017. The National Roll-Out of the "Social Solidarity Income" Scheme in Greece. Technical report, European Social Policy Network.